U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION NINE

WILD LIFE HANDBOOK

NORTH CENTRAL REGION

R.A.W.

CORRECTIONS FOR WILDLIFE HANDBOOK

Page	Correction
18	2 - e - 6 - Change "Illogal" to"Illegal"
24	Place a dash before the -34 in the symbol "Plantings of Animals." Lower number indicates the year planted.
2 5	Change G-SI "Stream Improvement" to G-SL "Stream Improvement"
25	Place following legend under Bird House legend:  - Feeding Station
27	"Gadwall" for "Gadwell"
38	Under "Boundary Lines" change the third sentence to read "A line should be cleared around a refuge 6 to 8 feet wide" in place of " A line should be cleared around a refuge the width of a truck trail fire line (twenty four feet.)"
40	Change the last sentence under objective to "A brief description of these lakes and stream classes is given in the appendix."
56	Eighth line from bottom "Several" for "Severql" Seventh line from bottom "while" for "white"
60	Last column should read "divide number of pounds to date by number of hours to date to get this figure."
64a	Cross out title at top of page.
76	Par. 5, third line "larvae" for "larvaes"
76	Par. 7, last line "Diptera" for "Dipters"
129	Place"G. Fish and Game, Form 140 R-9" at top of this sheet.
130	Last line "comprise" for "comprose".
131	"Merganser" for "Morganser"
223	Direction indicators ^ should appear only on the center line of the aerial survey travel routes.

APPENDIX

22	In column under "Animal Predominants", "Simulium" and "Gammarus" begin with capital letters.

G
Fish & Game, R-9

CORRECTION FOR WILDLIFE HANDBOOK

Page	Correction
228	Add the following directions to page 228;

Directions for calculating grouse Population.

$$P(\text{Total population for area censused}) = \frac{A(\text{Total area in Sq. Yds. of census area})}{X(\text{Total lineal yards of distance})} \cdot \frac{Z(\text{Total No. grouse seen on strips})}{Y(\text{Twice avge. flushing dist. in yards})}$$

EXAMPLE

A = 4 sections or contains 12,390,400 square yards
X = 32 miles of line = 56320 yards
Y = 19.2 X 2 = 38.4
Z = 33 grouse on total lines

$$P = \frac{12{,}390{,}400 \times 33}{56320 \times 38.4} = \frac{408833200}{21{,}626{,}880}$$

P = 189.0 grouse on 2560 acres
or
47.2 grouse per section

FOREWORD

Wild Life is one of the major resources of the National Forests of Region Nine. This Handbook outlines the policies, objectives, and instructions governing wild life management in the Region. The instructions in the Handbook will control until changes are approved by the Regional Forester.

In the management of National Forest lands, the production of Wild Life will be correlated with the production of other resources and its importance will be recognized regardless of whether or not there is a direct monetary return to the Federal Government. All Forest Officers in executive positions in the Region should familiarize themselves with the Wild Life Handbook and it will be expected that wild life management plans will be prepared and put into effect as rapidly as practicable.

Since this is an initial effort, constructive criticism and suggestions from the field are invited.

C. M. Granger

Regional Forester.

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OBJECTIVE AND POLICY

Objective

To recognize the recreational, economic, aesthetic and educational values of wildlife and to produce and utilize on a sustained yield basis the maximum number of wild animals which are compatible with social needs and within the productive capacity of the Forest.

1. Differences in Ecological and Physiological Requirements of Animals

Differences in ecological and physiological requirements of animals make it necessary to give only general plans and policies in this handbook. These general directions are therefore not expected to fulfill in detail the needs for managing every species of animal in all National Forests of this Region.

Every species bears different relationships to its environment and also has different physiological requirements. Likewise, each Forest may differ widely as to soil, water and vegetation from every other Forest and so offers a variety of conditions under which animals live. Thus the activity of the same animal will vary in each different locality, and the carrying capacity of each Forest will be different.

11. Correlation of Wildlife Administration with Federal and State Agencies

A. Biological Survey

THIS AGREEMENT, entered into the 4th day of January, 1935, by and between the Chief, Biological Survey, and the Forester, Forest Service, for the purpose of outlining the responsibilities and functions of each agency, and encouraging a maximum degree of cooperation, provides as follows:

1. Mutual recognition that:

   (a) The Biological Survey is the recognized bureau of the Federal Government directly charged with the responsibility for conducting research necessary to lay the foundation for wildlife management throughout the country.

   (b) The Forest Service is the recognized bureau of the Federal Government directly charged with the responsibility for the administration of the National Forests and for the management of National Forest resources, of which wildlife is one.

2. The general functions of the two agencies under this agreement will be as follows:

   (a) On lands under the control of the Forest Service, the Biological Survey will conduct fundamental

research to determine principles upon which wildlife management plans will be based and will act in an advisory capacity in the carrying out of such plans and principles. On National Forest land the responsibility and authority for correlation and integration of wildlife management with recreation, timber production, grazing and other uses of the Forest, will rest at all times with the Forest Service.

(b) On lands under the control of the Biological Survey, the Forest Service will conduct fundamental research to determine principles upon which timber and grazing management plans will be based, and will act in an advisory capacity in the carrying out of such plans and principles. On lands under the control of the Biological Survey, the responsibility and authority for correlation and integration of timber and grazing management with recreation, game and other uses will rest at all times with the Biological Survey.

(c) In the event the available resources of either bureau are not sufficient to meet the research demands of the other bureau, that bureau, within the limitation of its resources, will proceed with the study of specific problems, collection of all factual information possible, and preparation of the plans. Such plans will be submitted to the other bureau for review and comment before application.

3. Other general considerations agreed upon are:

(a) In the perfection and consummation of wildlife management plans, the two bureaus will cooperate to the fullest extent possible, and to this end there must be a free exchange of all pertinent data and frank discussion between members of the two bureaus.

(b) All questions pertaining to the cooperative work of the two bureaus which arise in the field will be discussed on the ground by the leaders of the Biological Survey and the responsible Forest officer. Questions of disagreement will be referred to the Washington offices of the two bureaus for decision.

(c) Members of both bureaus will refrain from expressing in public a view contrary to the accepted policy or plans of the other bureau.

(d) In so far as possible, the National Forest personnel will, in connection with its regular duties, make observations concerning life histories, numbers and other pertinent data essential to wildlife management and administration.

(e) To the fullest extent possible consistent with other work, the Forest Service will contribute time, equipment and improvements, and will aid in securing the cooperation of outside agencies in furthering the rodent and predatory animal control

projects of the Biological Survey.

(f) No predatory animal or rodent control measure will be undertaken on National Forest land without the joint approval of both bureaus.

(g) No game importations, involving the introduction of a new species, will be undertaken by the Forest Service without first securing approval of the Biological Survey. In such cases the Biological Survey will, unless the information is already available, make a detailed ecological study of the habits and habitat of the species at home, with special reference to the conditions it will encounter in the new location.

4. This agreement shall continue in force and effect until terminated by written notice by either bureau to the other.

Approved by the Biological Survey on the day and date first above written, and by the Forest Service this 4th day of January, 1935.

The U. S. Biological Survey,
By J. N. Darling, Chief,
The U. S. Forest Service,
By F. A. Silcox, Forester.

B. Bureau of Fisheries

THIS AGREEMENT, entered into the 18 day of March 1935, by and between the Commissioner, Bureau of Fisheries, and the Forester, Forest Service, for the purpose of outlining the functions and responsibilities of each agency in a cooperative program for maximum utilization of the fishery resources of the National Forests, provides for:

1. Mutual recognition that:

(a) The Bureau of Fisheries is the recognized bureau of the Federal Government directly charged with the responsibility for conducting research necessary to lay the foundation for fishery management throughout the country.

(b) The Forest Service is the recognized bureau of the Federal Government directly charged with the responsibility for the administration of the National Forests, and for the management of national-forest resources, including the fish life and lakes and streams.

2. Adoption of a national-forest stream and lake program consisting of:

(a) Surveys at needed intervals to determine the physical, chemical, and biological conditions of all important waters.

(b) Investigation of problems which require solution in order to fully utilize the results of surveys.

(c) Installation of structural devices and introduction of fish food species, where necessary and feasible, in order to create and maintain conditions more favorable to the survival, growth, and reproduction of fish life.

(d) Development and application of a comprehensive and scientific program for rearing and planting fish.

(e) Regulation of angling(through cooperative endeavor with the States or otherwise) in such a manner as to assure the greatest possible benefits from the improvement and stocking of waters.

3. The general function of each agency, within the limitation of its resources, as follows:

(a) The Bureau of Fisheries will conduct stream and lake surveys and related investigations to determine principles upon which fishery management will be based, and will act in an advisory capacity in the carrying out of such principles.

(b) The Bureau of Fisheries will provide the fish required thru rearing to the desired size in its own hatcheries or in rearing ponds constructed by the Forest Service; develop a planting and distribution plan for each Forest and furnish the Forest Service with instructions for handling the planting work.

(c) The Bureau of Fisheries will continue to operate fish hatcheries and expand such operations where necessary.

(d) The Bureau of Fisheries will conduct all feeding operations except that Forest officers may care for fish held temporarily in isolated holding pools.

(e) The Bureau of Fisheries will locate, develop specifications for, and supervise the construction of, all rearing ponds and holding pools.

(f) The Forest Service, with the technical advice of the Bureau of Fisheries, will undertake the construction of all necessary stream and lake improvements.

(g) The Forest Service will handle all planting work under instructions and recommendations provided by the Bureau of Fisheries.

(h) The Forest Service will assume responsibility for the administration and operation of management plans and will retain fulllauthority for the correlation and integration of such plans with recreation, timber production, grazing and other uses.

4. Other general consideration as follows:

(a) There will be a free exchange of all pertinent data and frank discussion between members of the two bureaus.

(b) All questions pertaining to the cooperative work which arise in the field will be discussed on the ground by the responsible representative of each bureau. Questions of disagreement will be referred to the Washington offices of the two bureaus.

(c) Members of both bureaus will refrain from expressing in public a view contrary to the accepted policy or plans of the other bureau.
(d) No fish importations, involving the introduction of new or exotic species, will be undertaken by the Forest Service without first securing the approval of the Bureau of Fisheries.
(e) No cooperative arrangements with States or other agencies, involving work on the National Forests, will be made by the Bureau of Fisheries without first securing the approval of the Forest Service.

5. This agreement shall continue in force and effect until terminated by written notice by either bureau to the other.

Approved by the Forest Service this 1st day of March,1935, and by the Bureau of Fisheries on the day and date first above written.

The U. S. Bureau of Fisheries

By Frank T. Bell, Commissioner

The U. S. Forest Service

By F. A. Silcox, Forester.

C. State Conservation Departments

The administration of fish and game will be carried on in cooperation with the State Conservation bodies. Such cooperation will involve the combined efforts of the Forest Service and the State Conservation Commissioner in regulating fishing, hunting and trapping on a sustained yield basis or of furnishing information on which laws can be based for the attainment of this objective. Data on yields, disease and hunting conditions shall be provided to these bodies. Forest officers will at all times assist the State in reducing law violations. Requisition for fish from State hatcheries or State rearing ponds will be made on September 1st. of each year thru the Regional Forester to the Conservation Departments.

D. State Colleges and Universities

Where special investigations in wildlife management are needed and cannot be fulfilled by proper governmental agencies, it may be possible for the Forest Service to enter into agreements with the appropriate officers of State Universities or colleges of the respective states for such research, and the Forest Service may provide men and equipment if such arrangements receive the sanction of the Forester and are not in conflict with other agreements

already in effect.

III. The Place of Wildlife Developement in National Forest Management

The great economic and social values of wildlife in the National Forests demand that attention be given this resource in proportion to its desirability and need.

The degree of desirability and importance will be shown by the public demand, as indicated by the use of wildlife resources. Animal resources in inaccessible areas or far from centers of population are used but slightly by the public and will need little or no attention in comparison with forest areas near centers of population where demands for animal products are intense. In the latter locations the priority of wildlife activities will be high.

Classification of areas as related to other forest uses are:

A. Dominate -

Areas which will govern the supply of wildlife needed to meet the heavy present or prospective demand of the public where there may be high potential qualities for desired wildlife production. Streams or parts of streams with cold feeder springs and wintering swamps for deer, winter feeding areas for various species, refuges for caribou, moose etc. are examples of dominate areas. In such areas no other form of occupancy or utilization, which impairs its potential wildlife producing abilities, will be allowed.

B. Coordinate -

Areas which will govern the supply of wildlife needed to meet a smaller demand, where the potential qualities for wildlife production are of minor importance, and in which the use will not conflict to an unjustifiable degree with other major uses of the Forest so as to entail unwarranted sacrifices to other economic or public interests, but will be regarded as a major service and will be provided for in coordination with other uses.

C. Subordinate -

Areas where present of prospective wildlife is and probably will be small or where wildlife potentialities are low and where management procedures for wildlife would conflict unjustifiably with other more important functions of the Forest or result in a sacrifice to other economic or public interests. Wildlife procedure on such areas will not be provided for or may be entirely ignored.

IV. Priority in the Management of Species

A. Animals that are in danger of extinction will have priority on restricted ranges over all other wildlife resources.

B. Where two species of animals of equal importance are competing for the same range, the one having the most exacting life requirements will have preference over one with greater tolerance as to life conditions.

C. Management procedures for species other than included under A and B will be on the basis of the demand as indicated by the greatest good to the greatest numbers. In general, the laws which govern priority of species will be on the following basis:

1. Total value of animal resource rather than individual value.
2. Needs of local people will have priority over the needs of equal numbers of visitors. Social value shall have priority over economic values.
3. Restocking, which concerns the use of a species native to a particular area as against the use of a non-native species of equal value will, in all cases, be decided in favor of the native species.

V. Priority of Wildlife Activities in Point of Time

Wildlife procedure is seasonal in nature. Therefore, the following rules will be observed in determining the priority of jobs as to time of operation:

A. Jobs that are seasonal will be given priority over all-season jobs.
B. Jobs restricted to limited periods of a few days will be given priority over all-season jobs.
C. Jobs depending on certain weather conditions will be given priority over longer period jobs.
D. Jobs in which the success or failure depends on exact daily timing or on changing animal conditions which will make the results void if done at other than a certain time will be given priority over all other operations.

VI. Developement of Wildlife Resources

The aim of the developement of wildlife resources on the National Forests will be to produce and maintain a capital stock compatible with the carrying capacity of the Forest and other Forest uses.

A. Refuges

Refuges are areas established for the purpose of maintaining reservoirs of various species of wildlife. The pressure from the natural increase will be sufficient to cause an overflow from the refuge, thereby furnishing a surplus for surrounding public hunting and fishing grounds. Refuges for all but migratory waterfowl should be established under such conditions that they can be discontinued when sustained yield management has been accomplished. Migratory bird refuges, however, must be established as permanent sanctuary areas.

B. Rearing Ponds for Trout and Pondfish

Sufficient rearing ponds for trout and various pond-

fishes should be established and constructed so as to adequately stock the lakes and streams within the National Forests.

C. Juxtaposition

The proper dispersion of food, cover, water and breeding areas shall be established and maintained with reference to the various species of wildlife being managed compatible with other forest uses and the public demand for both wood and wildlife products.

D. Winter Feeding

Wherever possible, the Forest Service will plant self-sustaining perennial winter foods. Where trees, shrubs and plants are not capable of sustaining a sufficient population to supply the public demand for a given species, consideration should be given to the planting of annual food patches.

Artificial feeding stations will be resorted to only under extraordinary conditions and then only thru the cooperation and assistance of local sportsmen.

E. Restocking

Stocking of native or exotic species shall be resorted to only when the numbers of suitable game animals within an area is insufficient , and only after it has been established that the area is capable of sustaining the animals and that they will receive adequate protection.

F. Diagnosis of Mortality Factors.

The Forest Service shall at all times attempt to diagnose the factors which cause mortality among wildlife populations.

VII. Control of Volume of Wildlife Resources

Adequate control measures must be enforced so that no species of wildlife becomes over-abundant or unduly depleted.

A. Measurement of the stocking and the annual increment of wildlife resources is important to proper control of volume.

B. Recommendation for hunting and fishing seasons will be based on the amount of the annual increment, and regulated by cooperative agreements with the respective State Conservation Departments and Federal Departments having jurisdiction over wildlife.

C. Bag and creel limits shall be determined by annual increment measurements and regulated by cooperative agreements with the various State and Federal wildlife agencies.

C. Cooperative hunting shall be attempted in order to determine the annual "take" of wildlife in respect to its abundance and location, and to educate the public to the advisability of a limited license system.

E. A limited license system should be encouraged, to properly utilize the annual increment.

F. Catching living wild animals will sometimes be necessary to alleviate over-population and to restock barren areas.

G. In case adequate control of wildlife on a sustained yield basis cannot be obtained through cooperation with the respective State Departments, other means must be sought.

PRINCIPLES OF WILDLIFE MANAGEMENT

"Wildlife Management" as referred to in the Wildlife handbook is the art of making land produce sustained annual yields of wildlife for recreational use."°

Wildlife production depends on a variety of conditions including soil, climate, vegetation and the activities of other animals. All of these conditions vary with each particular area so that plans for management must be made with a specific location in mind. There are, however, certain fundamental steps which apply to all areas. These steps have been outlined by R. T. King °° as follows:

a. Inventory (Reconnoissance)
b. Census
c. Yield
d. Diagnosis
e. Control

An explanation of these items follows:

a. Inventory (Reconnoissance) An inventory attempts to determine what species of animals and plants are present.
b. Census - The census attempts to determine the number of animals present on a unit of area.
c. Yield - Yield or productivity indicates the rate at which breeding animals produce a removable crop. This may be expressed as animals per unit or percent of the breeding stock.
d. Diagnosis - Diagnosis is the process of discovering the limiting factors which are working against high production of animals. Lack of food, lack of breeding grounds and over utilization are examples of limiting factors.
e. Control - Control is the process of removing one of more limiting factors with a resulting higher increment of animals for use by man.

°Aldo Leopold - Game Management 1933
°°R. T. King, Major Consideration of a Wildlife Policy. Proceedings Regional Wildlife Conference, Milwaukee, Wisconsin, 1934.

GENERAL INSTRUCTIONS FOR WILDLIFE

MANAGEMENT PLANS

The wildlife management plans for the National Forests of Region Nine will consist of:

Regional Plans
Forest Plans
Unit Plans
Sub-Unit Plans

Although all forms of wildlife will be considered, written plans will be made for only those animals important for fishing, hunting, trapping, education and recreation or as foods for other animals.

Regional Plans

The regional forester will devise plans for the management of wildlife resources which will set the general objective and policies for the region and will be based on scientific knowledge and accurate data which will serve as a guide and standard for work to be accomplished in the Forests.

The plans will be built with the demands of the public in mind and in harmony with the latest discoveries brought out in conjunction with land use planning.

The Regional plan will consist of a Regional Wildlife Handbook augmented by reports, maps, atlases and statistics. The purpose of these reports, atlases, etc., will be to guide the program along such channels as to accomplish the aim as set up in the objectives.

The Forest Plan

The Forest will be considered the working circle for wildlife management and the work area within the Forest will be the Unit.

The Unit will consist of all contiguous areas which possess similar physiographic and biological characteristics.

The sub-Unit will consist of each species of animal to be managed in each Unit.

The Forest plan will be prepared on letter-size sheets by the Forest Supervisor and sent to the Regional Forester for approval. Approval by the Regional Forester denotes the adoption of the plan. The Supervisor will then place the parts of the plan on maps and atlas-size sheets which will be known as the Wildlife Plan for the Forest.

There follows an outline and explanation of the Forest Plan, Unit Plan and Sub-Unit Plan:

1. Forest Plan
   - Index Maps
     - A. Resource Map
     - B. Development Map
   - Atlas Binder 18" X 21"
     - A. Wildlife Key (Table of Contents)
     - B. General Objectives and Policy statement
     - C. History and Present Status of Wildlife in the Forest
     - D. Economic Trends
     - E. Meteorological Conditions
     - F. Geological and Soil-Classification and Conditions.
     - G. Ownership Status
     - H. Statistical Information
     - I. Boundaries of Units

2. Unit Plans
   - Index Maps
     - A. Resource Maps
     - B. Development Maps
   - Atlas Binder
     - A. Wildlife Key (Table of Contents)
     - B. General Objectives and Policies
     - C. Ownership
     - D. Cover type Classification
     - E. Summary of Statistical Information
     - F. Reconnoissance of Wildlife

3. Sub-Unit Plans
   - A. History and present status of each species
   - B. Importance in the Community
   - C. Life History
   - D. Specific objective and Policies
   - E. Summary of Management Procedures and results
     1. Determination of the Present Stocking and the annual increment.
     2. Determination of and recommendations of removal of limiting factors.
     3. Recommendations or Utilization
   - F. Summary of General Conditions

1. Forest Plan

Index Maps

These maps will be on a scale of 1/2" or 1" to the mile, and mounted on standard wing map holders. Wildlife resources and developments will be indicated by symbols given in the Wildlife legend. Different classes of animals will be differentiated by colors and different species by numbers.

Until better methods are developed for determining true conditions of stocking, general terms such as "good fishing," etc., will have to be used.

The maps will contain the following items:

A. Resource Map

1. Lakes and streams affording good fishing. Indicate species by number (Legend).
2. Rearing ponds established for trout or pondfishes. Indicate location by legend.
3. Areas of good hunting. Use numbers to indicate species and place one figure of legend in each township considered. Place a number under the good hunting legend to indicate species hunted.
4. Areas of heaviest hunting. One figure of legend in each township of most heavily hunted territory. (Indicate species of animals hunted by numbers.)
5. Ranges of important species of birds and mammals. If the range of an individual species occupies the entire Forest Unit, indicate it on the map margin, but if either the summer or winter range is restricted to a part of the Forest this range should be indicated according to the legend. Game ranges should be revised each year as new information is available and the time of the change should be indicated by the year (1934, etc.,) When the map becomes confused with many new revisions, use a new map.
6. Refuges of all kinds - Federal, State or private- which are already established. Include date of establishment. (Legend-Maps.)
7. Hatcheries - Federal, State, Private (legend.)
8. Game or fur farms. Federal, State of Private.

B. Development Map

1. Areas to be restocked with fish, birds or mammals (legend.) Show the species by number in the upper half of the legend. When restocking is accomplished place date in lower half. (Detailed plans.)
2. Proposed lake and stream improvements. Indicate proposed improvements for the coming year. (Legend-detailed plans.)
3. Completed lake and stream improvement (legend.)
4. Rearing or holding ponds. (Legend-detailed plans.)
5. Plantings for wildlife. (Legend-detailed plans.)
6. Study areas, including plots, or patterns for census taking, demonstrations, research etc. (Legend-detailed plans.)
7. Proposed refuges - Federal, State or private in, or adjacent to Forest. (Legend-detailed plans.)
8. Game, fur farms or areas under special use permits for trapping. Federal, State or private. (Legend-detailed plans.)

(Copies of A and B due in Regional Office January 15)

C. Atlas Binder.

The atlas binder will be of standard size 18" x 21". The cover will be painted black with a 5" red Forest Service shield in the center, the word "Wildlife," in 2" red letters above the shield and the Forest and Units in 2" letters below the shield. The atlas binder in the Supervisor's office will contain the plans for the entire forest, including the plans for each unit and sub-unit. All sub-divisions of this folder should be separated by manila cardboard sheets, on which a marginal tab indicates the part to follow. The sub-units, or species will be arranged in the following groups: Fish, water-fowl, upland game, fur bearers, non-game animals. The atlas binder in each Ranger office will contain copies of the Unit and Sub-unit plans for the Units and Sub-Units which fall in that Ranger District.

A. Wildlife Key (Table of contents)Master Plan Form 130 R-9
B. Objective and policy statement - This will state the objectives and policies for the Forest as a whole.
C. History and present status of wildlife for the Forest. Under this heading will be included the past history of wildlife on the Forest as fas as it can be ascertained and the present status stated in general terms.
D. Economic Trends - Under this item should be given the economic developement of the area included in the Forest from as far back as it is known, as well as a statement of the conditions as to the how the people make a living at the present time and an indication as to what the trends for the future are.
E. Meteorological data will be largely in the form of tables of averages, together with graphs. The data will be obtained from standard local weather bureau stations.
a. Meteorological data (Sheet A, Regional Office.) The items needed for this classification are given by charts showing the items by months for the year 1931 to the present time, with space for the data to be filled in until 1944. The following items will be shown:

Temperature - Average monthly - graph
Monthly extremes - graph
Relative Humidity -Average by months.
Sunshine
a. percent possible by months.
b. average percent possible.

(All of the above on one sheet of 18" x 21" cross section paper.)

b. Meteorological Data (Sheet B. Regional Office.)
Statistics by months for:

Precipitation Average, Greatest, least.
Snowfall Average, Greatest, least
Snowfall - Average on ground 15th and end of month.
Frost data - Last in Spring

Frost data - First in fall.
Forest Fire data - Dates of last in spring
Forest Fire data - Dates of last in fall

F. Geological and Soil Classification and Conditions.

a. Geological History. A description of the geology of the region and the geological history up to the present.
b. Topography - General statement of the topographical conditions of the area.
c. Watershed - A general statement of the drainage condition and watersheds.
d. Soil - If a soil map is available in other branches of the Forest Service, refer to it. Soil information can be obtained from the U. S. Geological Survey, the U. S. Department of Agriculture, State Agricultural Experiment Stations and State Departments of Conservation.

G. Ownership Status:

If ownership maps are available in other divisions of the Forest Service, they should not be repeated here, but should be indicated as available.

H. Statistical information will consist of summary sheets G Fish and Game Form 128 R-9 Sheets 1-7. Current statistics will be posted monthly and seasonal statistics will be posted as soon as the reports are received.

I. Unit name and boundary:

If all of the area of a Forest is similar in physiographic and biological features, there will be but one unit for the entire forest. If there are differences, however, in the physiography and the biology of different parts of the forests, these parts become the units. Each unit will be given a name and the boundaries will be designated.

2. Unit Plans

These plans will be for only that part of the forest included in the unit to be managed.

Index Maps

A. Resource map (See Forest Plan. Repeat only for ranger's copy of unit plans.
B. Developement Maps (See Forest Plan. Repeat only for ranger's copy.

Atlas Binder

A. Wildlife Key (See Forest Plan)
B. Objective & Policy - Specific for a particular unit.
C. Cover type classification - This should consist of a general statement of the cover types, general interspersion of types and effects of cultural work on the cover. The best cover map available should be used. If cover maps are available in another branch of the Forest Service it need be only referred to here.
Fill in graphical cover sheet G Fish & Game Form 137 R-9
D. Summary of Statistical Information (See Forest Plan, kept in ranger's office for all units entirely within or partially within the ranger district.
E. Ownership - See Forest Plan
F. Reconnoissance of Wildlife - See Regional Office Reconnoissance Form G. Fish & Game 66 R-9 and G. Fish & Game form 100 R-9. The General Reconnoissance Sheet should be filled in yearly for fish and waterfowl. For other groups fill in only for the year inaugurated.

3. Sub-Unit Plans

For convenience in keeping records, the sub-units should be arranged in the following groups: Fish, waterfowl, upland game, fur bearers, non-game species. Indicate these subdivisions on the atlas by use of marginal tabs.
The sub-units or different species should be handled as follows:

A. History and present status of each species.

1. History - The history should include the known facts about the fluctuations in numbers of the species and any other facts about it that can be ascertained. Old residents will probably be the best sources from which this information can be drawn.
2. Present Status will describe the place the species holds as to numbers and importance at the present time.

B. Importance in the community - Under this heading both economic and social aspects of the species should be discussed. Any conflicts of thought by various groups such as tourists or local hunters should be given here.
C. Life History - This life history should be local in nature and include comments on health and vigor of the animals, the present sex ratio, mating seasons, migration habits, spawning season, etc., This material on life history should be assembled in the files and transferred to the sheet on Life History, G. Fish & Game Form 143 R-9, as it is summarized.

D. Specific Objective and Policy - The objective statement will be a brief summary of what yield should be expected when the area is fully stocked. The policy statement will state whether a maximum stocking of the area is desired and what is considered the highest use for the species. Any other special handling of the species should be considered here.

E. Summary of Management Procedures and Results.

1. Determination of present stocking and the Annual Increment.
The determination of the number of animals present is arrived at by the taking of a census. Census methods have been determined for many of our game animals. Through the use of various combinations of methods already developed and of others to be developed, it will be possible to determine the annual increment of each of our game animals. With some species, as the ruffed grouse, a series of censuses will be necessary to determine the shootable surplus.

a. Determination of present stocking - In all cases, an attempt should be made to determine the number of animals now present. This determination may be a statement of the number of animals as very abundant, common of rare; it may be an estimate of numbers based on a sample, or it may be the actual number of animals present. The last figure is the most desirable, but probably impossible to get in all but a few cases.

Acres per animals, and animals per section will be used with the upland animals. Very abundant, common and rare will be used with the non-game animals.

Fish abundance will be designated as pounds per acre, or as good or poor fishing.

b. The annual increment - The annual increment will be that part of the total stock after the original numbers and the natural losses are subtracted. Finding this involves knowing the original stock (spring or fall stock) as well as the numbers of all losses including wounding losses and other mortality.

Actually, only that part of the reproductive increase can be used for shooting above the numbers that are lost by natural causes added to the numbers that are needed to carry through the winter. It may take several years to determine this annual increment, as the losses from numerous causes will vary with the weather and the conditions of food and cover.

"Hunting or fishing take" may be determined on the entire area under management, or on samples which are representative of the entire area. " Other mortality " may be determined by direct methods, as an actual count of the losses on the entire area or on samples, or by subtracting the"hunting take" plus the spring census from the fall census.

The process of determining the annual increment will vary with the different species.

2. Determination of and removal of limiting factors -

The determination of factors which limit animal production may be quite obvious, as the lack of a sufficient quantity of food or the lack of escape cover. Limiting factors may, however, be some inconspicuous items as the lack of sufficient open soil for grit or the absence of a single plant species that would carry the animal over a critical period.

In the determination of the limiting factors, the following items should be considered:

a. Interspersion of types - the degree to which the cover types are intermingles on a game range.
b. Juxtaposition - the degree to which these types can be utilized, depending on the cruising radius of the species.
c. Food requirements
    1. Present needs of the species and the degree to which the range is utilized.
    2. Future needs, based on estimates of future populations.
d. Cover limitations - Effect of planting, cultural treatment and logging on food and cover.
e. Losses
    1. Predatory
    2. Diseases
    3. Winter killing
    4. Accidents
    5. Cyclic Fluctuations
    6. Illegal [illegible] utilization
    7. Legal over-utilization

The recommendations for the removal of limiting factors should consider all of the items listed under limiting factors. A resume of law violations, convictions and recommendations for improvement of law enforcement should be included.

Recommendations for refuges should be included.

3. Recommendations for Utilization - The kind of utilization should be determined by the greatest good to the

greatest numbers. The various kinds of utilization include:

a. Recreational, educational or aesthetic.
b. Hunting, fishing or trapping.

Recreational, educational or aesthetic use may decrease the breeding potential of a shy species like, moose, and recommendations for its use should consider these factors. The observational use of species like deer should be recommended only to the point where the forest cover is not damaged. Specific directions for this kind of use should include the designation of the place where observations can be made to advantage, and the type of structures, as blinds etc., needed whereby such observations can be made.

Hunting, fishing and trapping should include the amounts or numbers of each sex, if possible, and the age classes which should be removed. The method of removal should also be recommended.

Where the producing power of various areas differ within a unit, the amount of utilization should consider these differences, and recommend accordingly. Trapping areas should be designated by areas suitable for one trapper.

F. Summary of General Conditions:

Pertinent information as to the general conditions of the species will be brought together on Summary of Management G. Fish and Game Form 142 R-9.

Statistical Material

The statistical material will consist of field forms and summary forms. This material will furnish the data to fill in the summary sheets and will be used to determine the amount of utilization as well as recommendations for removal of limiting factors. The sheets should be filled out according to the following directions:

The Annual Wildlife Report G Fish & Game Form 128 R-9 consists of seven sheets of material and a job list Master Plan Form 131 R-9. These sheets should remain permanently in the Forest Plan and Unit Plans in the Wildlife Atlas in both the Supervisor's and Ranger's office. The same forms will be used for several years or as long as space permits. The Supervisor will place a set of forms in a binder which will be used to transfer the data from each Ranger district to the Supervisor's office. The Supervisor will bring the data together in the Forest Plan and will send a copy of the Statistics for the Forest together with explanatory material on the wildlife condition in his forest to the Regional Office previous to January 15 of each year.

G Fish & Game - Files

Fish

1. Refuges for Fish
2. Stream and lake survey by streams

3. Trout rearing ponds
4. Rearing ponds for pondfishes
5. Restocking requests
6. Restocking of waters
7. Stream Improvement
8. Lake Improvement
9. Dams
10. Total number of fisherman
11. Life History notes

Waterfowl

1. Refuges
2. Food and Cover Resources
3. Food and Cover Plantings
4. Census Records (Nest Records, etc.)
5. Mortality
6. Total number of Hunters.
7. Predatory animal control
8. Utilization - actual and recommended
9. Life history data

Upland Game

1. Refuges
2. Food and cover resources
3. Food and cover improvements
4. Census records (nests, etc.)
5. Mortality
6. Total number of Hunters
7. Predatory animal control
8. Utilization - actual and recommended
9. Life history data

Fur bearers

Same as upland game except No. 6 which should be Total number of Trappers.

Non-game animals

Same as upland game, except omit No. 6

Law Enforcement and State Cooperation

Open season and legitimate bag limits
Fees - Federal, State of Special
Warden Service, State or Federal, Regular or Special
Violation - Cases
Conviction - Cases
Cooperation with State and Federal Agencies
Transfer of Statistics

Maps & Detail Drawings

Maps of various projects of the unit plans will be on the basis of four inches to the mile, and as far as possible taken off the township maps of this size. Details, such as contours, substrata or special details of construction or location should be given for each project of the plan.

Drawings will be made according to the scale suggested in the Conventional Signs Legend Pamphlet.

All data which involves locations of work or structures must be shown on maps in the sub-unit plans of the species involved.

G
Fish & Game R-9

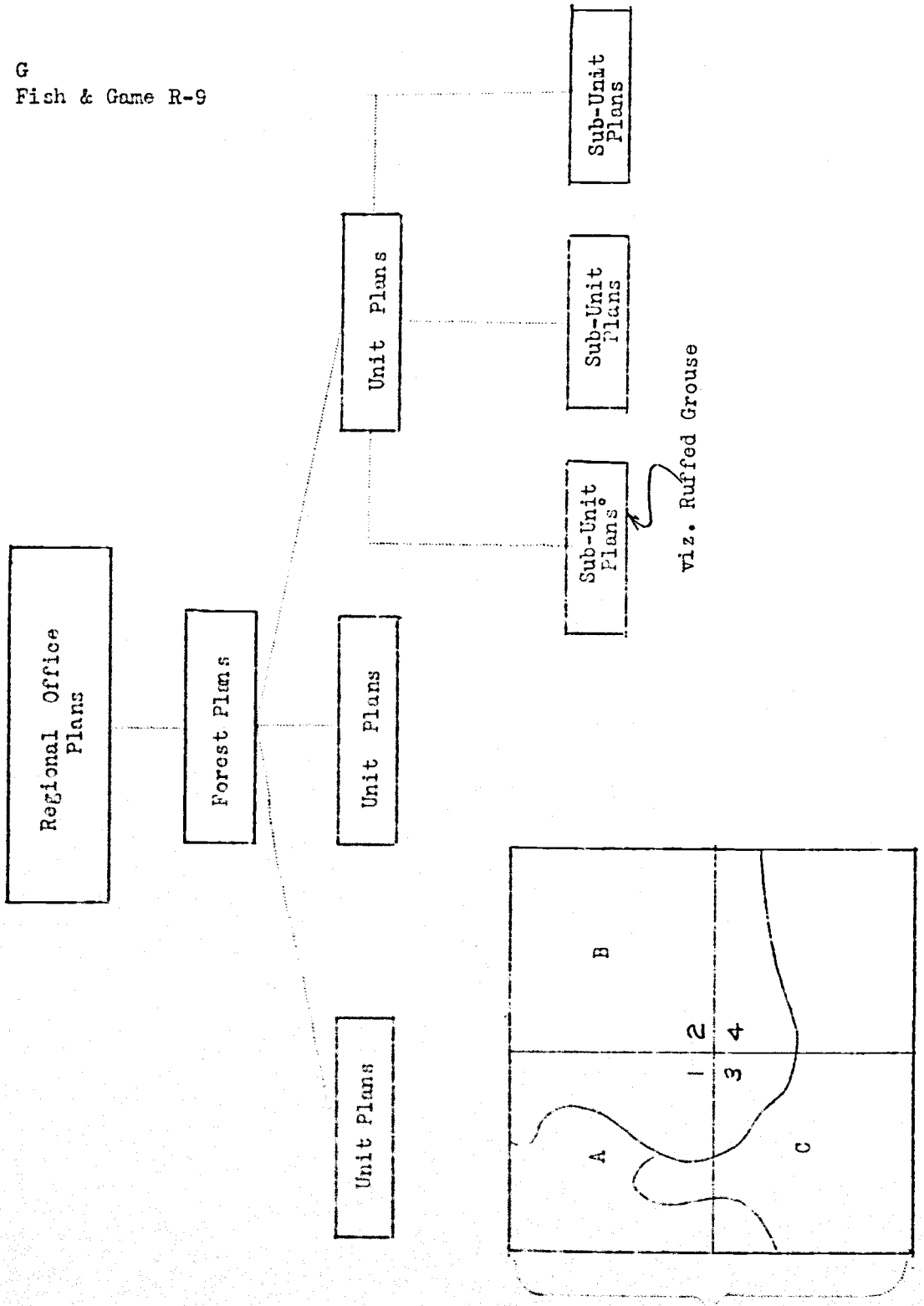


DIAGRAM FOR WILDLIFE MANAGEMENT PLAN

CALENDAR OF REPORTS - G FISH AND GAME

Due Date		
January 2	Reconnoissance of Waterfowl	100 R-9
January 15	Annual Wildlife Report	128 R-9
January 15	Summary of Wildlife Conditions (written material to accompany G Fish & Game 128 R-9)	
May 1	Items 67-79-91-103-115-127-127a (127a- Sharptail)	128 R-9
June 1	Items 27 to 29	128 R-9
July 1	Duck Food Requirements Report	98 R-9
August 1	Items 66-78-90-102-114-126-126a (126a - Sharptail)	128 R-9
September 1	Requests for Fish from "Federal Hatcheries"	140 R-9
November 10	Deer Census	183 R-9
November 15	Summary of Census and Hunting of game birds. Ruffed Grouse, Sharptail and Pinnated Grouse, Quail, Pheasant and Woodcock. Use G.Fish and Game 111 for all.	111 R-9
December 15	Summary for Deer Hunting Report	91 R-9
December 31	Items 21 to 24 inclusive	128 R-9
No due Date	Stream and Lake Survey	81 R-9
No Due Date	Proposed Dam Sites	113 R-9

Note corrections on Form 128 R-9, Sheet 1:
Change "Patrol Inventory" to "Fall Census"
Change 6 - "Miles per Hour" to "Total".
Change "Time of Patrol" to "Time of Census".
9- Month. 10-Date.
Make the following corrections on G Fish & Game Form 128 R-9:
Item 25 - Change "Spring" to "Fall".
Item 26 - Change "Spring" to "Fall".

LEGEND FOR WILDLIFE

Color Designations

Fish	Red
Waterfowl	Blue
Fur bearers	Brown
Upland mammals	Green
Upland birds	Orange

Pencil Color Designations

(321½)	Dixon's	Best	Lake Red
(320)	"	"	Sky Blue
(343)	"	"	Brown
(354½)	"	"	Light Green
(324)	"	"	Orange

Game Ranges


Winter

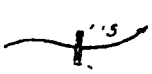

Summer


Fur bearers

Dams


Dam

Beaver



Waterfowl

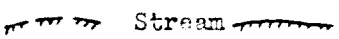
Study or Census Area


Various Species

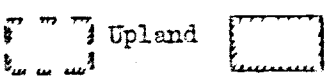

Routes of Travel

Refuges

Proposed Completed


Stream


Lake


Upland

Status of Refuges

F- Federal
S- State
P- Private

Hatcheries

Federal

State

Rearing Ponds

Trout

Pondfish

Other Operations

Plantings for wildlife

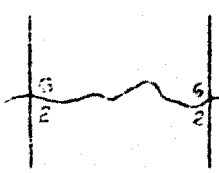
Cultural Operation for wildlife

Place where seeds of plants can be collected.

Plantings of Animals

Streams, Lakes and Marshes

I-II-III-IV- Classes of Lakes
A - B - C - Classes of Streams



Section line
Width of stream
Depth of stream


Intermittent Stream

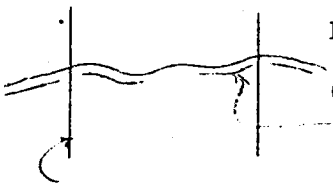

Wild Rice Bed (Blue)


Wild Celery


Cattail

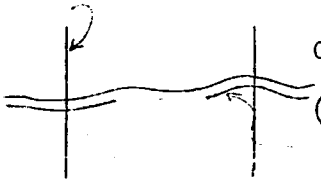

Boggy Lake Shore

G
Fish & Game, R-9

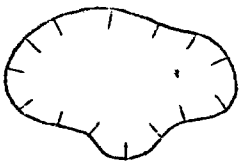


Proposed Stream improvement (red) - - - red line

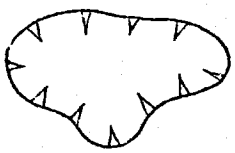
40 line



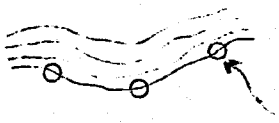
Completed Stream improvement (red) - red line



Proposed lake improvement



Completed lake improvement



Good Fishing (red)

Timber line boundary

Aspen site boundary

Miscellaneous Symbols

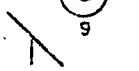
Beaver house(brown)

Dens in hollow trees

All other dens or houses(use numbers to indicate species)

Salt Lick

Dusting Spot



Otter Slide

Bird House

Surveys

G-S.L.	Stream and Lake
G-F.C.	Food and Cover
G-U.G.	Upland Game
G-W.	Water fowl Reconnoissance
G-F.B.	Fur Bearer
G-N.G.	Non-Game

Improvements

G-SI	Cultural Operation
G-CF	(Cover Planting (Food Planting
G-D	Dusting Spot
G-SI	Stream Improvement
G-LI	Lake Improvement

Utilization

HHH	Heavy Hunting
TTT	Heavy Trapping
FFF	Heavy Fishing
G.H	Good Hunting
G.F	Good Fishing
C.S	Checking Station.

Standard Topographic Symbols

Road - hard surface

Road - fair

Road - dirt

Trail

Railroad

Abandoned Railroad

Telephone line

Telephone line along road

Telephone line along trail

Transmission line

Hunters' or Trappers' Cabin

Abandoned House

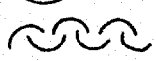
School House

Sawmill

Log Landing

Lookout Tower

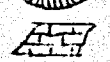
Lake



Pronounced Ridge

" Hill

Kettle Hole



Rock Ledge

Stream Improvement Symbols

1 - Rock Dam
2 - Log Dam
3 - Hewitt Dam
4 - Side Deflector or Wing Dam

Over-under Deflector

"Y" Deflector

"A" Deflector

"I" Deflector

Digging Log

Bank Cover

Triangle Cover

Bend Cover

Square Cover

Tepee Cover

Log Cabin Cover

Brush Shelter

W Established Weed Bed

P Plant Cover

O Dig out Spring and Tile

B Blast out Side Rock for Material

Wherever it is necessary to indicate the presence of a species, or group of species, or an operation for a particular group of animals, such species should be indicated by numbers as listed below:

9. Ruffed Grouse
10. Sharp-tailed Grouse
11. Pinnated Grouse
12. Canada Spruce Hen
13. Wild Turkey
14. Bobwhite Quail
14a. Woodcock
15. Waterfowl
    - 15a. Mallard
    - 15b. Black Duck
    - 15c. Gadwell
    - 15d. Widgeon
    - 15e. Pintail
    - 15f. Green-winged Teal
    - 15g. Blue-winged Teal
    - 15h. Shoveller
    - 15i. Wood Duck
    - 15j. Redhead
    - 15k. Ringneck
    - 15l. Canvasback
    - 15m. Greater Scaup
    - 15n. Lesser Scaup
    - 15o. Golden-eye
    - 15p. Bufflehead
    - 15q. Old Squaw
    - 15r. Ruddy Duck
    - 15s. Hooded Merganser
    - 15t. American Merganser
    - 15u. Red-breasted Merganser
    - 15v. Coot
    - 15w. Canada Goose
    - 15x. Snow Goose
    - 15y. Swan
16. Ring-necked Pheasant
17. Hungarian Partridge
18. Deer
19. Moose
20. Elk
21. Bear
22. Beaver
23. Muskrat
24. Mink
25. Weasel
26. Fisher
27. Otter
28. Marten
29. Raccoon
30. Opossum
31. Red Fox
32. Gray Fox
33. Wolf
34. Coyote
35. Bobcat or Bay Lynx
35a. Canada Lynx
35b. Badger
36. Snowshoe Hare
37. Cottontail Rabbit
38. Jack Rabbit
39. Gray Squirrel
40. Fox Squirrel
40a. Red Squirrel
41. Brook Trout
42. Brown Trout
43. Rainbow Trout
44. Lake Trout
45. Whitefish
46. Muskallunge
47. Northern Pike
48. Small-mouthed Bass
49. Large-mouthed Bass
50. Wall-eyed Pike
51. Sunfish
52. Crappie
53. Shad
54. White Bass
55. Perch
56. Bullheads
57. Channel Cat
58. Mud Cat
59. Spottailed Minnow
60. Chub
61. Shiner
62. German Carp
63. Mud Minnow
64. Common Sucker
65. Black Sucker
66. Red Horse
67. Buffalo

COLLECTION AND PRESERVATION OF PLANT, ANIMAL AND PATHOLOGICAL SPECIMENS°

PLANTS

Plants not commonly recognized by foresters should be collected, preserved and identified. Such materials are useful in learning to recognize the plants that furnish food for animal life. All parts of the plant may be preserved, but in different ways. The stem, flowers and leaves are dried and preserved in this form. Water plants or fruits may be preserved in a formalin solution, and seeds are usually preserved dry.

1. General Directions

All plants which are thought to be of value to wildlife should be collected. Each specimen should be accompanied by an identification tag on which is given a number, a date, the location and name of the collector. A number should be used to identify any notes of particular interest about the specimen. All of the above items should be executed as the specimen is collected.

2. Collection of Plants

Collection of plants which have both flowers and fruit attached are desirable, if this is possible. August and September are therefore good months for collecting plant materials.

After being collected, plants should be placed between several (5 to 10) sheets of ordinary newspaper. The newspaper acts as a blotter and helps to remove the water from the plant. The bundle of papers with specimens in place should be placed between specimen frames and the frames tied together so that the blotters (papers) are in close contact with the plants. The frames should be 12" X 17" in size. Large plants may be bent into a V shape.

All except an inner fold of paper should be replaced twice a day by new dry papers for the first two days, and once a day for a week after this, or until the specimen is thoroughly dry. From the drying sheets the specimen should be attached by adhesive tape to specimen sheets or a specimen book. The genus and species together with the number, date collected, location from where it came and the collector's name should be given on the specimen sheet.

3. Mounting Specimen

Pulpy fruits and specimens of aquatic plants should be preserved wet in a formalin solution. (Ordinary formalin is a 40% solution.) Glass jars with a large mouth should be used. Place the specimens in a 2% to 5% solution of formalin for several days and then in a 5% solution. A teaspoon of sugar added to each jar will help to hold the natural color of the specimen.

4. Seeds.

Collections of seeds used as bird and mammal foods should be placed in small wide-mouthed vials°. These vials should be labeled with the generii and specific name and the locality where collected.

ANIMALS

1. Preservation of Animal Specimens.

Small birds, fish or mammals which are killed or found dead should be properly labeled, packed for shipment and sent to a pathologist°°. Place the animal in a card board container, such as an ice cream box and then place this in a larger container in which ice and saw dust is present. If a mammal has just recently died, a sack made of a double layer of cheese cloth should be tied securely around the body before the animal cools off in order to catch ecto-parasites. A tag showing the number, date, locality where collected and the name of the collector should be placed with the specimen. Mark "perishable" on all boxes and ship by express.

Collections of fish may be made in a 10% formalin solution for identification purposes in the forests.

2. Tissue for Bacterial and Parasitic Analysis

Tissues such as lung, spleen, liver or other gland tissue or entrails of animals which are to be examined for micro organism, or parasites, should be placed in cardboard containers such as ice cream boxes or wrapped in wax paper and then placed in a larger container which should contain a mixture of ice and sawdust. This package should be labeled " perishable" and sent by express to a pathologist.

3. Preservation of Viscera of Animals

Under ordinary conditions the viscera of animals should be examined while fresh. The alimentary tract should be split open and the contents carefully examined for lesions, food contents and parasites. Parasitic worms should be washed in warm water and preserved in Lavdowsky's solution. Fifty percent grain alcohol or even wood alcohol can be used if the solution mentioned above is not available. Each vial should be carefully labeled with a number, date, location and name of collector.

4. Preservation of Stomach Contents

Mammals - The stomachs of all animals found dead or killed, such as predators etc., should be saved for analysis. Carnivor stomachs should be tied in a sack of cheesecloth, properly labeled, and placed in a two quart can of 10% formalin or in Lavdowsky's solution. The stomachs of animals , like rabbits or deer or woodchucks must be handled differently. With deer, only a portion of the stomach contents should be saved. A slice cut in the shape of

° See Sheet No. 31
°° See Sheet No. 32

a wedge should be taken from a large stomach so as to give a representative sample of the contents of the stomach. This should be thoroughly dried on absorbent paper of newspaper, properly labeled and sent to a laboratory for analysis, or placed in a closed can, or carefully wrapped for future analysis. With the smaller animals the entire contents can be dried and preserved in the same way.

The contents of crops and gizzards of birds can be spread out and dried, or the entire crop and gizzard can be placed in a cheesecloth sack and preserved in Lavdowsky's solution in a glass jar.

Fish - Place fish stomachs in a ten percent solution of formalin. Place only one stomach in a jar and label correctly according to species, and also where, when, and time specimen was taken. If large jars are used, many fish stomachs may be kept in the same jar, provided they are tied in separate cheesecloth sacks and labeled.

5. Preservation of Hawk and Owl Pellets or Feces

Bird pellets or feces from birds or mammals should be thoroughly dried and placed in envelopes or glass containers after being properly labeled.

6. Ticks, Fleas and Insects

Small animals like ticks and fleas should be placed in either 50% grain alcohol or Lavdowsky's solution in small glass vials tightly stopped. Large parasitic worms can also be preserved by this same method. Insects should be killed by being placed in a cyanide bottle, and then can be preserved as described above or placed in insect boxes by sticking an insect pin through one side of the Florax. As the skeleton is on the outside in insects, the creature is perfectly preserved and will keep its shape if it is thoroughly dried and protected by moths.

SOLUTIONS AND CONTAINERS

1. Making Solutions

In diluting a solution of known percent to a lower percent, place as many units of the solution in the container as you wish the final solution to be in percent, and fill the container to the point of the original strength with distilled water. Thus, if a 10% solution is to be made of a 40% formalin solution, place 10 units in a graduated cylinder and fill the cylinder to 40 units with distilled water.

2. Lavdowsky's Solution

This is a mixture of grain alcohol, actic acid, formalin and distilled H_2O in the following proportions:

Grain Alcohol 95%	55 parts	Formalin(commercial)	5 parts
Glacial Acetic Acid	2 parts	Distilled (or soft) water	40 parts

Containers for specimens.

Various sized containers are needed for different types of specimens. These specimens may be classified as follows:

	Type of Specimen	Container
1.	Dry seeds and nuts	Screw cap glass vials Vials 60 X 16 mm
2.	Wet specimens, pulpy fruits acquatic plants	Round glass specimen jars. Height 4 5/8"X 1 7/8"
3.	Animal specimens, as parasitic worms and diseased tissue	Round glass specimen jars Vials 60 X 16 mm
4.	Stomach contents	Standard fruit jars EZ Seal 2 qt. jars.

The caps of all wet specimen containers should be dipped in paraffin to insure a perfect seal.

A label should be placed on each container on which is placed the following information:

No._____ Date_____
Common Name_____
Scientific Name_____
Place Collected_____
Collector_____

A card file of 3 X 5 library cards should be kept for the collection. There should be one card for each specimen and each card should carry the same information as is given on the specimen label.

Identification of Parasites and Diagnosis of Pathological Specimens.

Parasites such as ticks, fleas, bot fly larva, screw worms, etc. will be identified by the U. S. Bureau of Entomology and plant Quarantine. Vials and containers for sending in small specimens can be furnished by the Regional Office.

Specimens of parasites should be placed in containers as directed and sent to Dr. F. C. Bishopp, Bureau of Entomology and Plant Quarantine, Washington, D. C. Report all shipments and results to the Regional Office.

Pathological specimens should be sent as directed on the following sheet:

CHART SHOWING WHERE PATHOLOGICAL SPECIMENS ARE TO BE SENT

	Moose	Deer	Rabbit	Grouse or Partridge	Turkey or Quail
Minnesota	Moose or deer found in a dying condition should be reported by phone to Dr. R. Fenstermacher, Department of Vet. Medicine, University Farms, St. Paul, Minnesota. Reverse charges. Report carcasses to same address by letter or card. Send lung and spleen samples to Dr. R.G.Green, Minneapolis, Minnesota		Keep cold. Specimens of animals which are representative of large numbers of animals dying from unknown causes should be packed in sealed containers and sent to Dr. R.G.Green, Department of Medical Science, University of Minnesota, Minneapolis, Minnesota		
Wisconsin	Send specimens of small dead or diseased animals or parts of large animals to Dr. E. F. Graves, Wisconsin State Experimental Fur Farm, Poynette, Wisconsin express propaid. Also send samples of small animals dying of epidemic diseases and lung and spleen tissues of deer to Dr. R. G. Green, Minneapolis, Minn.				
Michigan	Send especially important specimens (total) to Dr. Don R. Coburn, c/o Anatomy Building., East Lansing, Michigan, express collect. Parts of lungs and specimens suspected of having lung worms should be sent to Dr. E.C.O'Roke, School of Forestry & Conservation, University of Michigan, Ann Arbor, Michigan. Also send tissue of lung and spleen to Dr. R.G.Green,Minn.				
Illinois	Send animal parasites and specimens which have died of unknown causes to Illinois State Natural History Survey, Natural History Building, Urbana,Illinois, express prepaid.				
Missouri	Send dead animals, thought to have died of parasites or disease to Dr. Rudolph Bennitt, University of Missouri, Columbia, Missouri, express prepaid.				

G
Fish & Game, R-9

Form #66, R-9

FISH, GAME AND FOOD

RECONNOISSANCE

1. The purpose of this Reconnoissance is to determine the presence and relative abundance of various forms of Animal Life and their Foods in this Region.

2. The information obtained will be used as a guide in the administration of Fish and Game Activities.

3. It is desired that Forest Service officers, E.C.W. workers, local sportsmen and other people interested in Wild Life fill in the sheets and send them to the Regional Forester, U. S. Forest Service, Milwaukee, Wisconsin.

G
Fish & Game, R-9

Form #66, R-9

FISH, GAME AND FOOD RECONNOISSANCE

Forest 1-2 Ranger District 3

Day 4-5 Month 6 Year 7 Serial No. 8

Fill in the blanks above. This survey sheet is to determine the abundance and importance of the several animal species on each Forest Unit.

INSTRUCTIONS FOR FILLING OUT BLANKS:

A. Fill out all blanks above instructions except serial number.

B. Check ✓ the animals that you know to be present. Do not guess!

C. Check ✓ whether animals present are very abundant, common or rare.
°Give basis of your estimate _____

D. Under Value check species that are of the highest value for Hunting, Fur or Recreation, of Secondary value, or unimportant.

Species	Present	Very Abundant	Common	Rare	Relative Value of Species: Very High	Secondary	Unimportant
9. Ruffed Grouse							
10. Sharp-tailed Grouse							
11. Pinnated Grouse							
12. Canada Spruce Hen							
13. Wild Turkey							
14. Bobwhite Quail							
14a Woodcock							
15. Waterfowl							
16. Ring-necked Pheasant							
17. Hungarian Partridge							
18. Deer							
19. Moose							
20. Elk							
21. Bear							
22. Beaver							
23. Muskrat							
24. Mink							
25. Weasel							
26. Fisher							
27. Otter							
28. Marten							
29. Raccoon							
30. Opossum							
31. Red Fox							
32. Gray Fox							
33. Wolf							
34. Coyote							
35. Bobcat of Lynx							
35a Canada Lynx							
35b Badger							
36. Snowshoe Hare							
37. Cottontail Rabbit							
38. Jack Rabbit							
39. Gray Squirrel							
40. Fox Squirrel							
40a Red Squirrel							
41. Brook Trout							
42. Brown Trout							
43. Rainbow Trout							
44. Lake Trout							

°Is your Estimate based on hunting, presence on roads, etc.

Species	Present	Very Abundant	Common	Rare	Relative Value of Species: Very High	Secondary	Unimportant
45. White Fish							
46. Muskellunge							
47. Northern Pike							
48. Small-mouthed Bass							
49. Large-mouthed Bass							
50. Wall-Eyed Pike							
51. Pan Fish-Croppies, Bluegills & Sunfish							
52. Catfish, Bullheads							

FOODS FOR ANIMALS

Instructions for Filling out Blanks:

A. Check ✓ the plants listed that you know to be present. Do not guess!

B. Indicate by check ✓ whether these Food Plants are very abundant, common or rare.

Species	Present	Very Abundant	Common	Rare
53. Clovers				
54. Wheat				
55. Barley				
56. Oats				
57. Corn				
58. Buckwheat				
59. Aspen				
60. Willows				
61. Dogwoods				
62. Poplar				
63. Birch				
64. Elm				
65. Sumac (Poison)				
66. Sumac (Staghorn)				
67. Berry Bushes (All kinds)				
68. Beechnuts				
69. Walnuts				
70. Hickory Nuts				
71. Acerns				
72. Cedars				
73. Maples				
74. Wild Rice				
75. Pond Lillies				
76. Wild Celery				
77. Duck Potato				
78. Pond Weeds				
79. Rag Weed				
80. Smart Weed				

_____
(Signature)

_____
(Official Title)(if any)

Address: _____
Street City State

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Form 100 R-9

Forest _____

Date _____

RECONNOISSANCE OF WATERFOWL

	Species	Breeding				Migrant			
		Abundant	Common	Rare	None	Abundant	Common	Rare	None
15a.	Mallard								
15b.	Black duck								
15c.	Gadwall								
15d.	Widgeon								
15e.	Pintail								
15f.	Green-winged teal								
15g.	Blue-winged teal								
15h.	Shoveller								
15i.	Wood duck								
15j.	Redhead								
15k.	Ringneck								
15l.	Canvasback								
15m.	Greater Scaup								
15n.	Lesser Scaup								
15o.	Golden-eye								
15p.	Bufflehead								
15q.	Old Squaw								
15r.	Ruddy duck								
15s.	Hooded Merganser								
15t.	American Merganser								
15u.	Red-breasted Merg.								
15v.	Coot								
15w.	Canada Goose								
15x.	Snow Goose								
15y.	Swan								

Recorder _____

NOTE: Check each species twice - once if a breeder or not, and once if a migrant or not. Due January 2 each year.

REFUGES FOR WILDLIFE

A refuge is an area where wildlife may live and reproduce under favorable conditions with the least possible disturbance. Animals, such as waterfowl, which are international in their flight habits, will need permanent sanctuary areas. Mammals, such as moose and marten which do not breed rapidly and are particularly shy, will also need permanently secluded areas which can be kept free from disturbances by human agencies. Refuge for other species will be needed only so long as the factors of production and utilization are not under control. When the number of animals lost by accidents, disease, predators and legal and illegal hunting and fishing can be controlled, so that only the yearly increment of increase is taken, then there will be no further need for refuges.

The purpose of a refuge is to maintain a reservoir of wildlife from which the pressure from the natural increase will be sufficient to cause an overflow beyond the limits of the refuge, thereby furnishing a surplus for the surrounding public hunting or fishing grounds. This increase will be greater if refuge areas are improved in the way of food, water and cover conditions. Refuges must be protected from all disturbances, including guns, traps, snares, nets, fishing, motor or other boats, picnicking or hiking groups and the presence of stray dogs and cats. It is expected that utilization of timber products will be carried on in refuges, but in such a manner as to produce an optimum condition for wildlife.

Administrative Authority for Refuge Establishment

Refuges are of two kinds:

1. Federal Refuges
2. State Refuges

Federal refuges can be established in National Forests as directed under "Waterfowl Refuges," also "National Game Refuges." See National Forest Manual.

State refuges can be established under state law, through the cooperation of the State Conservation Departments, and the Regional Office.

It is understood that refuges established for one species of animals may also meet the requirements for several other species. Thus a refuge for deer will also be a refuge for grouse, quail, turkey, rabbits and many other kinds of wildlife.

The selection of sites for the establishment of refuges should consider the following items:

1. Size and distance apart,
2. Surrounding public shooting grounds.
3. Status of ownership of the surrounding lands.
4. Change of status of the refuge.
5. Boundary lines
6. Predatory animal control.

Size of Refuges

The following schedule of size and distances should meet the requirements of the animals listed:

Animals	Area in Acres (M = 1000)	Distance Apart in Miles
Waterfowl	200 and up	50 - 100
Moose	25M - 75M	
Deer	2M - 8M	12 - 25
Turkey	2M - 8M	12 - 25
Quail	1/2A - 10A	1/2 mile- 2
Cottontail	1/2A - 10A	1/2 mile- 2

Public Shooting Grounds

Where refuges are established for animals that are legal game, provision should be made for public shooting grounds surrounding each refuge area. In general, the shooting ground should contain three times as much area as the refuge.

Status of Ownership

All land within a game refuge must be under Federal ownership, state ownership dedicated to refuge purposes or be privately owned land that is under an agreement with the State for refuge purposes on a long time basis.

Change of Status

Provision should always be made so that a refuge can be discontinued when its usefulness has passed, as will be the case when utilization is brought under better control. Although no refuge should be established for more than five years, provision should be made so that the refuge can be continued longer if necessary.

Boundary Lines

Boundary lines around refuges should be marked so it is easy to distinguish the refuge from adjoining area. Roads, abandoned railroad grades, and other established landmarks should be used when possible. A line should be cleared around a refuge the width of a truck trail fire line (twenty four feet). Where such a line passes through large timber, the brush only should be cut, leaving the merchantable trees standing. Refuse lines should follow around the edge of small swamp areas where possible and without too much additional mileage, rather than cut through them. This procedure can only be followed, however, where small points of swamp extend out of the contemplated refuge area.

The refuge boundary line should be kept clear of weeds, shrub and tree reproduction by annual maintenance. The entire refuge should be surrounded by a No. 9 smooth wire hung to trees or posts about four feet above the ground. State refuge signs should be placed at intervals of 150 feet, six feet from the ground.

Where it is possible, all roads leading into a refuge should be under control. All human activities should be positively barred from refuge areas except as otherwise specified in the discussion of " Correlation of Forest Management Activities in Relation to Deer." and also under "Predatory Animal Control" and "Refuges for Waterfowl." Every effort should be made to control trespass and illegal hunting and trapping on refuge areas.

Predatory Control in Refuges

So many animals have been killed in the name of predatory animal control that this activity should not be carried on except in special cases, and then only in cooperation with the R. O. In cases where control of a specific group of animals, like the timber wolf or coyote, is desired, the Biological Survey will be asked to carry on the operation. Where a certain individual animal has developed habits that are detrimental to game, they will be removed by the Forest Service unless they are protected by state law, in which case they will be removed in cooperation with the Conservation Departments.

Factors that apply to refuges for specific animals and not for refuges in general will be discussed under the directions for the management of each species.

Fish Refuges

The same general principles apply to game refuges, also apply to refuges for fish.

Refuges are necessary in lakes only under special conditions. Often it is advisable to protect bass spawning grounds, and to protect runs of smelt, etc. Such areas can be adequately surveyed and staked out and posted with state refuge signs.

The function of stream refuges is very important. Wherever possible, small feeder streams not capable of producing any appreciable amount of legal fish should be posted and maintained as refuges for small trout.

Only under special conditions is it advisable to close a portion of a large stream. In all cases should an endeavor be made to confine the take to the production, and so only when there is a failure to manage in this way will it be advisable to close off sections of rivers to increase the capital stock.

On one famous Canadian brook trout stream, only fly fishing is allowed, and the fishermen may take only one legal fish per day. Such a river is a sportsman's stream, and under this method of angling has produced excellent fishing for a number of years. Such an attempt might be tried on several National Forest streams. Wherever the Forest Service owns an entire trout stream, such management may be comparatively easy.

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Fish & Game R-9

FISH MANAGEMENT PLAN

Objective:

To produce to the full capacity of our streams and lakes a reasonable yearly increment of fish so as to permit a sustained yield.

To arrive at this objective and to properly manage our lakes and streams, it is necessary to have a thorough knowledge of their types and the conditions found in these types. Just as there are well defined land communities represented by certain dominant plants and animals there is a similar condition in our waters. An understanding of the site preference of our forest and range plants has allowed the forester and range examiner to determine what sites are most favorable to each species of herb, shrub and tree.

Our fish and fish foods, just as the terrestrial plants and animals, have site preferences. Some prefer cold, deep, rocky lakes; others the shallow, warm lakes. Some require cold, swift-flowing brooks, and yet others prefer wide, slowly-moving rivers. The species of fish differ in their site preferences immensely.

It will be necessary, therefore, to determine what aquatic sites our different waters represent. We already know the site preference of our fishes. Our duty then lies in a classification of our waters, and the introduction and management of fish in them which are best suited to the individual sites.

There are four classes of lakes and three classes of streams commonly recognized by the limnologist. They are merely individual stepping stones among myriads of others, and are used only as a guide or an orientation for further discussions and research. A brief description of these lake and stream classes is given under the instructions for the stream and lake survey.

Steps in Fish Management

Proper management of our fish life must consider the following points:

1. Survey
    a. Classification of the waters
    b. Species of fish present
    c. Site preferences exhibited by the fish.
2. Yield - How much fish life can the waters now produce?
3. Diagnosis - What is lacking for optimum development of the fish?

4. Control - What can be done to improve conditions?

Some of the inventory is rather easily obtained, but only a keen observer is capable of determining the yield of a certain body of water, what is wrong with it, and what can be done to improve it. A thorough knowledge of the plants and animals present and their environmental relationships with each other will permit the trained observer to analyze conditions correctly. In determining what can be done it is wise to remember that by working with nature we can accomplish much. Final radical decisions should not be reached until it is assured the results will not be nullified by the force of natural phenomena. In other words, the natural succession of lake and stream communities is difficult to alter.

Survey

This entails a list of all the waters on our Forest by name, classification and location and the species of fish now residing in them. The range and dispersion of our fishes can then be shown on maps from which the investigator may readily define the distribution and range limits of the various fish. Such data can be used as a basis of further study and attack.

A record of the plant life and cover in each stream and lake is necessary in forming an estimate of the site quality. Dredge samples, plankton samples, temperature ranges at various depths, pH readings (concentration of the free hydrogen ions), and oxygen tests should be carefully recorded as fast as it is possible to cover the various bodies of water in our forests.

Our survey would then give us the following points, all of which need not be taken at once, but a gradual accumulation of these facts is very desirable.

1. Name of body of water.
2. Location by forest, district, town and range.
3. Classification - whether Class I, II, III, IV lake or Class A, B, C stream.
4. Vegetation - whether abundant, common, rare and by species.
5. Cover - whether logs, brush, overhanging vegetation is present. Use abundant, common and rare.
6. Species of fish present.
7. Temperature - at various depths.
8. Oxygen - at various depths.
9. pH tests - at various depths.
10. Bottom characteristics of lakes and streams.
11. Dredge samples - list species found - take samples at various depths.
12. Plankton samples - list species present - take at various depths.

A thorough understanding of these points will permit the formulation of workable plans, and the greatest efforts toward improvement will then be expended where they are most needed. Fluctuations and variations can be determined by similar studies each decade, so that we will eventually know what each stream and lake is capable of producing.

Each ranger should be held responsible for the collection of survey data on his own district, much of which can be readily obtained from local woodsmen, naturalists and forest rangers. The study of dredge and plankton samples can be more expeditiously handled by our universities, cooperation with whom will enable us to fill the gaps in the information we are able to gather.

Yield

It is impracticable to secure a census of our fish populations. Migratory habits and shifting populations can best be studied by banding, a technique which has been employed by the Bureau of Fisheries.

Though it is hard to arrive at a true population figure of the fish in our waters, we are able to determine the yield these waters are capable of producing, because the amount of food present in a lake or stream is directly proportional to the amount of fish life the waters will produce. The Germans long ago realized that lakes of an extremely high food content produce enormous fish populations, and fertilized their carp ponds to increase the organic material, thereby obtaining a greater population of small animal life such as protozoa, water fleas, minute plankton algae and insect life. The chain of life did not end there for the carp took advantage of the increased food supply, and the carrying capacity for fish was in many instances doubled. The German fish culturalist had fertilized the waters and in return had reaped a greater yield of fish.

Food must be present to support fish life, and the greater concentration of this food per cubic foot, liter or cubic yard, the greater the fish population. Dredge samples taken at various depths permit the investigator to accurately determine the carrying capacity of a body of water, the yield of fish being directly proportional to the amount of animal and plant life found in these dredge samples. Plankton counts help to verify the findings of the dredge samples.

In management of our waters it will be well to know the carrying capacity of each lake and stream before we stock it or introduce improvement devices, for it may be that a great share of our lakes are carrying all the fish life they can support. Due to barren sand and rocky bottoms many of our northern lakes are poor fish producers because of their low carrying capacity. Such lakes, if they are virgin, are probably carrying all the fish life they can support, and fertilizing them is out of the question, because, first, it would not pay, and secondly, the effects would not be

lasting, and continued fertilization would be necessary. If these lakes are not heavily fished, they will take care of themselves. Our efforts should be confined to those lakes which are over-fished and whose carrying capacity is greater than the fish population they produce.

Diagnosis (What is lacking)

Several things may be limiting the population of fish. Lack of food may be one. Suitable spawning grounds may be scarce or inaccessible. Lack of cover in the way of logs, brush, rocks, etc., may prove a handicap to the development of various species of fish.

Waters may be improved for fishing if the investigator understands the site preferences of the fish and if he is able to discern the absence of these site preferences, which is difficult of determination at a glance, but is the most important phase of the work, as errors may be costly. It shall be the purpose of an investigation to determine what limiting factors are the most detrimental and which should first be attacked, provided it appears that satisfactory results are possible. Such limiting factors are:

1. Lack of feed
2. Over fishing
3. Lack of spawning grounds
4. Lack of cover and vegetation
5. Lack of oxygen during winter and nights in summer
6. Waters may be too acid or too alkaline
7. Parasitism of the fish may be heavy
8. Predators may be too numerous
9. Waters may be too warm or too cold
10. Lack of fertility.

Other limiting factors may be peculiar to certain lakes and streams and each should be taken into consideration when determining why the fish population is not fully productive. Some lakes may be nearly perfect in their requirement of fish life, but they may need restocking. Expend every bit of energy where it will do the most good.

Control (What can be done)

Once a correct determination of what is wrong has been made, the proper procedure is to quickly correct matters. Some fish sites, as mentioned before, cannot be improved, but in many cases conditions can be infinitely bettered by the introduction of improvements. Cold waters may be warmed by damming and exposure to the sun. Warm waters are cooled by shading and increasing the flow of water. Mud and silt may be washed from trout spawning grounds by deflectors, or such mud and silt may be washed into a

lake or stream to increase the fertility. Man can manage things to improve conditions immensely.

Some of the limiting factors in streams and lakes with their measures of control are listed:

1. Lack of feed - Fertilize the waters; deposit rich mud, decaying organic matter, etc.
2. Over fishing - Stock lake; close lake to fishing; improve carrying capacity of the lake.
3. Lack of cover - Install brush covers, logs, etc.
4. Lack of spawning grounds - Put in deflectors to wash out gravel for trout. Place gravel boxes in lakes and streams. For crappies put in logs, brush and the like.
5. Lack of oxygen in the winter - Break up the ice; expose waters. Lack of oxygen during summer nights - Cut excess vegetation.
6. Water may be too acid - Clean out rotting vegetation; put in lime.
7. Water may be too alkaline - Put in rotting vegetation, etc.
8. Predators may be too numerous - Trap, shoot, scare and net destructive predators.
9. Parasitism may be heavy - Introduce parasites of the parasite; introduce chemical washes.
10. Waters too warm - Shade waters as much as possible; increase rapidity of flow.
11. Waters too cold - Dam waters; expose to sun, etc.

All of these adverse conditions may be successfully controlled whenever the results will warrant the expenditure of the time and money.

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Fish & Game
Form #81 R-9

STREAM AND LAKE SURVEY

1. Forest _____ 2. Unit _____ 3. Township _____

4. Range _____ 5. Section _____ 6. Date _____

7. Name of Water _____ 8. Class _____

9. Bottoms of Lakes and Streams (check each one)

	1% - 25%	26% - 50%	51% - 75%	76% - 100%	None
Rock					
Sand					
Marl					
Clay					
Gravel					
Muck					
Silt					
Boulders					

10. Air Temp. _____ 11. Water Temp.-Surface _____ Bottom _____

12. Oxygen _____ 13. pH _____ 14. Maximum depth for lake _____

15. Ave. depth of lake _____ 16. Area for entire lake in acres _____
Area for stream flowages in acres _____

17. Length of stream in section _____ miles

18. Volume of stream flow during late summer _____ gals. per min.

19. Tributaries, Outlets, Inlets, Feeders, etc.

NAMES:	DESCRIPTION BY CLASS:
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____

20. Cover _____

21. Ownership in percent - Government _____ Private _____

22. General character of surrounding soil _____

23. General description of timber types _____

24. Number of farms _____

25. Accessibility _____

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26. Fed by_____

27. Fishing_____ 28. Reasons for_____

29. Fish (check most abundant species)

Brook Trout_____	Shad_____	Mud Cat_____
Rainbow Trout_____	White Bass_____	Spottailed Minnow_____
Brown Trout_____	Pickerel_____	Chub_____
Lake Trout_____	Gr. No. Pike_____	Shiner_____
Whitefish_____	Muskallunge_____	German Carp_____
Large-mouthed Bass_____	Wall-eyed Pike_____	Mud Minnow_____
Small-mouthed Bass_____	Sand Pike_____	Common Sucker_____
Rock Bass_____	Perch_____	Black Sucker_____
Sunfish_____	Bullheads_____	Red Horse_____
Crappie_____	Channel Cat_____	Buffalo_____

30. Vegetation - (check each species)

	Abundant	Common	Rare	None
Wild Celery				
Chara				
Green Algae				
Blue Green Algae				
Pond Lilies				
Bulrushes				
Rice				
Cattails				
Watercress				
Reeds				
Duck Potato				
Pondweeds				

31. No. of active beaver dams_____ No. of inactive beaver dams_____

32. No. of active beaver houses_____ No. of inactive beaver houses_____

33. Aspen - Ave. d.b.h._____ Ave. Ht._____ Ave. No. trees per acre_____

34. Beaver recommendations_____

35. Muskrats_____

36. Recommendations for fish stocking_____

37. Recommendations for fish or duck refuge - Yes_____ No_____
Ducks_____ Fish_____

38. Extent of refuge - Miles for stream_____ Acres for lakes_____

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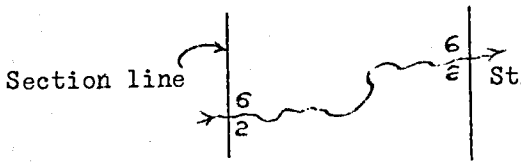
INSTRUCTIONS FOR STREAM AND LAKE SURVEY

Each item is given a number, and a description of the points entailed under each number is herewith given. Do not guess or be swayed by preconceived notions. All questions should be answered if it is possible to acquire the information. Send a copy of each of the survey forms to the R. O.

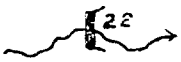
1. Write name of the Forest
2. Write name of Ranger District
3. Township
4. Range
5. Section - Each stream will be studied in the various sections of land through which it flows and separate survey sheets filled out except in cases where a stream flows through only a corner of a section. In such a case this small portion should be added to the survey of the next section. Scale on map 4" - 1 mile.

A lake will be mapped and studied as a whole. Any scale may be used. Record scale on map.

SYMBOLS (for map)



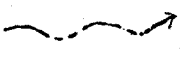
Stream - Six feet wide and two feet deep; indicate depth and width on entering and leaving section.



Beaver Dam

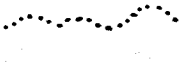
Other Dam

Beaver Houses



Intermittent Streams

Timber Type Boundary



Aspen Site Boundary

Blue.....Gravel)
Black.....Sand)
Yellow.....Silt) To be placed
Orange.....Clay) on maps of
Red.....Muck) lakes and
Green.....Marl) streams

(S).....Spring
10-6--60.....10 trees per acre, 6" average d.b.h., 60' average height.

①②③....Good, medium and poor sites respectively. Locate sites on map.

6. Date

7. State whether stream or lake. Some of these questions apply only to lakes and some only to streams. This question should give the name of water and it should be designated either as a lake or stream, as Lake Bertha or McKinley Creek.

8. This applies to the class of lake or stream on which the survey is being made. There are four classes of lakes and three classes of streams which are commonly recognized by limnologists and rheologists. They are merely individual stepping stones among myriads of others, and are used only as a guide or an orientation for study. If a stream or lake represents a condition half way between any of these classes, check the class toward which you believe the succession is bound. See "Appendix" Wildlife Handbook. for description for the various classes.

9. Rock means bed rock. Gravel is construed to mean anything coarser than sand but will not include boulders. Sand includes fine and coarse sand. Muck - fine, partially decomposed organic material. Marl - white calcarious matter left from the disintegration of snail and clam shells. Silt - fine, largely inorganic material. Use the color scheme representing these different types of stream and lake bottoms and place on the map in correct positions. For lakes the outline of the various bottoms may be drawn on the map without shading in solid areas.

A simple bottom sampling device can be made of a bucket weighted along one side. The bucket can then be dragged along the bottom. Ten pounds of weight should be used and if the rope required to haul the bucket is graduated into feet, soundings can be taken at the same time the bottom is studied.

10. Air temperatures will be taken by holding the thermometer at the level of the eyes. Take air temperatures immediately prior to taking the water temperatures and directly over the place where the water temperatures will be taken.

11. Water temperatures must be read under water and not until three minutes have elapsed. Lake temperatures should be taken at deepest portions and at the surface. Use a maximum and minimum thermometer. Take stream temperatures only during the summer.

12. Oxygen samples will be taken if necessary, where other diagnostic characteristics are not clear in making decisions. Titrate with sodium thiosulphate and figure the parts per million of oxygen in the water. See bulletin "Standard Methods of Water

Note - Indicate depths at which oxygen samples are taken.

Analysis, "American Public Health Association." 50 West 50th Street. New York, N. Y.

13. The determination of the free hydrogen ion concentration of various waters is very often desirable. (Indicate depth at which PH is taken.

14. Self-explanatory.

15. The determination of the average depths of lakes requires many soundings which can best be made during the winter. Be sure you find the deepest portion. Do not estimate this item. Use a ten pound sounding lead. Place correct location of the soundings on the field map, and make a topographic map of the lake with 5' contours.

16. An accurate estimate of the acres covered by every lake must be made; also, acreage of flowages and ox-bow lakes of a stream in each section.

17. The length of the stream should be accurately measured in miles through each section of land the stream traverses.

18. The volume of flow of gallons per minute for each stream in each section of land it flows through may be made by the following technique:

MATERIAL NEEDED

1..... Watch with a second hand.
2. ..... Ruler graduated into inches.

PROCEDURE

1..... Locate place in stream where the banks are comparatively straight and the flow of water uniform over the entire stream bed.

2..... Measure width of stream in inches.

3..... Measure along each bank and in the center the depth of the stream and average. Place sticks where the measurements were made.

4..... Two feet above the aforementioned sticks, place other sticks in a direct line with the current.

5..... Compute the volume of the rectangular parallelepiped marked off in cubic inches.

6..... Compute cubic feet in parallelepiped (1728 cubic inches in a cubic foot.)

7.....Take average time in seconds it takes a headless match to float downstream between each of the three pairs of sticks.

8.....Compute number of gallons present in the cubic feet (about 7.5 gallons per cubic foot.)

9.....Compute gallons per minute flowing through the stream channel.

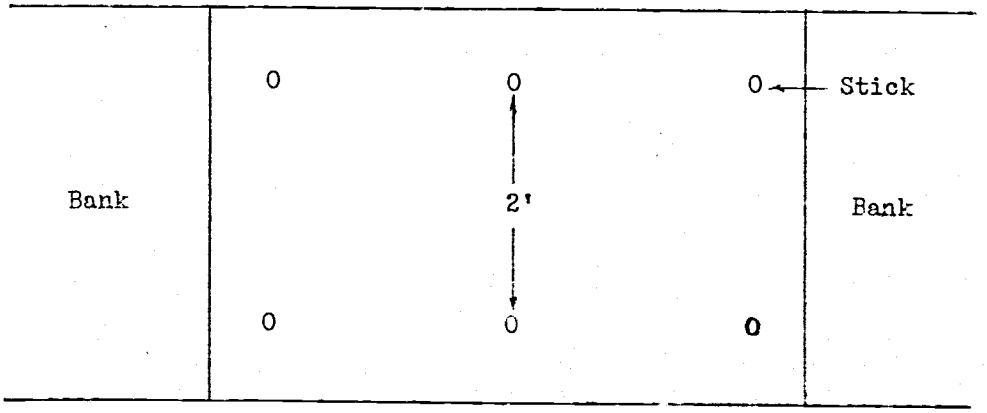
EXAMPLE PROBLEM

3.5 cubic feet
x 7.5 gallons per cubic foot
26.25 gallons

3 seconds time to flow in two feet

3)26.25
8.75 gallons per second

8.75
x 60
525.00 gals. per minute*



19. Tributaries, feeders, outlets, etc., entering into each lake should be named and classified. All feeders to a stream should be listed in each particular section of land they join the main stream, and these feeders, etc., must be surveyed by the section if they are large enough to attract fish of a catchable size.

20. Cover is construed to mean any logs, brush, rock, overhanging vegetation, weeds, etc., which affords fish life suitable hiding places. State if it is abundant, common, rare or none.

(*Subtract from 15 - 20% from this final figure - as the bottom waters are not traveling as swiftly as the top waters.)

21. List the percent of Government and private lands along each section the stream flows through and the percent of Government owned lands and privately owned lands around each lake.

22. The general character of the soil which surrounds the streams and the lakes must be ascertained. A classification which will be used is as follows:

A.....Gravel - Small water smoothed rocks, containing up to 30% fine materials.

B.....Sandy Soils - Containing 80% or more of pure sand - (a) Fine sand (b) Coarse sand

C.....Clay Soils - Finest possible state of division, is very cohesive, dries to a rock-like hardness, plastic when wet and composed of 60% or more of clay.

D.....Loam Soils - Comprises those soils ranging between sand and clay, and possessing more or less of these two constituents.
(a) Heavy clay loams...10% to 25% sand
(b) Clay loam.....25% to 40% sand
(c) Loam.....40% to 60% sand
(d) Light sandy loam...75% to 90% sand

E.....Marl - Calcarious deposits, carbonate of lime never to fall below 15% nor the quantity of clay to rise over 75%.

F.....Lime Soils - Calcium carbonate from 50% to 75% of total.

G.....Peat - Soils resulting from partial decay of vegetable matter while under water.

H.....Muck - Soils resulting from partial decay of vegetable matter under water, but differing from peat in that it is not as compact and will break up into powder when dry.

I.....Humus Soil or Vegetable Mould - Product of vegetable decomposition not under water. Vegetable matter up to 70% of dry matter.

23. Check the types of vegetation using the standard F. S. Symbols. List the most important types bordering each stream in each section of land it flows through and the most important types surrounding each lake. By importance is meant the types which are most apparent and exert the greatest influence on the soil, etc. Type as far back from shore as you can see and map in these types.

24. List the correct number of farms draining into each section of stream and the number of farms surrounding each lake.

25. Accessibility - whether the water is readily reached by auto, trail, railroads, etc. Use easy - not very easy - very inaccessible.

26. State whether the body of water is fed by springs, lakes, swamps or surface drainage.

27. Is the fishing good, poor, etc? Ask natives, sportsmen, etc.

28. Give reasons for your choice in stating that the fishing is good or poor, etc.

29. Check the species of fish which occur in the lakes or streams. Be sure of your identifications. Minnow nets and hooks and lines may be used to advantage in determining the various species. Local inhabitants may be questioned, but their opinions and knowledge must be checked.

30. A study of the vegetation of lakes and streams is useful to determine amount of cover and food present in the waters. Weeds harbor and foster much animal life such as immature insects, snails and minnows. Pondweeds (Potamogetons) known as buck weeds, bass weeds, etc. Chara - an alga sometimes known as stink weed - grows in quite deep waters (10-15' deep). See "Duck Foods," Wildlife Handbook.

31. Number of beaver dams which are being used and the number which have been vacated should be listed.

32. Give the number of active beaver houses and the number of inactive houses.

33. Take three sample plots of 1/10 acre for each change of aspen site to determine the average number of trees per acre, average d.b.h., and average height. See Symbols. Average these plot figures at the end of each day and place results on the survey form so that we may know in general the average tree height, average d.b.h., and average number of trees found per acre along any particular section of stream or around each lake.

We want to find out how many cords of aspen (total unpeeled volume) are around each lake and stream extending four chains back from the shore. Studies will be necessary to determine the increment of aspen on the various sites found and the volumes in cubic unpeeled stems. Studies of this are now being carried forward. Under favorable conditions beaver will double in numbers each year.

One 1" d.b.h. small aspen has been found sufficient to feed a beaver for a day.

34. Beaver recommendations should consist of whether the beaver should be removed, left alone or thinned out. Removal of beaver will be done on streams having a high yearly increment of trout. Beaver should be thinned out where their numbers are so numerous that their food supply is being exhausted beyond the ability of the food supply to regenerate.

35. Check whether the muskrats are abundant, common, rare or none on the lake or stream portion on which you are working.

36. State whether you believe trout, bass, pike, etc., should be planted. Lakes little fished and virgin lakes should not be planted unless it is desired to introduce other species not already present.

37. State whether you would recommend a fish or duck refuge.

38. List how many miles of stream per section should be closed and how many acres of a portion of a lake be closed to fishing or duck hunting. Locate on map.

CREW ORGANIZATION AND OPERATION

Each stream and lake survey crew will consist of three men who will operate as follows:

1. Leader and recorder

This man will have the leadership of the crew and should be specifically trained in taking and procuring the necessary data desired on the survey form. It will be his duty to see that the crew functions properly and that every member is operating as he should. He will keep the survey form up-to-date. When each section of stream flow is investigated, he will immediately see that all the necessary data which can be procured is recorded and that the Regional Office copies are made every night. He can be assisted by his helpers in details with which he feels they can be trusted.

2. Compass man and mapper

This man will have to follow the stream courses or the banks of lakes. His work can be accomplished with a pocket or box compass and the chainage may be paced. Before entering the field the mapper must have copied on acquisition map blank (Form 878) the spots where the lake or stream crosses or meets section lines, etc. This information can be procured from timber survey

or acquisition maps. The mapper can then tie into these places when he is in the field and so correct his own course, which will probably be inaccurate, due to the box compass method of running the traverse. However, if he is able to check himself every mile or half mile, the traverse run by means of the hand compass will be accurate enough. The mapper's duty entails the proper typing of all the timber types along the streams and lakes for a distance of four chains back from the shore. He will also type in all changes of aspen sites by means of a dotted line. All symbols to be used on the map must be familiar to him and used correctly. He must be equipped with the necessary colored pencils to use for mapping the stream and lake bottoms.

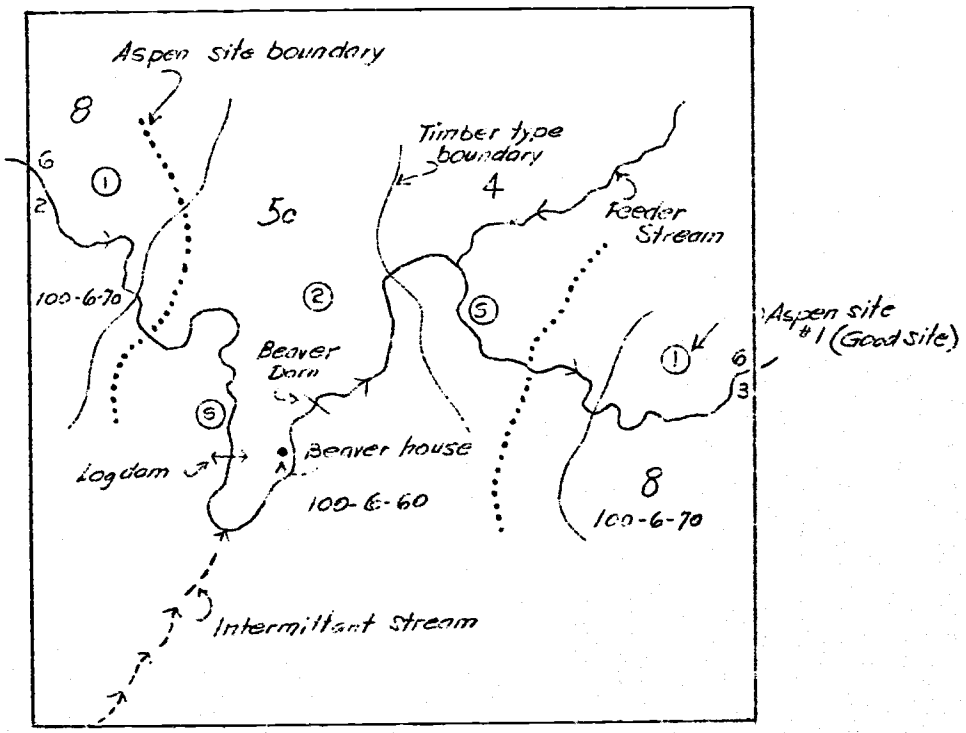
3. Timber Estimator

This man will be fully trained in recording the stand per acre of aspen in the various sites. It will be his duty to determine the site boundaries and estimates to the mapper for entering on the map. Three sample plots of one-tenth acre each will be taken for each change of aspen site. The sites are three - good, medium, poor. The plots will determine the average number of trees per acre, average d. b. h., and the average height. Aspen growth is figured for only four chains back from each shore on a stream and four chains back from the lake shore.

The Regional Office copy need not be accompanied by a map, but the original copy must have attached to it the field map - (Form 878),

When a stream is finished all the forms pertaining to that stream must be filed in order.

When the necessary data has been collected concerning aspen growth, each forest can review these lake and survey forms and determine from these maps and figures the carrying capacity of their forests in regard to beaver. By gathering the necessary data now we will not be compelled to go over our lakes and streams for further studies.



MAP LOCATING ASPEN SITES, ETC.

METHODS OF WATER INVESTIGATION

1. Determination of Oxygen Dissolved in Water

Solutions

The following solutions are needed for determining the free oxygen. (Parts per million.)

a. 480 grams Mn SO_4 per liter of water.
b. 6.2 grams Na thio SO_4 per liter of water.
c. 700 grams K O H plus 100 grams K I per liter of water.
d. Concentrated Sulphuric Acid.
e. Solution of Starch.

Test

a. Procure a 200 cc water sample.
b. Place 1 cc Mn SO_4 in water sample.
c. Then place 1 cc K O H plus K I (solution c) in water sample.
d. Then place in water sample 2 cc of the con. sulphuric acid.
e. Pour out 202 cc of water sample and titrate with sodium thiosulphate. Stop titration when the water sample turns colorless. Then use starch solution to more accurately determine the end point. The starch will turn the solution a violet color and further titration with Na thio SO_4 will clear the solution. When this is accomplished, the cc of sodium thio SO_4 used denotes the parts per million of dissolved O_2 in the water.

Be careful not to unduly shake or roil water sample when taking it, as this may allow dissolved O_2 to enter the water from the air.

2. Echman Dredge:

This is a dredge which takes a bottom sample of 6" X 6" or in other words covers 36 square inches of bottom surface. The volume measure is about 216 cubic inches. The jaws are closed by means of a spring which after being set is released by a messenger.

3. Peterson Dredge:

This dredge is heavier than the Echman and more adaptable for taking samples on a hard surface.

The measurement of the Peterson between the jaws are 7 X $10\frac{1}{2}$ inches or in other words, they will cover $73\frac{1}{2}$ square inches of the bottom surface when set down.

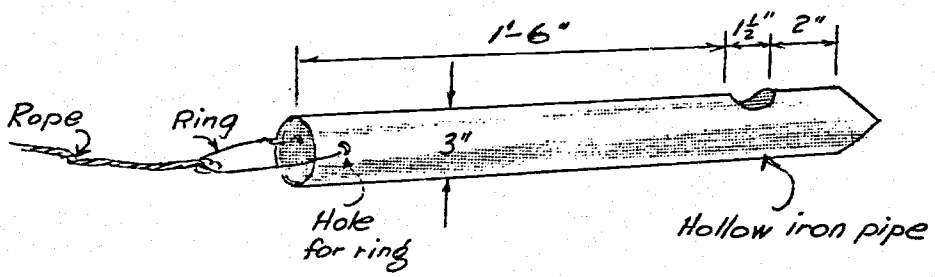
4. Determination of Free (CO_2) Carbondioxide

Pour 100 ml (i.e., 100 cc) of water sample in a narrow vessel being careful not to shake the sample. Add 10 drops of phenol-phthalein indicator and titrate rapidly with N/44 sodium hydroxide, stirring gently until a faint pink color is evident. The free CO_2 in parts per million is equal to 10 times the cc of N/44 sodium hydroxide used. Run test immediately after taking water samples as the CO_2 escapes rapidly.

Free CO_2 expressed as $CaCO_3$ may be determined by multiplying parts per million of free CO_2 by 2.272.

(See Standard Methods for the Examination of Water and Sewage 7th. ed. 1933. American Public Health Ass'n. 50 W. 50th. Street, New York, N. Y.

5. Bottom Sampler



6. Kemmerer Water Bottle.

Supplied by the Forest Mechanical Specialty Co.,
2407 Ballen Street,
Chicago, Illinois.

1200 cc. Capacity.

A DETERMINATION OF YIELD IN LAKES AND STREAMS

To facilitate the management of waters on a sustained yield basis, it is desirable that a yield study be made of the various classes of lakes and streams found in the National Forests.

Two examples of each class of lake and stream found on a Forest should be chosen for this study, but if it is impossible to find a typical class of lake or stream, it will be desirable and worthwhile to substitute other bodies of water which are approximately typical.

The lakes and streams which are to be under observation should be quite accessible to the fishing public, but do not choose waters which have been overfished, dynamited or netted. It is best to investigate the history of each lake and stream to be put under observation. These lakes and streams will be handled the same as administrative study plots and all records kept in duplicate and accurate maps and survey data kept. Sections or portions of a stream system may be used, but lakes must be studied as a unit.

Men must be stationed at these lakes and streams during Saturdays and Sundays of the fishing season so that they may contact the public and explain to them the purposes of the investigation and take the necessary information.

The pounds of fish caught by each fisherman should be obtained by accurate hand scales, and the number of hours and fractions thereof spent in catching these fish recorded, to find out how many pounds of fish the various waters are producing each year for every man-hour spent in fishing.

Care must be exercised in determining how many hours a man spends in fishing, as he may go fishing but decide to do something else when out of sight of the recorder. Each fisherman should be asked if he fished the entire time he spent on the lake or stream and if he did not, find out how much time was taken in doing other things.

It is desirable to compare lakes and streams on various forests in respect to their ability to produce fish life. Comparisons will assist in determining what one lake or stream lacks which perhaps another one possesses. It may be a difference in fertility or a difference in protection. At any rate there will be several bodies of water in each class that will have a high rate of productivity while others will show a low rate, the first of which will be termed good sites and the latter poor sites, from which can be constructed a normal yield table for the productivity of waters. The question of how to make some of the various waters more productive will then be the problem of improvement and controlling the limiting factors. There is no doubt but that all waters in the National Forests can be

made to produce maximally. The only question will be--Is the lake or stream worth improving and controlling, as determined by need and priority of this type of work? It is apparent that those lakes and streams which are called upon to produce the most should be the ones first attacked. Virgin lakes and lakes little fished can very well take care of themselves and provide plenty of sport to those wishing to fish them. Efforts for improving must be confined to those waters which are being used incessantly by the public.

Each lake being studied for yield data should be accurately mapped and survey data taken in full. If a Class III lake is being studied, it must be known exactly when the thermocline conditions take effect and how much of the waters are above the thermocline, etc. The records must be accurately kept, including all facts pertaining to interesting findings, such as the catching of an exceedingly large fish or a rare species, etc.

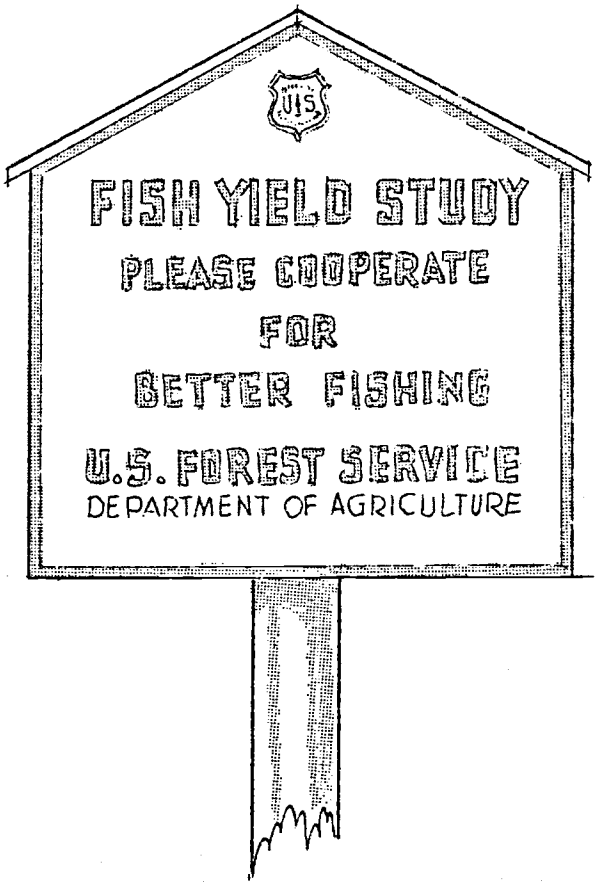
Yield can also be measured by study of dredge samples and by plankton counts. However, this entails special technique and equipment and will serve only as a check on fish yield studies. Work of this kind will be carried on by the Bureau of Fisheries, or various Universities in cooperation with the Forest Service.

As the forester ascertains soil quality in relation to the growth, so the limnologist has derived means of determining the production of lakes and streams by the following factors:

1. Fish yield studies
2. Dredge samples
3. Plankton samples
4. Actual measurement of water fertility
   (Measurement of salts and elements in waters.)

Note

The value of the figures derived from this study of fish yield will be entirely dependent upon the accuracy with which the field men accomplish their work. The greatest care must be exercised in not guessing the time element. It must be remembered those figures mean little unless compared to other figures. If every investigator does his work carefully, the results will be very much worth while.



Place such a sign wherever fish yield studies are being made.

G
Fish & Game
Form 92 R-9

DAILY FIELD RECORD OF FISH YIELD

Species° _____ Date _____

Lake or Stream _____ Class _____ Forest _____

Name of Fisherman or Other Designation	Time of Fishing		Pounds of Fish Caught	Remarks
	Time Began	Time Stopped		

° Use a separate sheet for each species.

G
Fish & Game, R-9
Form 93 R-9

Due December 1 each year

ACCUMULATIVE RECORD FISH YIELD

Species _____

Lake or Stream _____ Class _____ Forest _____

Date	No. of fisher-men	No. of fisher-men to date	No. of fish-ing hours	No. of fish-ing hours to date	No. of pounds of fish	No. of pounds of fish to date	No. of pounds per man hour today	No. of pounds per man hour to date
								(Divide no. lbs. to date into no. hours to date to get this figure)

INSTRUCTIONS FOR STREAM IMPROVEMENT

(Diagnosis and Control Measures)

The production of trout depends almost entirely upon the stream conditions of water, stream bed, food and cover.

Improvement of these will increase the number and growth of fish by providing better spawning and hatching grounds, more food, better protection, more resting places and the much needed colder water.

Limiting Factors and Relief Measures

1. Lack of fertility- Drain farm yards into stream; deposit fertilizer in water; haul in hay and leaves; plant forest cover and keep out fires.

2. Lack of cold water - Seep springs may be dug out and ditched to insure a cold stream of water emptying into the main stream. (Split hollow cedar logs make excellent tiles for such drains.) Beaver may be moved.

3. Lack of adequate shelter. - Dams, deflectors, covers, etc., may be constructed to provide resting places for trout. Young trout especially are in need of brush shelters, etc., for their protection.

4. Lack of spawning grounds. Gravel, if present, must be exposed if covered with silt, or may have to be hauled into the stream, if not present. Spawning grounds which will permit the eggs to become covered with silt must be altered to prevent such silting.

5. Lack of food - This is corrected by establishment of food producing riffles and weed beds.

6. Over fishing - It may be necessary to close some parts of the stream to fishing. Small feeder brooks may be closed for the protection of young trout. Planting of fish and building of rearing ponds may be necessary.

The limiting factors of fish life as divulged above gives an idea of the complexity of the various things affecting the life of the streams. Those factors should be attacked first which needs an abundant supply of man power to control. Therefore do those things first which, though they may not be the most important in improving our streams, require a large amount of manual labor.

It is apparent, then, that the construction work must be accomplished now. This brings us to a discussion of the various methods of improving our trout streams by constructing covers, deflectors, dams, ditching seep springs and planting shade plants. This work requires many man-days of work and should be done while we have the CCC labor.

Natural Work

Precaution must be used to keep the various structures of stream improvement work natural and not unsightly and repulsive. Build deflectors only high enough to take care of the average flow of waters. This may mean that a deflector will stick about 6" above the low water stage. High flood waters may flow over the structures without any damage provided they are well anchored. Keep covers, etc., under or at the surface of the low water line.

Tops of stakes must be sawed off at the level of each deflector or cover and not allowed to stick above the water, as this gives the improvement structure a very unsightly and unnatural appearance.

There is an art in camouflaging and concealing deflectors, etc., which is very important for foremen to master. Pile on and wire sticks at various angles to the covers. It will make them more effective and less unsightly, as they will then take on the appearance of brush or drift piles. Sod placed over deflectors and covers where streams do not overflow makes natural looking work.

Tools and Equipment

The necessary tools must be provided for the work and kept in good condition. Sufficient tools to equip the crew should be at hand so that each member of the crew will be effective.

When available, a horse can be used advantageously to haul logs and boulders for the construction work.

A motor-driven fire pump and hose frequently is a real economy in jetting in the many stakes and posts needed in some units. The pump and engine must be floated on a raft. A five foot jetting pipe is necessary, its end being reduced to 3/8" opening. At least 50 feet of hose should be used to place the jettying tool where it is needed.

Equipment should be charged to individuals who are using it and each held responsible for its return.

The needs of the crew should be determined in advance and requisitions should be made in anticipation of the work to be done.

Work

The crew foreman should designate the work on the ground in advance so that no time will be lost by the crews. Stakes will be set along the stream and marked with symbols indicating location and type of work to be done. These symbols are standardized

and included on a separate sheet, attached hereto.

Small crews of probably three to six should be assigned to separate jobs in order to avoid crowding, duplication of effort, and confusion. Some units will require larger crews to handle heavy material. It is suggested that each man and each group have definite jobs assigned to them, as has been done on many streams where the group was divided into four crews. First, there is the "staking" crew, composed of two or three men whose duty it is to place the stakes for the structures the foreman has designated by symbols. The men on this crew will have to be trained to know what the various symbols mean and where to place the stakes. They will progress downstream as fast as they can drive or jet in the stakes.

Another crew, with or without the use of a horse, can gather material to be deposited on the shore of the river, where a "driving" crew can then take the logs, stakes, etc. downstream in sufficient quantities and in suitable places for the construction crews.

One or more construction crews can be used to build the various stream improvement devices.

Conditions on every stream are different, however, and a plan that may be suitable on one creek may be unfit on others. One thing must be guarded against on all jobs, and that is putting too many men in one place. It is better to have a minimum of men working than a maximum. The work can be planned so that each man is kept busy and there do not arise conditions during which one or two men are doing all the work while half a dozen look on.

Work should begin at the upper end of the stream within the camp work zone and one stream with its system of feeders must be finished before the crew leaves for another stream.

All slash and debris resulting from the work should be disposed of. Holes dangerous for animals or people must not be left on the shore where gravel, etc., was obtained.

All structures must be firmly anchored or staked to the substrata. These devices for stream improvement must be durable. All logs used for deflectors and some of the cover logs should be butted into the banks at least three feet and those ditches then covered. Each deflector log and cover log anchored to stakes must be securely fastened by #9 wire and spikes. Stakes should be driven or jetted into the stream bed so that they will be embedded at least three feet below the bottom of the hole that will be excavated.

Where ice forms and there is danger of its tearing out improvement devices, the covers must be submerged and fastened under water so that they will be free from the ice.

Seep Springs

Seep springs should be dug out and led to the stream to insure a continuous and cold flow of water directly into the stream. Wooden tiles can often be constructed from hollow cedar, but any wood may be used. Logs can be split in half and hollowed out or troughs may be built.

If the trough is closed to keep debris out, the halves must be bound together tightly with number nine wire. In many cases the drain need not be covered; however, where an open drain is likely to become clogged it should be covered.

Live Trees, Shrubs, Sod

No living trees or shrubs which shade the waters at any time of day must be cut. Sod which is protecting the banks must not be disturbed.

Beaver Considerations

It may be found advisable to move beaver from trout streams to other localities due to their dams impounding and warming the water, blocking the migration of fish, and causing a deposition of silt over gravel spawning grounds. However, streams incapable of holding trout without the pools afforded by beaver dams should be managed for beaver.

In order to avoid any harm to the beaver their elimination from trout streams may be accomplished by tearing out their dams, catching them by their tails, and placing them in boxes for shipment. As the water begins to run from the ponds, the beaver will try to escape upstream. The procedure is to station men where the stream is narrow and catch the beaver as they make their appearance. Some will try to enter bank burrows. Such places must be watched. Others will stay around the house even though practically all the water is drained off.

Where very young beaver are present no attempt should be made to move the family. Beaver should not be moved or their dams torn open after August 15. They must have sufficient time to relocate themselves in their new homes and gather food for the winter supply.

Permission of Conservation Departments or local conservation officers should be obtained before beaver are moved. Likewise no beaver should be moved without notifying the Branch of Lands at the Regional Office.

EFFECTS OF BEAVER WORK ON TROUT STREAMS

Beavers cause numerous changes to occur in trout streams. Some of these changes are listed below:

1. Beaver ponds accumulate a great amount of organic matter. This matter is a drain on the oxygen content of the water. Sometimes it is so large a drain that it kills living organisms in the pond.

2. As beaver damages increase, acidity occurs which results by release of carbonic and tannic acids from flooded and submerged timber.

   Trout that are able to survive in such waters are hardly palatable.

3. A beaver dam, even a small one, causes a rise in stream temperature from one to several degrees and also may cause a great loss of water by excess evaporation.

4. Many miles of good trout spawning waters have been spoiled because of the rapid cooling of water back of dams in early winter due to increased exposure to the air. Brook and brown trout spawn in late fall and the water may be cooled below the temperature best suited for their spawning.

5. All dams, beaver or others, cause the waters to deposit a large amount of fine silt. In times of high water, this silt is washed down stream for a great distance, heavy deposits of which cover a large amount of food and trout eggs previously spawned and also covers spawning grounds.

6. Fish near the spawning stage attempting to reach the head waters or other good spawning grounds are prevented this ascention by beaver dams. Not being able to ascend the stream, the trout will eventually spawn below the dams when and if the water temperatures are right.

7. Streamside trees, especially aspen, cut by beaver for food, results in loss of shade. Other timber may be killed and shade destroyed for a great distance on either side of a stream.

° J. C. Salyer. Report on Beaver Trout Study. (Unp. Mns.)

Cleaning Out Streams

Streams littered with logging debris which is clogging up the stream beds and causing a deposition of silt must be cleaned out and deflectors installed to create holes and wash away refuse.

Many streams are unduly warmed and silted because of windfalls, accumulation of dead brush and beaver litter. All such material not of benefit should be cleaned out.

Types of Stream Improvement Devices

Deflectors

Deflectors are perhaps the most useful devices in stream improvement work and can be used advantageously on any stream which lacks suitable holes, spawning grounds and shade. By their installation the power of the water can be used to dig holes into the bottom of the stream; currents may be pushed under overhanging shade and holes formed under the natural cover; silt, sand and muck may be washed away from gravel beds; waters may be confined and the temperature of the stream lowered. It has been demonstrated that by doubling the velocity of the water, the eroding power of the stream is quadrupled and the carrying powers are increased 64 times.

Gravel beds exposed by deflectors not only afford suitable spawning beds for trout, but they are very productive of animal life. Shifting mud and sand bottoms smother animal life and are poor producers of trout food. Larvae and nymphs of the various aquatic insects require a permanent substrata to which to cling, and will die if they are covered up or cannot become attached.

In the slack waters behind the deflectors weed beds are likely to establish themselves, affording a suitable environment for large numbers of aquatic insects which are always acceptable to trout.

Underpass Deflectors

Underpass deflectors are perhaps the simplest and most efficient structures which can be placed in sandy or silty streams. They readily create holes and uncover existing gravel deposits. Covers may be anchored to them, making such structures doubly effective and serving two purposes.

The "digging log" is a common underpass deflector adapted to our streams. An end is butted into the bank and the log anchored about 6 to 10 inches above the surface of the stream bed. The bottom of the log may be slanted to a 45° angle to offer the water less resistance and so force it more quickly against the stream bed. Several logs may be wired together if one log is not sufficient. These deflectors must be put securely in place and must not be movable by stream action. (See Figure 6).

Construction of Deflectors on Rocky Bottomed Streams

In streams which possess a bedrock bottom or streams in which the bottom is so littered with large stones that stakes cannot be driven into the substrata to anchor deflectors, it has been found necessary to employ the following methods of construction:

A core of wood is laid down which, for instance, may be a large cedar log. Over this is placed a mat of poles and number nine telephone wire. The poles are placed about two feet apart, and wire is fastened to them at right angles every three feet. This lattice is then thrown over the cedar log; large stones and boulders are piled over the mat, and around the log. The stones catch and are held between the poles and serve to anchor the whole structure firmly to the bottom of the stream. Such a mat of poles and wire then acts as a brace to the whole deflector. It has been found that such structures hold well in streams of this type.

The end of the log should always be sunk at least three feet into the bank and covered up. (See Figure 13).

Trout holes can be made in hard-bottomed streams by blasting out holes in the rock and gravel. Such holes will be more effective if deflectors are placed so as to shoot the water into them.

Construction of Deflectors on Very Sandy or Mucky Streams

Where there is excessive undermining of deflectors due to shifting, sandy bottoms, the only way to permanently stop seepage and undercutting is by means of a brush and wire mat. Brush is interlaced with wire and placed over the deflector log. The brush mat must extend three feet on each side of the deflector and be covered with sand or sod. Undermining is then impossible. Stakes should be used in connection with mats. (See Figure 16).

Covers

Many of our forests have been repeatedly burned so that the land is practically denuded and the streams exposed to the direct rays of the sun for long periods of time. Where such conditions exist every possible advantage should be taken of any natural cover. The current of the streams can be made to travel under overhanging brush and stumps by the use of deflectors.

Deep cut bends and banks are advantageously covered by log rafts. Brush should never be used in such places as a cover, as it slows down the current with resultant deposition of mud and silt, and the natural hole is quickly filled in. Covers not only

afford protection and hiding places for trout, but covered areas are less exposed to the sun's rays and the waters are, therefore, kept cool.

Covers can be attached to underpass deflectors and placed over the holes occasioned by these devices. All covers must be securely anchored above the stream bed to be effective. Water-logged covers will in time sink if they are not held in place by stakes, etc.

Stumps, make excellent covers, but they must be anchored securely under water to become permanent, effective and not unsightly.

Most covers act as underpass deflectors in that they force the current downward and create holes beneath themselves. Long stakes should, therefore, be used for covers, and driven into the stream bed as far as they would be for a deflector.

Planting

Where natural cover has been destroyed or is otherwise lacking, it is very desirous that shrubs and trees be planted along the banks of streams.

Cedar is the best cover tree which can be planted along streams, as it casts a deep, full shade, and will grow into a large tree, which under ordinary circumstances will live a hundred years. Young cedars are best transplanted from their native swamps in the fall, but if grown in nurseries the seedlings can be planted either during the spring or fall. Plant cedar eight feet apart, in double rows six feet apart, along each bank of the stream.

Willow and tag alder make good cover, and will grow and spread so rapidly they will soon form a dense mat of brush along streams near which they have been planted. The cuttings of these two species should be about 10" long, and may be procured during early spring, as soon as the sap begins to run, and stuck along stream banks. Take two-year old branches which possess many buds and put the cuttings into the ground about four inches where the water table is high enough to be within one foot of the stem, and plant them one foot apart in a single row along the banks.

Bundles of cuttings 10" in length can be gathered during the fall and "heeled in" in a well drained sand bed over winter, and planted the following spring. Always take two-year old stems on which there are buds.

Brush Shelters

Small side channels and feeder streams may be screened by brush to afford protection for young trout. However, brush placed

in streams causes a deposition of silt, etc., and this practice is not usually warranted. Large trout are prone to work down small streams into the larger rivers and so may not constitute a menace to young fish being raised in the feeder streams. Where small feeder creeks are not available for the rearing of young fish, brush shelters may be placed behind deflectors on the downstream side, but should never be thrown directly across streams.

Dams

Damming of trout streams is not to be suggested as a valuable stream improvement method. Damming tends to warm the waters and extensive damming may so raise the temperature that the lower reaches of a trout stream will be ruined.

Never dam the cold head waters or the upper stretches of a stream. Allow as much cold water as possible to reach the lower portions of the river.

Dams may be advantageous if built of rock and so constructed that there are one or more channels through the dam. Holes will be dug where the water pours out of the channels.

Hewitt Dams

In the construction of Hewitt dams, woven fence wire may be used instead of poles, if poles are scarce, and the woven wire is available. When poles are used they should be nailed to the large base log and must be fitted so that there is a minimum of space between them. (See Hewitt Dam - Improvement in Michigan Trout Streams, by Carl L. Hubbs.) Woven wire generally provides as good a base as poles and is more economical, if labor costs are considered.

Cedar or balsam boughs should be placed over the poles or wire to a depth of six inches. Clay and then gravel on this will make the structure quite water-tight. Large boulders should be placed on the dam to hold it in place. Sometimes stakes may be driven into the substrata to anchor it. Hewitt dams are suitable particularly for streams with solid rock bottoms where other structures would be washed away. (See Figure 14.)

Method of Tightening #9 Wire Around Logs and Stakes

One man staples the wire to a stake or log and then inserts the wire into the claws of a carpenter's hammer, putting the head of the hammer against the stake or log and using the handle as a lever. As he pushes down, the head of the hammer will act as a fulcrum and the wire can be tightened. Another man can then staple the wire to the log and stake while it is being held taught in this manner.

Stakes

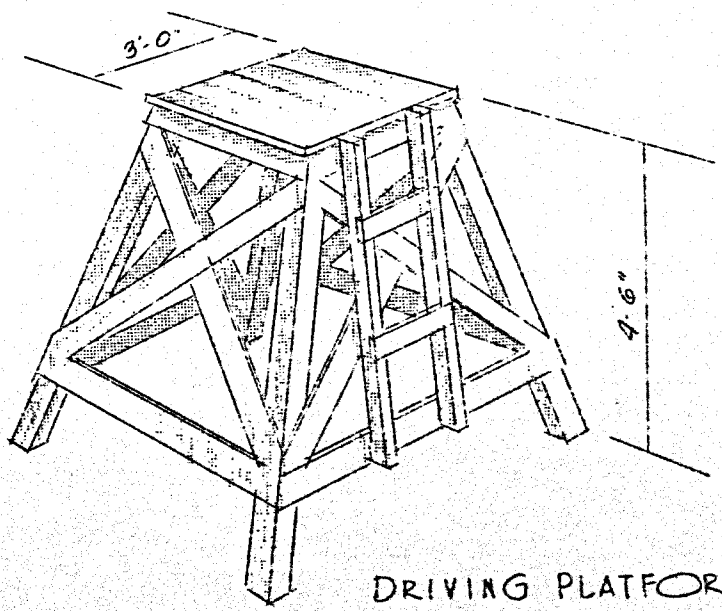
Cedar or tamarack stakes are the best material to procure for anchoring deflectors and covers. Any other wood may be used provided the cedar or tamarack stakes are not available, but some plans can usually be made during winter months to procure the best materials.

Stakes must be driven deep enough into the stream bed to hold the various structures. In gravel, stakes may hold well if only 2' in the ground, but a good rule to follow is to drive stakes at least 3' below the level of any probable wash-out due to undercutting or digging of the waters by deflectors or covers.

Some very silty streams with loose shifting bottoms may require stakes 8 to 10 feet long. It is unnecessary, however, to use such long stakes on every stream, for conditions found in one river are seldom repeated in others. Individual streams may differ somewhat in texture of bottoms and so require different lengths of stakes, and there is nothing gained in driving 8' stakes into the ground, when a five foot stake will do.

Stakes are best driven into the stream bed by means of a steel sixteen pound sledge. The tops of the stakes must be wired to avoid splitting.

It is very often necessary to make a driving platform from which a man can drive the stakes into the ground. Michigan conservation workers use a tower-like structure which proves very practical.



RW

DRIVING PLATFORM

Records

A Daily Progress Record will be kept and accomplishments for each stream posted. A day will be construed to mean a six (6) hour working period. One man-day is one day for one man. The standard symbols for the type of work will be used. Structures built during the day will be recorded in one of the accomplishment columns, and the number of each kind of structure placed in the following column. This progress record must be posted daily. (A sample form is attached.)

A Progress Map on a scale of four or more inches to the mile will be kept. The stream must be located on this map and the standard symbols inserted in the correct place, as the work progresses.

Gathering of Material and Data

Material such as logs and stakes can best be gathered and placed at advantageous spots along the stream during inclement weather in the working season and also during the fall, winter and spring. A horse is very useful to skid material out to the banks. One horse used during the winter for this purpose lessens the work of the following summer considerably. The materials can then be floated into place when needed.

During the winter the foreman should scout out the areas to be worked, mapping in all the streams and their feeders and determining the status of all lands surrounding the creeks. An accurate traverse of the streams and a status map should be ready for use before work is started, but if this cannot be entirely completed before the work is initiated, it must precede construction by several days. It is a better procedure, however, to have this preliminary work entirely out of the way before work starts. The winter is the ideal time to do this.

All optioned and Forest Service land may be worked without permission. Private lands cannot be worked unless the owner's permission is gained by written agreement containing the following stipulations. (See form attached.) Duplicate forms must be filled in; one copy to be retained in camp and one sent to the Supervisor's office. Work no private land without permission.

Temperatures to be Taken on Stream Work

Temperatures should be taken before and after work on the various stream waters which are being improved. Air temperatures should be taken immediately before water temperatures, and the thermometer should be held at the level of the eyes and taken above spot where water temperatures are to be taken. The reading of the water temperatures should be taken under water and only after a lapse of three minutes. Accurate centigrade thermometers

have been sent to the field for this purpose.

The temperature readings before work has started should be taken every half-mile along the entire stream to be improved. If work has already started, take first reading one-half mile downstream from the work. Reading points will be marked by permanent posts labeled inthe following manner: Each post should possess a number and be located on the progress map. See Figure 19.

Temperatures at these locations should be taken every week during the working period. At the end of the working season these reports must be filed and be accessible to carry on the investigations the following year. See form attached.

When work has progressed one-half mile beyond such stakes, "after temperature" readings should be taken and recorded every week.

All temperatures taken should be obtained at the same time of day each week. If the first temperature of location #1 is taken at 11:00 A. M., all subsequent readings at this location should be taken at 11:00 A. M.

Most of the small streams and springs which are ditched or cleaned out should have "before" and "after" temperature readings. Attached are sample forms to be used in recording these temperatures.

A trustworthy employee, after proper training, may be delegated to gather the temperature readings if the foreman is too busy to do the work.

A thermometer is a good instrument to use when making a survey of the different streams and in determining the mode of attack. A thermometer should be us ed in connection with staking out work for the crews in the summer, as seep springs may be located with its use and deflectors and covers correctly placed. Cold spots in the river may be found toward which waters may be directed. Excessively warmed areas are often detected and can then be covered or eliminated.

IMPROVING SMALL SPRING FEEDERS

Small spring feeders are often nurseries for immature trout. Adult fish migrate into them to make their redds and spawn.

Often these small feeder streams are choked with beaver dams and other debris, making spawning conditions wholly impossible and blocking migration of adult trout to gravel beds. Many of our large streams possess feeders which are affected in this way, and therefore natural reproduction has become virtually impossible in them.

These nursery streams must be cleaned out, and all refuse which is blocking the water flow removed and piled on the banks. Silt and bark will then be washed away down stream and if gravel is present it will be quickly exposed. Small deflectors can then be advantageously placed in the stream and water cress planted in the slack water area behind the deflectors, thereby developing a very desirable cover and feeding area for small trout. Mosses such as the genus Fontinalis can be introduced on the gravel rapids and riffle areas, and further enhance the food and cover possibilities.

Under no consideration should extensive brush deposits be placed in those streams which will cause a deposition of silt, or block the migration of adult trout during spawning periods.

Where gravel is lacking suitable spawning grounds may be made as follows: Place boxes of gravel° in moving waters where silt etc., will not cover them and where the gravel will be subject to continual washing by a fairly good current. Such a box every 50 feet should be provided in small feeder streams not containing gravel deposits. Where a bottom of sand, bed rock or clay is present, gravel may be dumped directly on the stream bed in sufficient quantities to provide spawning beds. Whenever gravel, so deposited, is likely to sink or be covered up by silt or sand, deflectors should be installed to confine the stream and so raise its carrying power enough to prevent sand etc., from covering up the gravel. Gravel sizes should range from a small pea to a walnut.

Planting of cedar, willows, etc., near small feeders will keep them cool. A man with a spade can also make excellent holes and hiding places under banks where small trout can find refuge.

IMPROVEMENT OF BASS STREAMS
(This applies to streams on which erosion is not a factor.)

Cold waters are not so essential to the development of smallmouthed bass as they are for trout. Many of the famous bass streams in the Lake States have been seriously affected by excessive floods during wet weather and by an almost total disappearance of water during protracted drought periods.

°See "Gravel Boxes" Lake Improvement for Fish.

The one permanent improvement of these streams will, of course be reforestation; but until that time arrives, we must attempt to keep bass in our streams and to afford fishing to the public.

The installation of dams is a good method whereby sufficient large pools can be made in which bass may live during low water stages, provided the deposition of erosion material is not too great. Dams may be advantageously placed at the neck of narrow defiles and other locations where the river is not likely to wash out around one end. In all cases a sluice-way or notch may be left in one or more places along the dam to allow fish and canoeists easy access over the dams. Also dams should never exceed 5' in height.

In making such dams a large mat such as described under the general discussion "Stream Improvement" must be thrown over a core log, the ends of which should be butted in the banks. Dams made in this manner will not wash out.

A series of dams along a water impoverished stream will greatly improve its carrying capacity for fish as aquatic insects etc., will have constant water area wherein they can develop. Another important biological point is, that as waters become older they become more productive.

As mentioned before, under the general discussion of stream improvement, damming cold trout waters is not a desirable means of improving a trout stream, and may, in cases of excessive damming, utterly ruin the waters for trout development.

Where excessive silting is known to occur in bass streams dams should not be installed but instead wing deflectors should be placed in order to carry away silt and erosion debris. In many bass streams such deflectors will cause excellent holes to be dug around their ends wherein bass may find acceptable conditions.

STREAM IMPROVEMENT IN MISSOURI

The streams of the Ozarks present quite different conditions than our more northern waters. Many of them originate from great springs or underground rivers, and possess a rapid flow of water, which upon issuance from the ground measures about 55°F, but soon becomes warmer, provided other springs are not present.

For perhaps two or three miles these rivers will be cool enough for a trout habitat, but soon the waters are no longer desirable for trout and are inhabited mainly by small-mouthed bass and pike perch.

The upper trout-bearing stretches of these streams should be improved, with careful consideration being given to the special requirements of trout. In all cases, waters should be restricted and confined under shady ledges of rock, and overhanging shelter. Covers, such as logs and stumps, are excellent to place in deep holes and along slack waters. It may be possible to continue trout fishing for several miles further downstream after improvements have been made.

Practically all Ozark rivers are eroding their banks with disastrous results, not only to farm lands but to themselves as well. Many of the small headwater streams have become filled with gravel and the waters are choked, running below the gravel beds and invisible. Everywhere there are shifting gravel and sand beds which allow no development of aquatic insect life.

In order to tie down these gravel beds and confine the stream channels, wing mat deflectors° are the only applicable structures to construct. The wire and pole mat will catch the rocks and hold them in place without the hazard of high waters tearing them away. The mat with its load of rocks acts as an automatic dam sheeting and presses down over the core log and seals any undermining. Poles and wire should be close enough together to catch the rocks used for the deflector. Such structures should extend about one foot above the average water flow. A three to one slope on the downstream side and a two to one slope on the upstream side will be enough to give the structures the right proportions.

Wings are best placed just upstream of soft eroding banks or where the waters need to be shoved onto a hard ledge of rock. Just downstream of these wings brush should be wired, as this will help to slacken the current and allow the deposition of gravel and sand. In time, suitable weed pockets may develop back of these wings to further enhance the fishing possibilities.

°See "Construction of Mat Deflector," Stream Improvement Instructions.

Cover such as stumps, etc., is often advantageously anchored in deep holes along the stream courses and will provide suitable resting and hiding places for bass and sunfish. Also, valuable fish food will collect on them.

Actively eroding gullies which are discharging debris and excess waters into the rivers should be checked by gully dams and planted to locust or other suitable plants which will bind the soil. Sheet erosion will be overcome by reforestation.

° Where conditions exist similar to those described for Missouri the directions given above may be used.

INSECTS WHICH INHABIT STREAMS

Trout feed extensively on insects, taking both the immature forms as well as the adults. Other animal life such as cray fish, small minnows etc., are not often taken except by larger trouts, which, due to their large appetites consume almost anything which they can capture. Even small snakes and mice are readily taken by them.

Many insects, inhabiting streams, fasten themselves to rocks or sticks and there undergo development. There are five common groups of insects found on rocks in fast flowing streams. Stoneflies (Plecoptera) are sometimes very common, being discovered around rock crevices or tightly clasped to the undersides of stones. These insects are recognizable in the larval stage by their two caudal appendages or cerci. No gill filaments are found on the abdomen, but are present on the ventral portions of the thorax.

Mayflies (Ephemerida) are very important as trout food, being found both on riffles and in slack waters. They can be differentiated from the stoneflies by the three cerci they bear on the caudal abdominal segment and by the fact that they possess gill filaments along their abdomen.

Nearly every rock in a stream will at times be covered by the cases of Caddis flies (Tricoptera.) Some of the larvae build cases of small pebbles, others build them of sand, sticks or leaves.

The larvae of the Neuroptera or Dobson flies have long been favorite bait for small mouthed bass fishermen. Trout find the larvae just as acceptible. The larvaes are often called Helgramites.

Black flies (Simulium) are commonly found clustered on rocks in fastly flowing streams in the spring. At times rocks will be completely covered by them, and when they hatch, trout find an abundant source of food.

Of the insects that do not relish swift water but are commonly found in slack waters and weed beds in streams and lakes, the Damsel and Dragon flies (Odonata) and the aquatic beetles (Coleoptera) are the most common. Also the Tipulidae larvae (Diptera), chironomous larvae (Dipters) and many species of mayflies are to be formed.

It is well that our fieldmen acquaint themselves with these various groups of insects so that they may become fully cognizant of the role these animal forms play in stream communities.

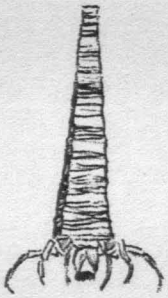
W. F. Morofsky in the Journal of Economic Entomology, Vol. 28. No. 1, February 1935 states that Stream Improvement definitely increases the insect population in streams. He says:

> " In conclusion, basing out studies made on bottom fauna and examination of trout stomachs, regardless of the many other factors which might determine an entire change, It was found that there is a correlation between the numbers and kinds of insect present in a stream to the species of trout

> present, and also that over a period of one year in an improved stream there was a decided increase of insect population over the unimproved areas, with a decrease in other animal life."

Scientific proof is therefore available to justify stream improvement.

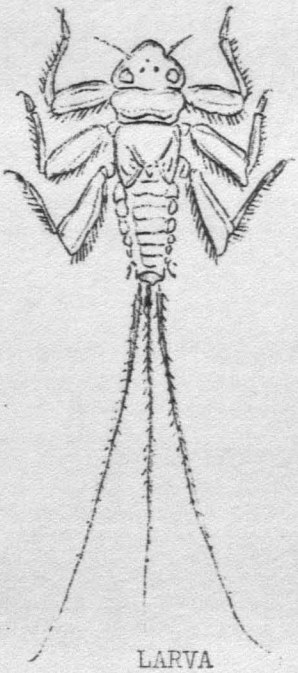
CADDISFLY



LARVA

ADULT

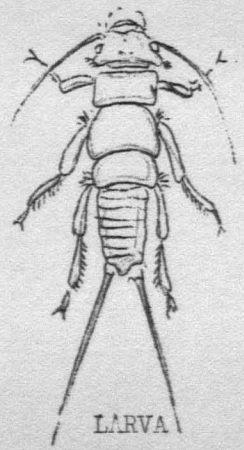
MAYFLY



LARVA

ADULT

STONEFLY



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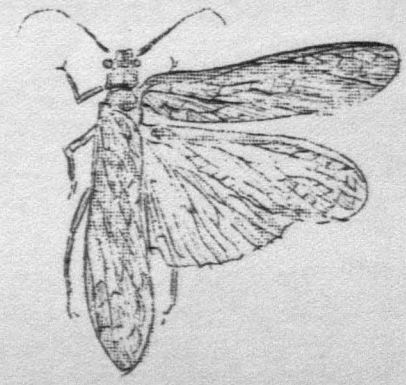
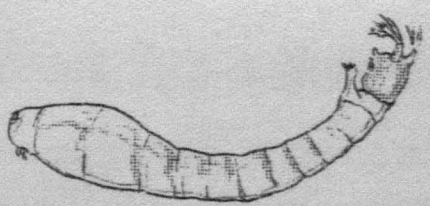


ADULT

BLACKFLY



LARVA

G
Fish & Game
Form #85 R-9

PRIVATE OWNER'S REQUEST FOR IMPROVEMENT
OF STREAMS IN THE NATIONAL FORESTS

It is hereby agreed that I _____,
owner of land described as follows: _____ (Township), _____ (Range),
_____ (Section), _____ (Forty or Lot), bordering or enclosing a
portion of _____ (Stream), in the _____ (Forest),
and _____ (Unit), request the United States Forest
Service to improve the _____ (Stream), bordering on
or flowing through my land by standards and methods approved by
said Forest Service. In return, I agree to allow the public free
access to those stretches of the _____ (Stream), which have
been directly affected by the improvement and which are flowing
through or bordering on my land. It is understood that no living
trees or shrubs will be cut in connection with the work. Only dead
snags may be taken out, if necessary for the construction of improve-
ment devices.

_____ (Witness) _____ (Owner)

_____ (Witness) _____ (U.S.F.S.Officer)

G
Fish & Game
Form #86 R-9

TEMPERATURE READINGS
(Stream Improvement)

Post Location No.	Location - T., R., S., F.	Foreman
Forest	Unit	Stream

Date	Time	Before Improvement		After Improvement	
		Air	Water	Air	Water

(Each post location to have separate data sheets.)

G
Fish & Game
Form #87 R-9

TEMPERATURE READINGS
(Seep Springs, etc.)

Forest	Unit	Stream	Foreman

No.	Date	Before Improvement		After Improvement		Remarks
		Air	Water	Air	Water	

STREAM IMPROVEMENT

Symbols

1 - Rock Dam

2 - Log Dam

3 - Hewitt Dam

4 - Side Deflector or Wing Dam

V - "V" Deflector

 - Over-under deflector

Y - "Y" Deflector

A - "A" Deflector

I - "I" Deflector

 - Digging Log

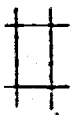
 - Bank Cover

 - Triangle Cover

((- Bend Cover

 - Square Cover

 - Tepee Cover

 - Log Cabin Cover

* - Brush Shelter

W - Establish Weed Bed

P - Plant Cover

O - Dig Out Seep Springs and Tile

B - Blast Out Side Rock for Material

These symbols will be used on daily progress reports and on progress maps. They will be used in marking stakes to locate work in advance of the crew.

LIST OF SUPPLIES
STREAM IMPROVEMENT WORK
(20 man crew)

1. Cant-hook----1
2. Timber carriers----3
3. Pickeroons----4
4. Pike poles (15 foot)----2
5. Steel Sledges (16 pounds)----4
6. Blacksmith hammers (4 pounds)----2
7. Fence pliers (12")----3
8. Spikes (eighty penny)----1 keg
9. Staples (galvanized)----1 keg
10. Wire (No. 9)----2 miles
11. Cross cut saws (two man)----1 to 3
12. Shovels (long handled)----4 to 6
13. Axes (double or single bit)----4
14. Drift pins----100 - various sizes
15. Splitting wedges----2
16. Dynamite, etc.
17. Picks (miners)----1 to 3
18. Stone Boat or go-devil for horse hauling
19. Skid chain for horse hauling
20. Boat or raft to transport tools, etc.

The amount of material and number of tools necessary will vary with each size crew and stream condition. The tools listed above are in most cases indispensable.

STREAM IMPROVEMENT

DAILY PROGRESS RECORDS

Camp ______________________ Stream ______________________

Date	No. Men	Man Hours	Total man hours to date	Man Days	Total man days to date	Linear yards constr.	Total linear yards constr. to date	Structures Symbol	Structures No.	Remarks
(Balance brought forward)										
(Total balance carried forward)										

Note: Deflectors must be measured in linear yards and all covers must be measured in linear yards along their longest axis.

Fig. 1 - WING DEFLECTOR
(Never placed on outside of the curve - used to dig holes and shoot current under natural shade and cover. Gravel will also be exposed.)

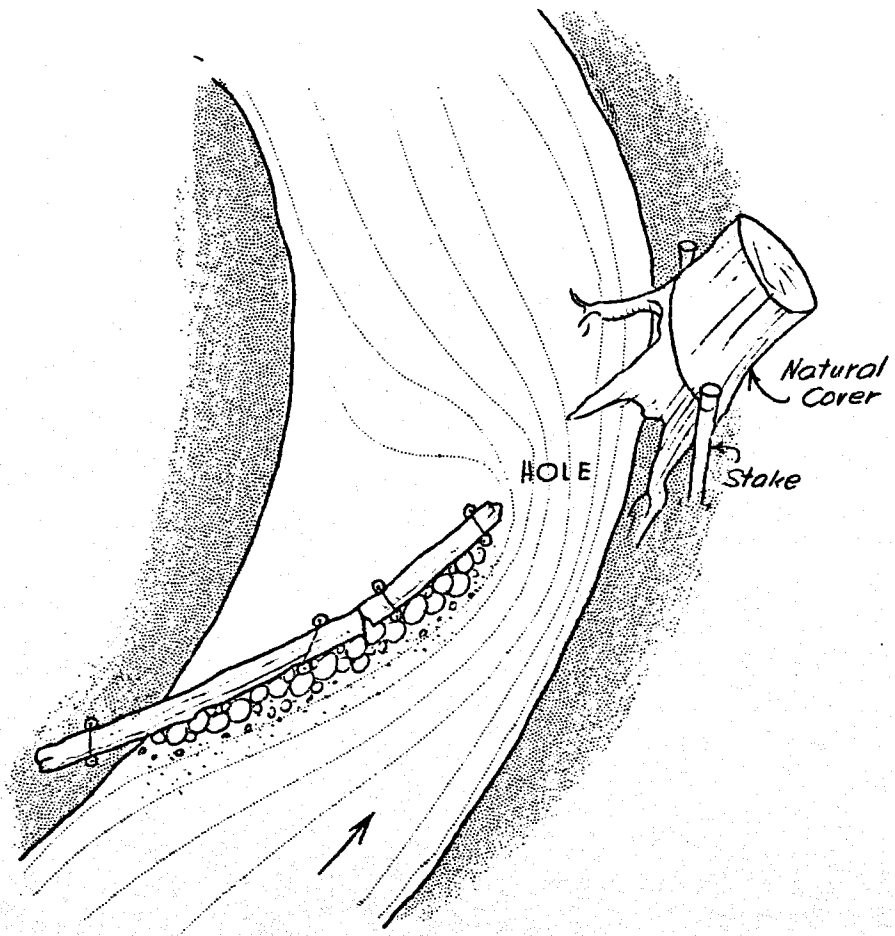


Fig. 2 - V DEFLECTOR
(This type is adapted for washing out silt, exposing gravel, and creating a large hole.)

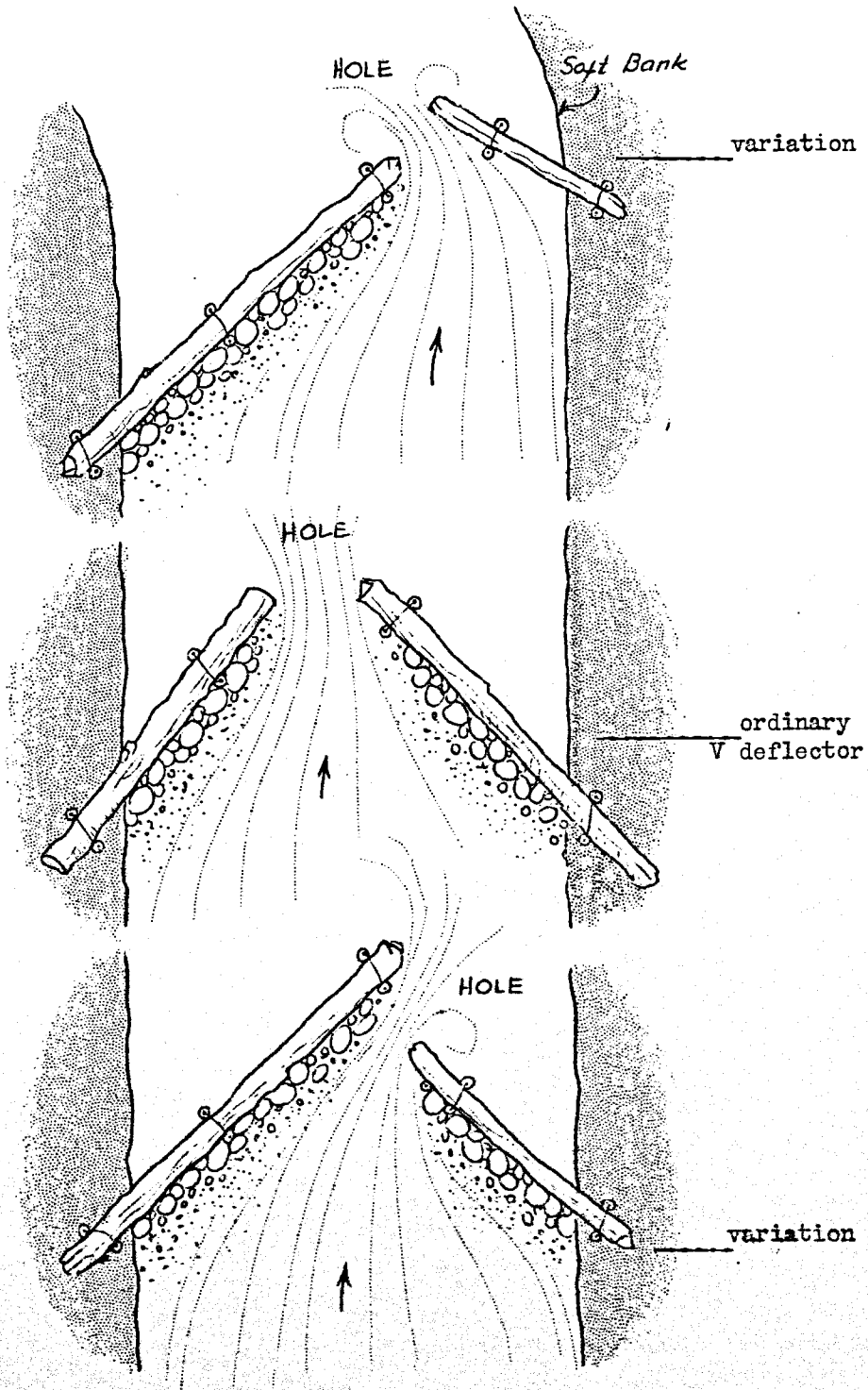


Fig. 3 - Y DEFLECTOR
(Cuts a long deep hole - adapted in washing away silt, etc.)

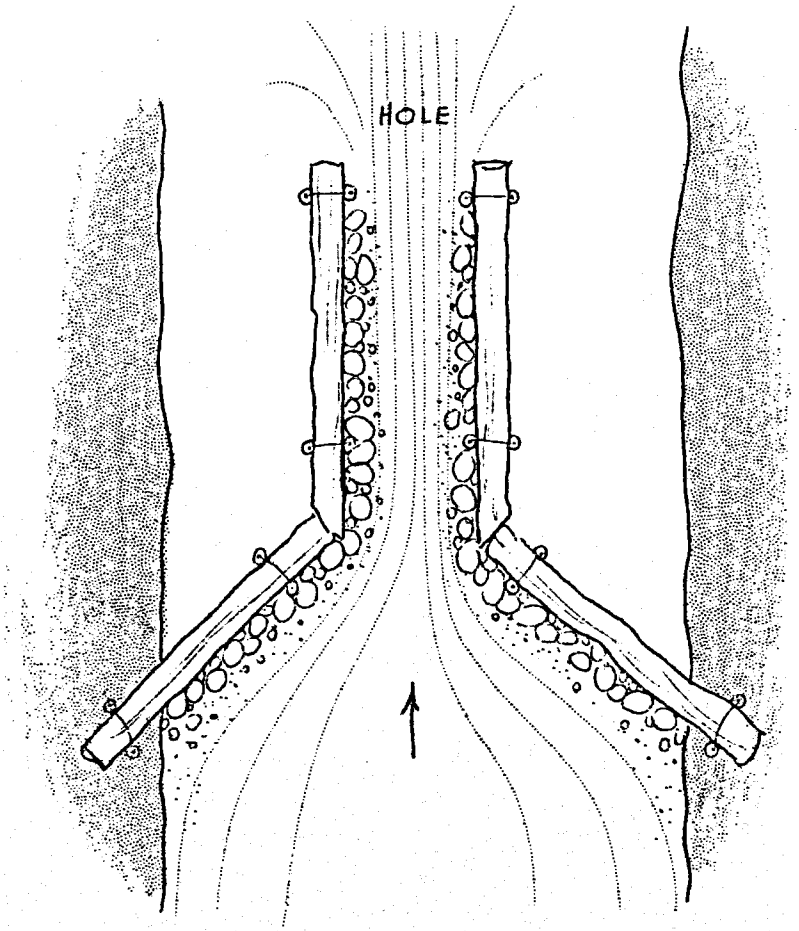


Fig. 4 - I DEFLECTOR
(Not to be used on warm streams, or streams with little drop.)

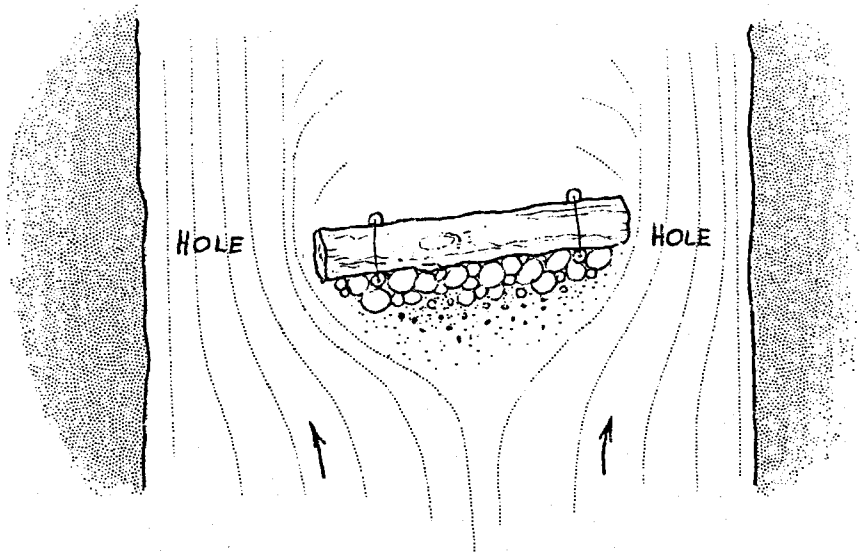


Fig. 5 - A DEFLECTOR

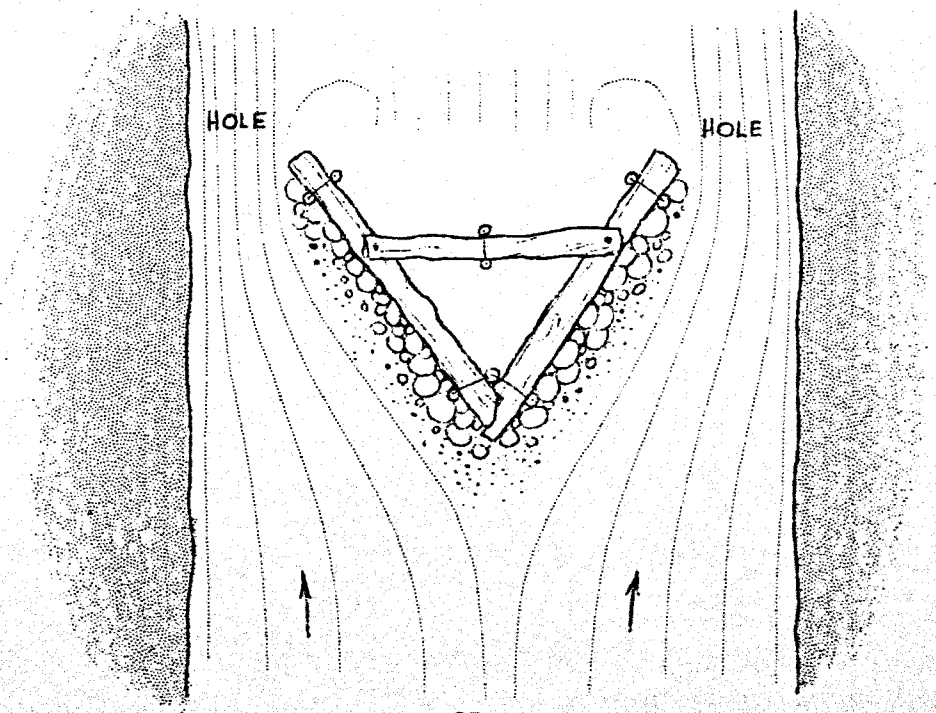


Figure 5a-, Crib Deflector
for large, rock bottom streams.

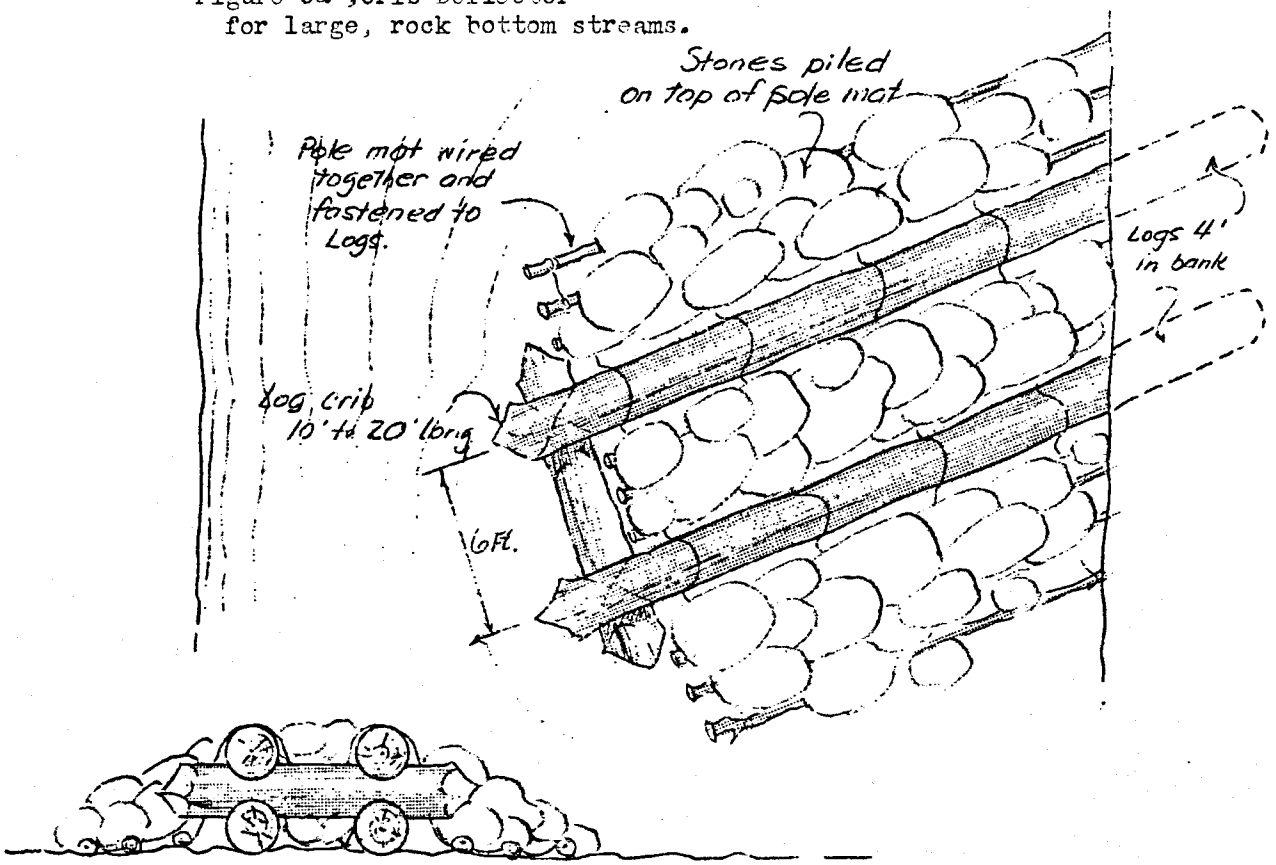


Figure 5b - Crib Deflector
For large, rock bottom streams.

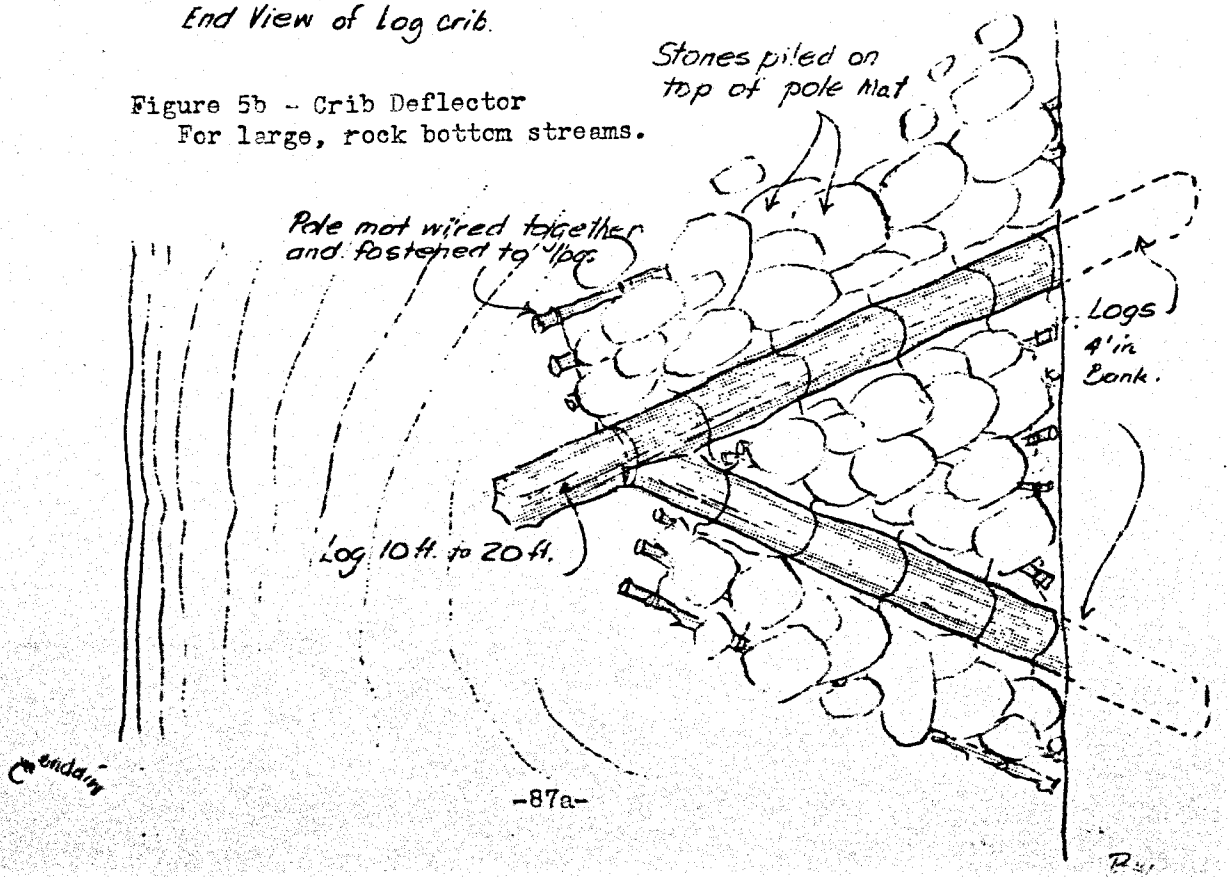


Fig. 6 - UNDERPASS DEFLECTOR
(digging log)
WITH COVER

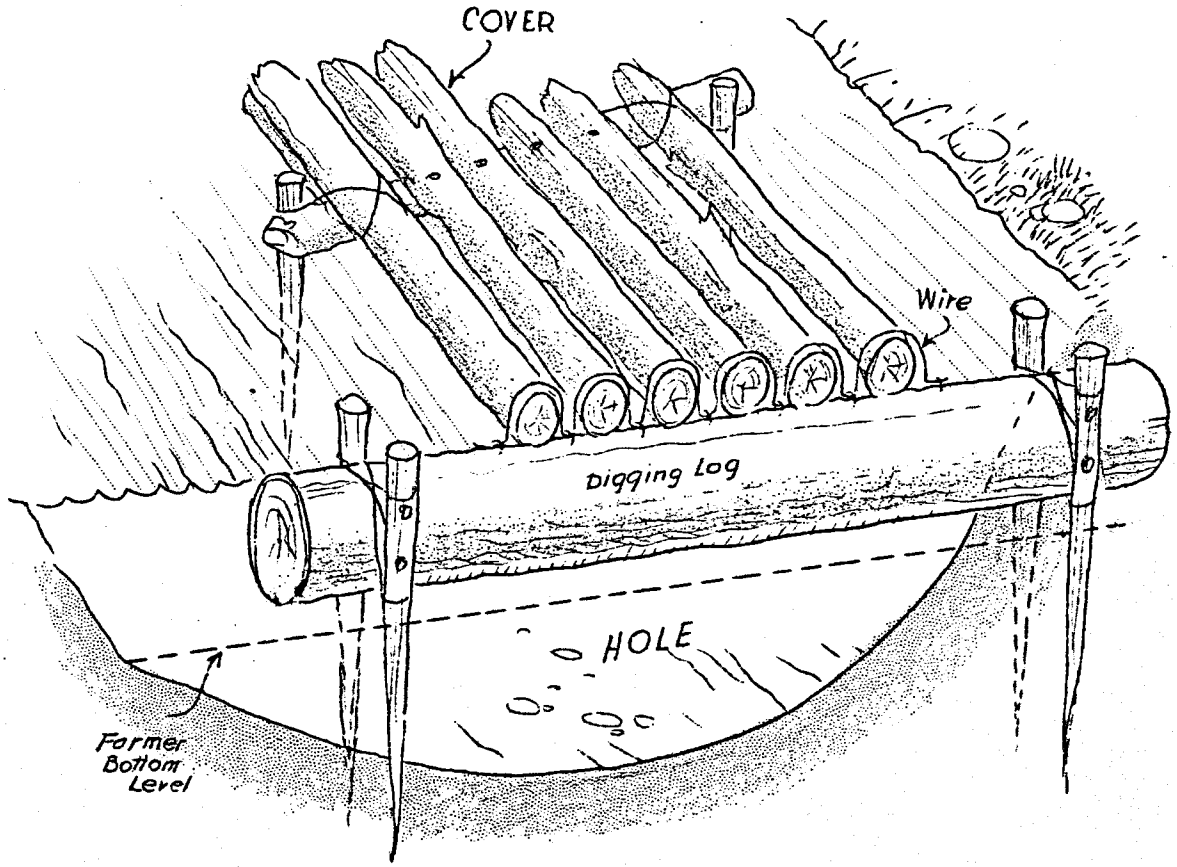


Fig. 7 - BOOM COVER
(The upstream end will remain open until sufficient drift wood is enclosed to make the cover. The open end then may be closed.)

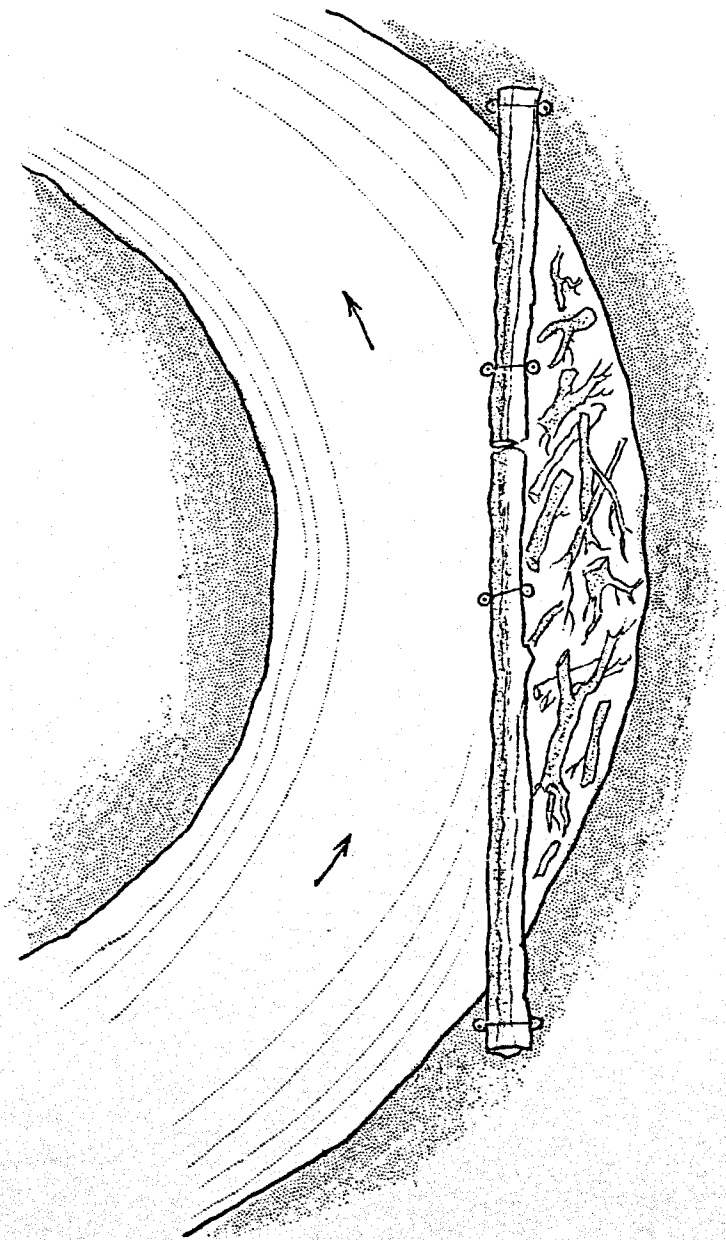


Fig. 8 - BEND COVER

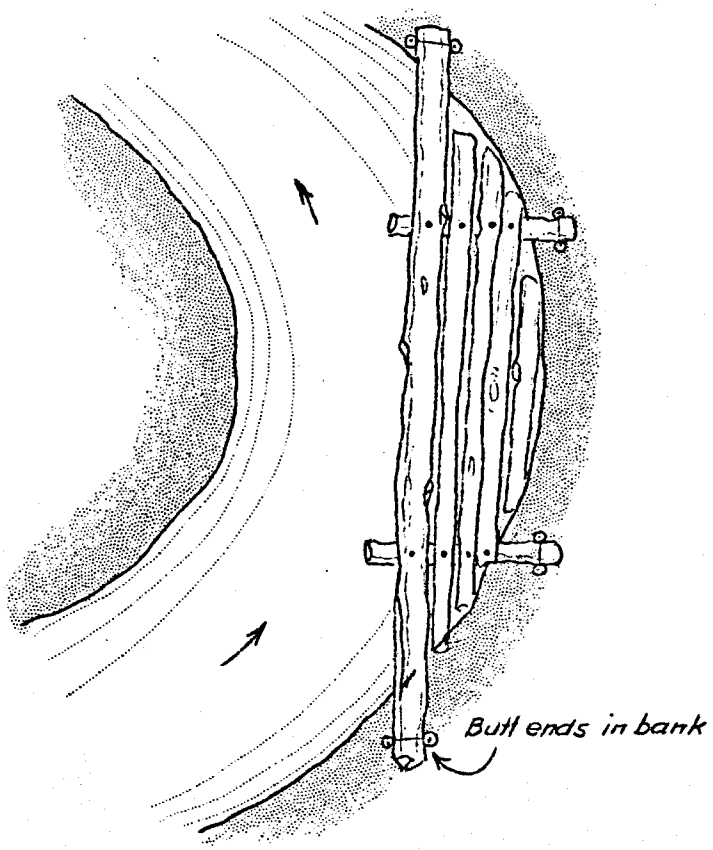


Fig. 9 - BANK COVER

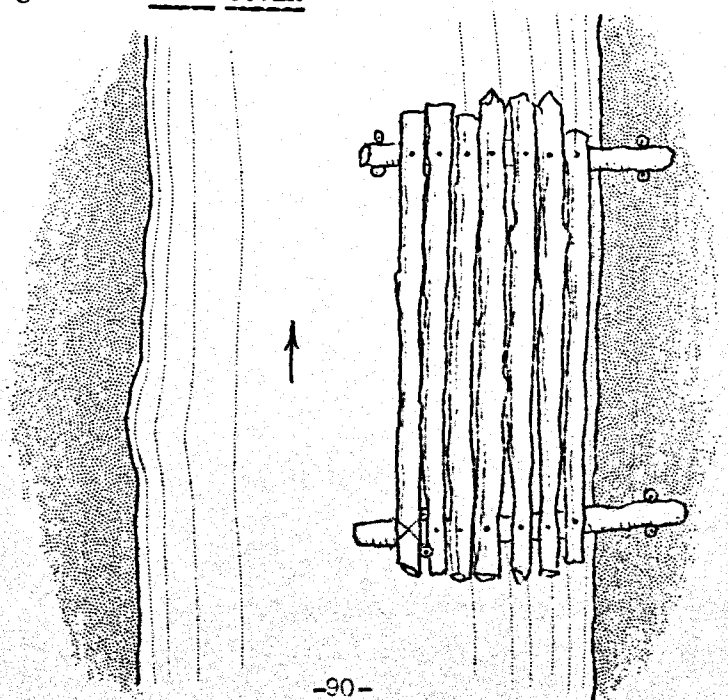


Fig. 10 - SQUARE COVER

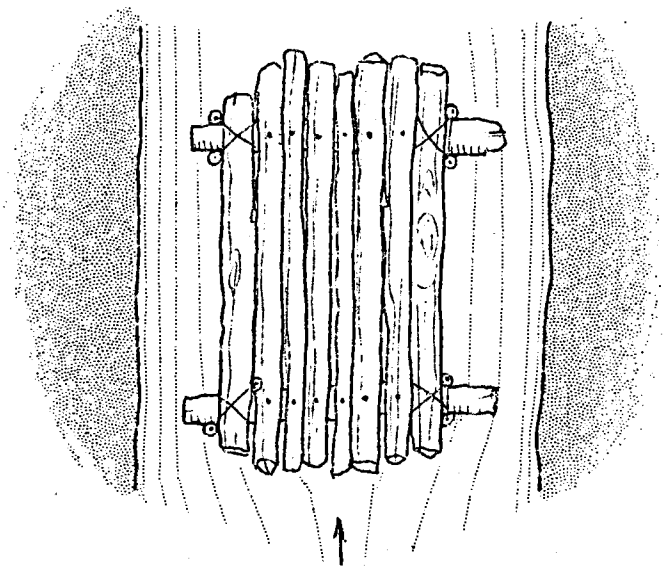


Fig. 11 - TRIANGLE COVER

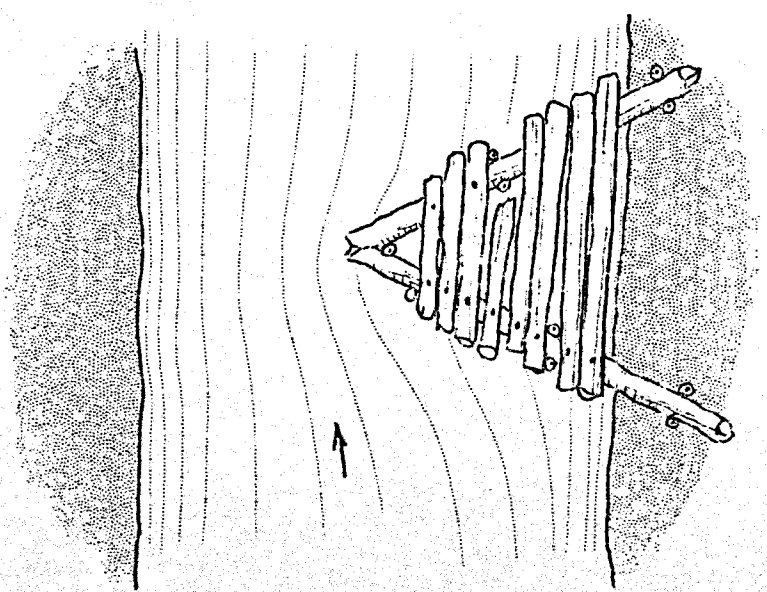


Fig. 12 - TEPEE COVER

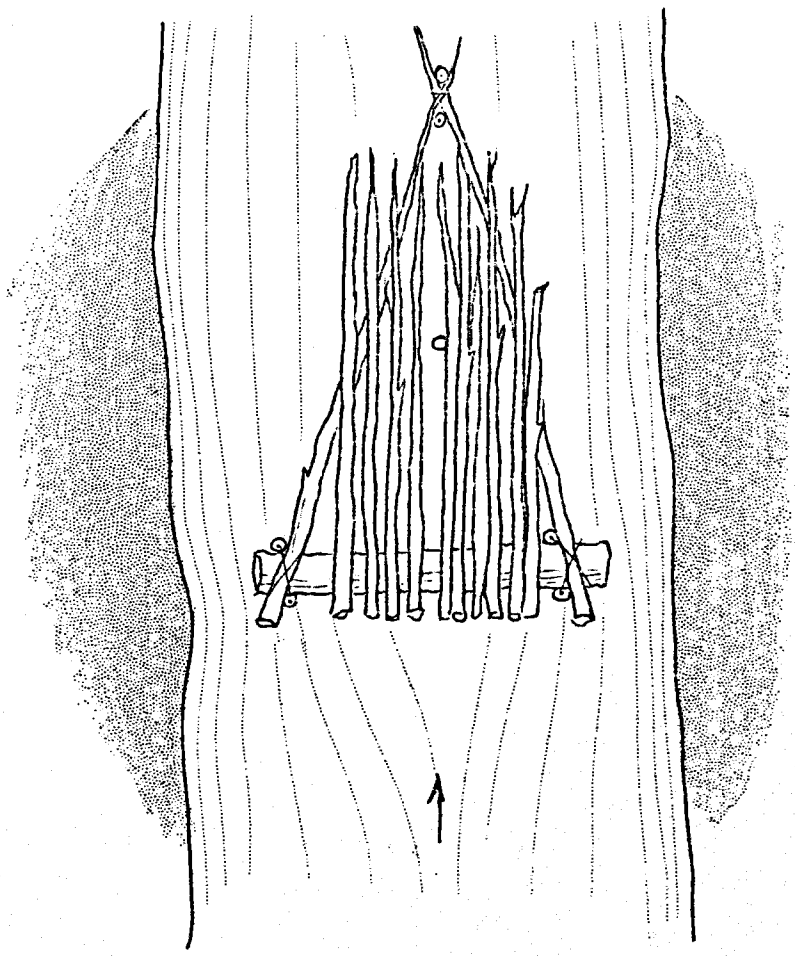


FIGURE 13.

CONSTRUCTION OF DEFLECTORS ON ROCK BOTTOM STREAMS.

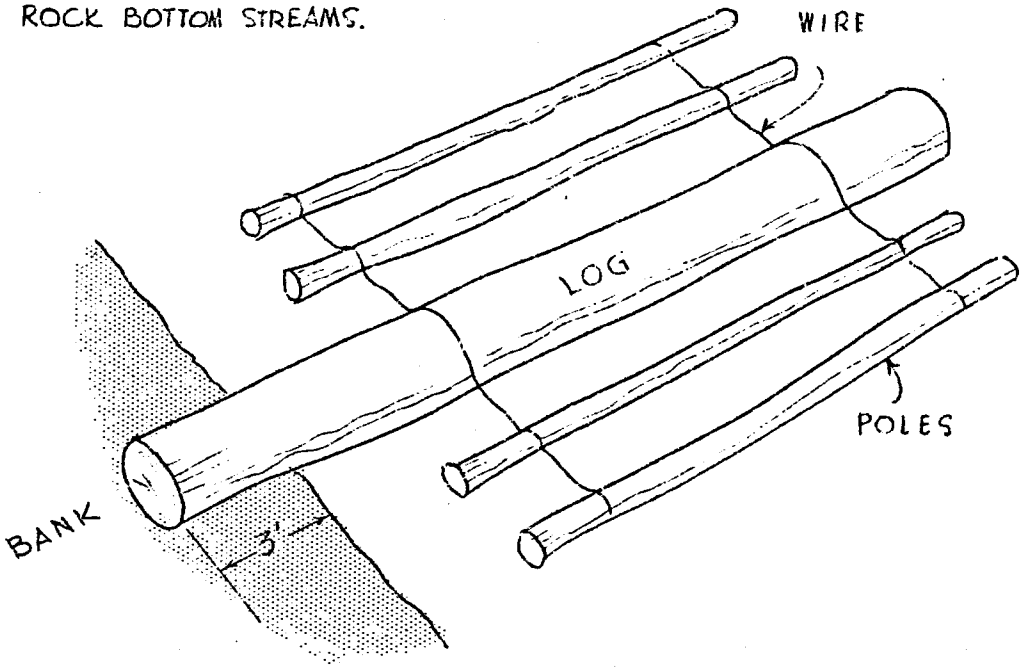
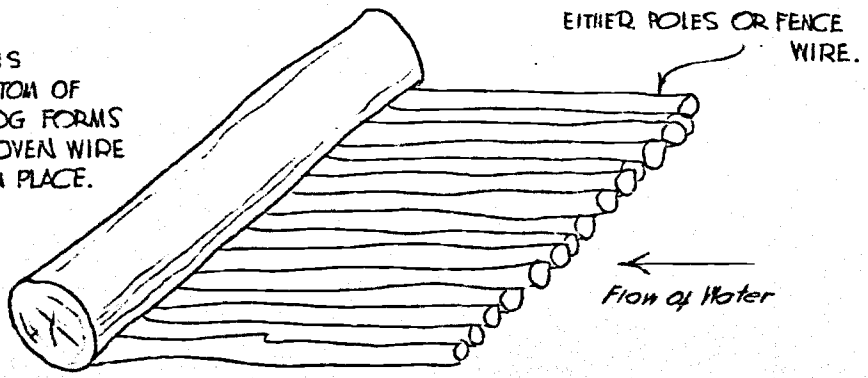


FIGURE 14.

HEWITT DAM.

THIS CONSTRICTION IS PLACED ON THE BOTTOM OF THE STREAM. THE LOG FORMS THE DAM AND THE WOVEN WIRE OR POLES HOLD IT IN PLACE.



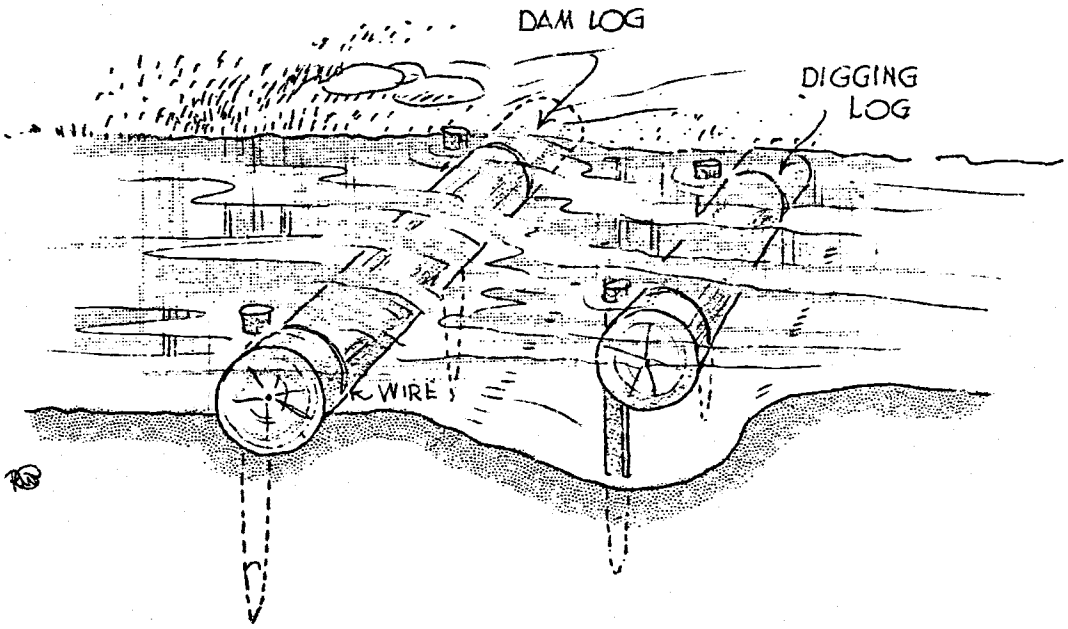


Fig. 15 - Over - Under Deflector

(A large dam log is placed across a stream from bank to bank and firmly entrenched and anchored on the stream bottom. Sheeting may be necessary to keep the waters from undermining the log. Sheeting may consist of a row of three foot stakes driven along the face of the log. A hole will be dug by the waters pouring over the log. About two feet below the dam log one or more digging logs should be inserted. This enlarges the hole in front of the dam and makes it deeper. Cover is also provided.)

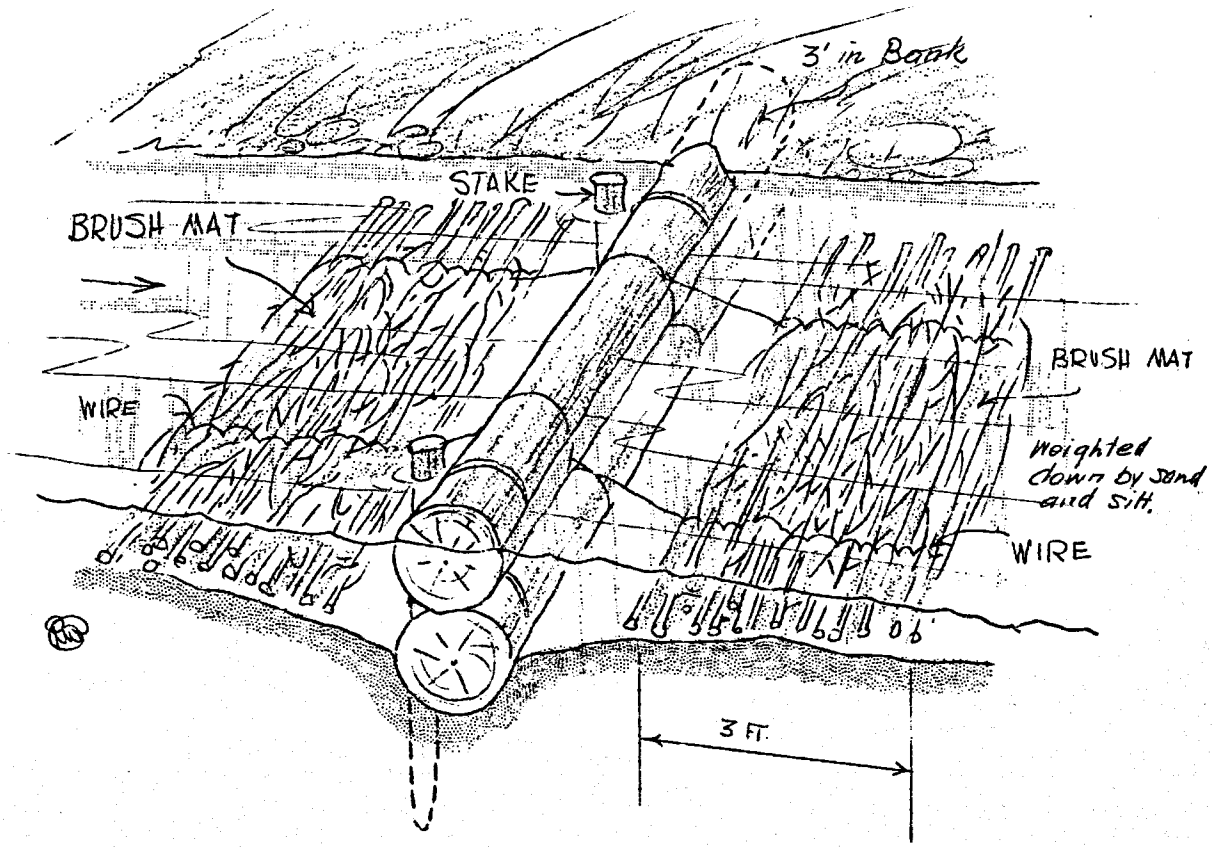


Fig. 16 - Use of brush to check deflectors from undermining.

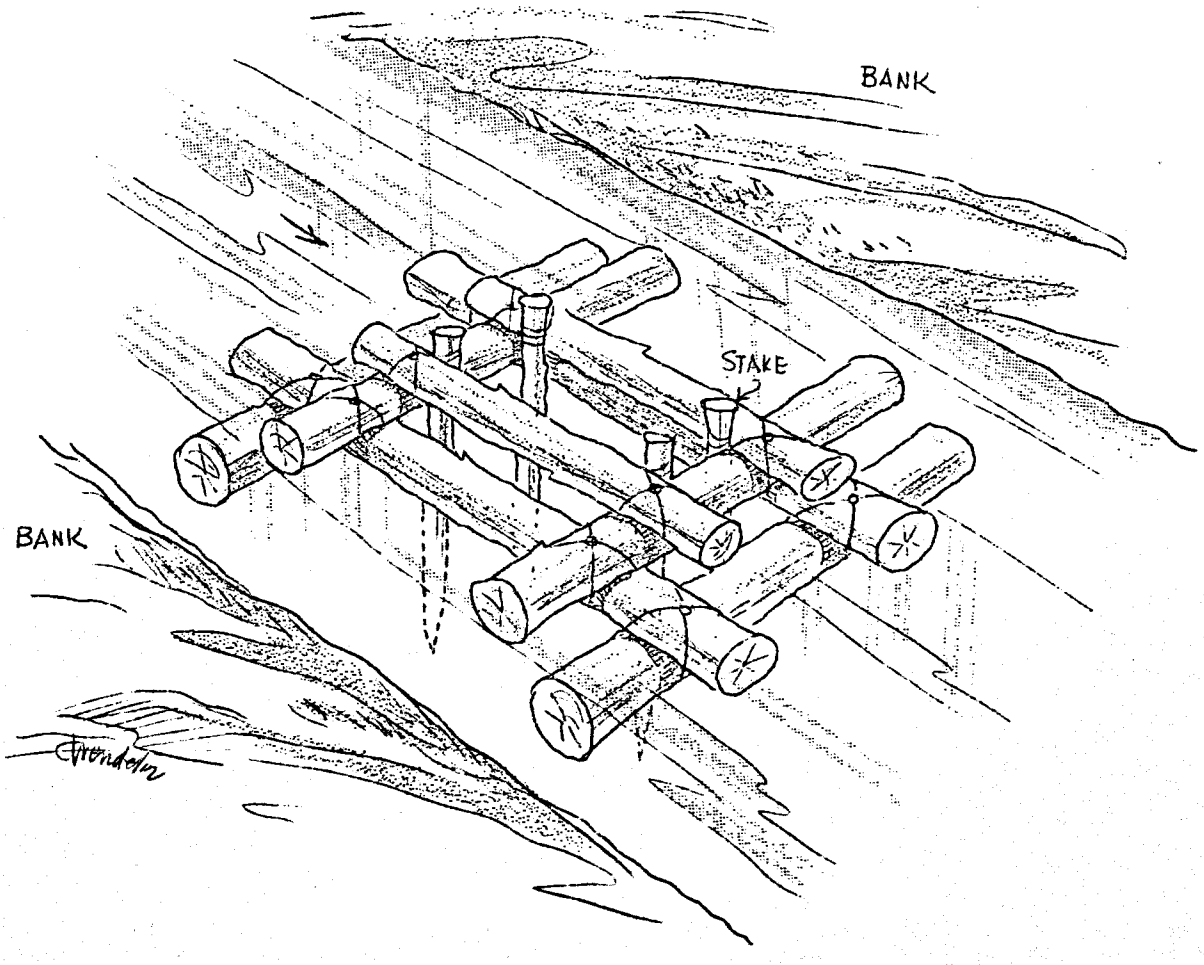


Fig. 17 - Log Cabin Cover (as developed by Michigan conservation workers)

LAKE IMPROVEMENT
(FOR FISH)

Most of the lake improvement work which has been done has consisted of creating spawning grounds and escape shelters for fish. This work has been very necessary in lakes which are barren of snags, windfalls and dead heads, or lack suitable gravel spawning beds for bass and sunfish.

Although large-mouthed bass will spawn on soft bottoms, they desire gravel upon which to deposit their eggs. In small-mouthed bass waters, gravel is quite essential. Spawning covers for the blunt-nosed minnow, Hyborhynchus notatus, and other valuable forage fishes having similar habits are made by placing boards or other flat material around shallow shores of lakes. These fish will burrow under the boards and attach their eggs to the under side. Crappie very often spawn on logs, etc.

The establishment of weed beds and other natural cover is quite desirable. Very often tops of trees, if dragged into lakes, make excellent cover areas and are less costly to handle than other types of cover. In all cases they should be branchy enough to be a protection to small fish. Do not use tree tops which are old and rotten, or those which have lost the smaller branches.

Fish using brush shelters for cover and protection are:

1. Bass (both large-mouthed and small-mouthed)
2. Crappie
3. All sunfish
4. Rock bass
5. Bullheads
6. Most of the minnows

It is doubtful that the placement of brush covers in lakes of a low carrying capacity, due to a lack of fertility, will raise the pounds of fish yield per acre per year. However, lakes heavily fished, having an abundance of the necessary nutrients, but not producing the maximum yield of fish per acre on account of over-fishing, will benefit greatly by the introduction of brush shelters, or, if need be, gravel spawning boxes.

Some lakes in our Northern Forests are too shallow for proper fish development, due to lack of oxygen in the restricted body of water under the ice during winters. A dam placed at the outlet of such lakes may raise the water level enough to protect the fish, but often nothing can be done, and it is then far better to manage such lakes for waterfowl than to attempt fish management.

Most of the pioneer work in lake improvement was done in Michigan under the direction of Carl L. Hubbs, and there is no

handled very easily during the summer.

A single pole from eight to twelve feet long is used, and bunches of brush about four feet long attached at right angles from the cover. Place from one to two sandbags on each end to weight down the structure.

Circular Shelter

The circular shelter looks very much like a large brush pile when completed. The butt ends of brush or branches which should be from two to four feet long, are placed together in a circular pattern, over a wire. When enough brush has been deposited, the wire is drawn tight and sand bags attached.

Spawning Device for Minnows

Slabs, old boards or split boards make ideal spawning sites for several of our minnows. They can be easily constructed and placed into position in the summer. Place five slabs or boards over each other so as to form a whorl; radius to be about two or three feet. Stake the structure under water securely to a depth of about one and one-half feet. A boat or a pair of hip boots will be required to put them in place.

Gravel Boxes

Small-mouthed bass require gravel to spawn upon and it is desirable that gravel boxes be placed in lakes managed for small-mouthed bass where gravel is lacking or not well distributed, A box 2'X2'and $\frac{1}{2}$' deep, filled with gravel, is standard. Place these boxes in from 1 to $2\frac{1}{2}$ feet of water where there is little wave action or silt deposition. Old boards, slabs, split logs, shakes etc., can be used to construct these boxes. Use gravel ranging in size from a pea to a small walnut in filling the boxes. Place these structures when the lakes are free of ice.

As has been discussed before, under the various factors influencing lakes and streams, fertility is in many waters the controlling factor which is responsible for the yield of fish. Every time we protect the cover by putting out a fire or planting a tree, we are improving the fertility of our lakes, and in the final analysis this improvement will be the most lasting and show the greatest yield. It should not be misunderstood however, that shelters spawning boxes etc., are never desirable, as in response to their placement sometimes lies a quick return to the fisherman, a fact which must not be disregarded.

doubt the work has been of great benefit to many lakes of Michigan.

Types of Brush Shelters

Ladder Shelter

Procure four poles, two, four to six feet long and two, ten to twelve feet long. Notch and fit the poles into each other as in fitting log cabin timbers. Wire and nail these joints together securely.

Next cut some hardwood brush, preferably of oak or other brush which does not possess the tendency to lie flat. Cut some long branches and lay them lengthwise of the frame; then place a layer of brush cross-wise of the structure, and repeat in this manner until a depth of three to six feet is obtained. To tie the brush down, place a cross pole along the longest axis of the frame on top of the brush, and tie securely over the brush by means of wire. Brush should extend at least two feet on each side of the frame.

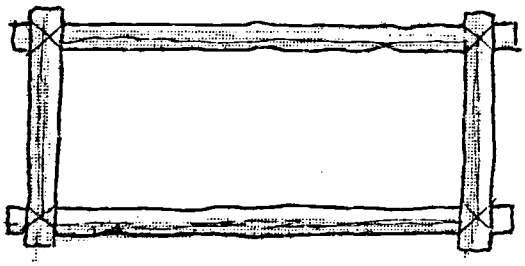
These shelters can easily be made near the lake in the winter and hauled upon the ice where they can be placed over water which will cover them by about two feet. They will be let into the lake by cutting out a block of ice large enough to accomodate the shelter. The block of ice cut out should be forced under the ice bordering the hole. The shelter etc., is then let through this hole in the ice. A bob sled or sleigh hauled by a horse is the best method of moving the shelters, for when completed they are very heavy.

Care should be taken in weighing shelters so they will not drift upon the shore and prove unsightly. Six 100 lb. sand bags or their equivalent in rocks are preferable, but never any fewer than four. Attach the sand bags with wire to the corners of the frame. Use cement sacks for sand bags; coarse gunnysacks are unsatisfactory. Never put brush shelters on large lakes where ice will shift and throw them on the shore or in deep water. It is better to wait until spring and tow the shelters to the desired places.

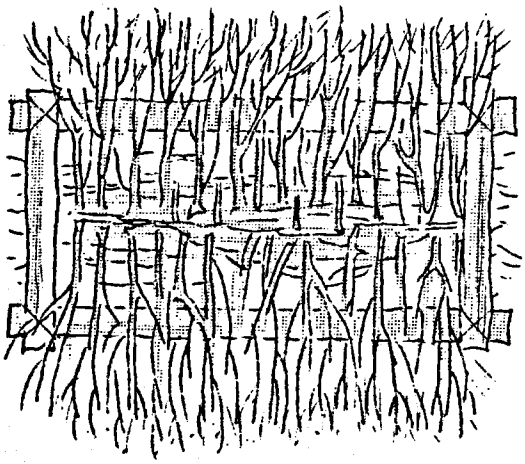
When towing shelters, put them in the lake from banks which have an abrupt drop off from the shore. so that the brush will not drag and become stuck. Use a motorboat if possible for towing. Two rowboats may be lashed side by side and the shelters placed on them and transported more easily than by towing.

"I" Shelter

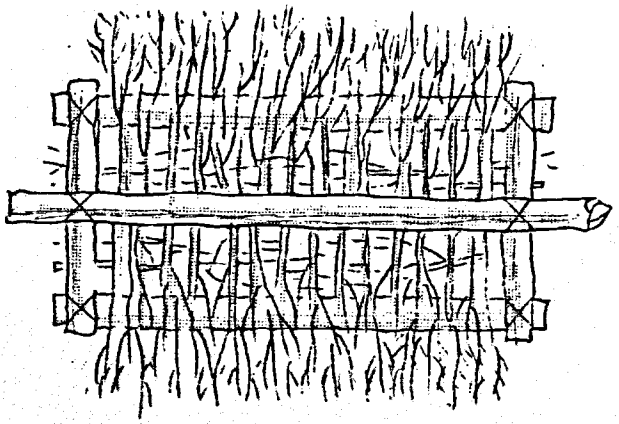
An "I" shelter is much simpler to make, though less effective than the ladder type, but because of its lightness it can be

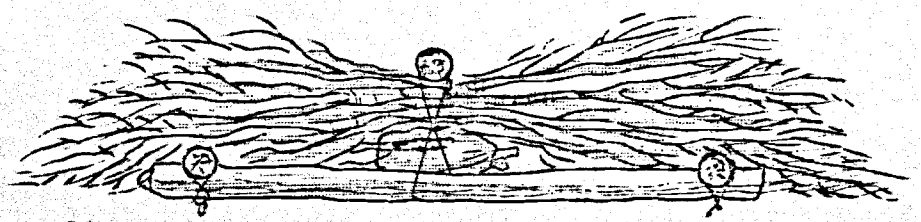


TOP



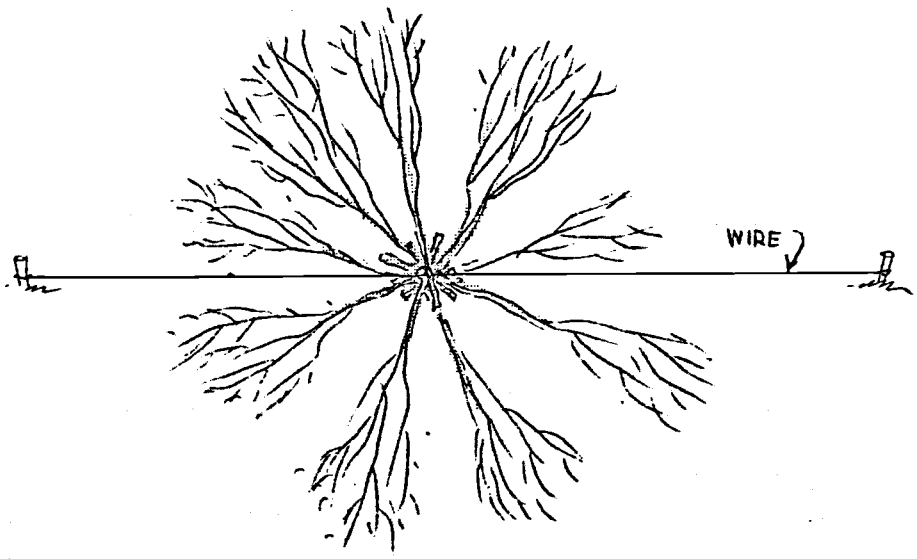
VIEWS





END VIEW

Figure 18
LADDER SHELTER



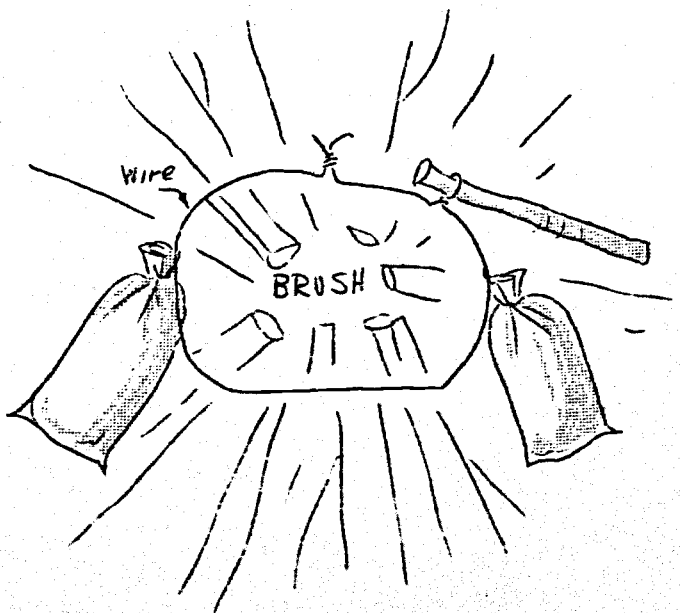


Figure 10
CIRCULAR SHELTER

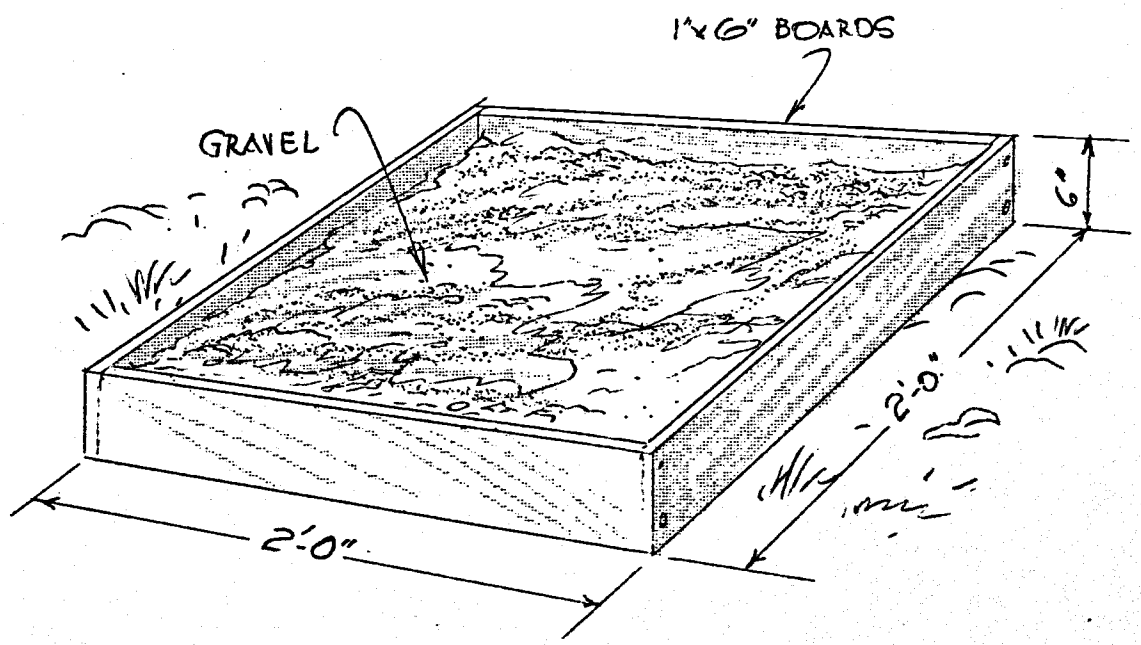


Figure 22
GRAVEL SPAWNING BOX

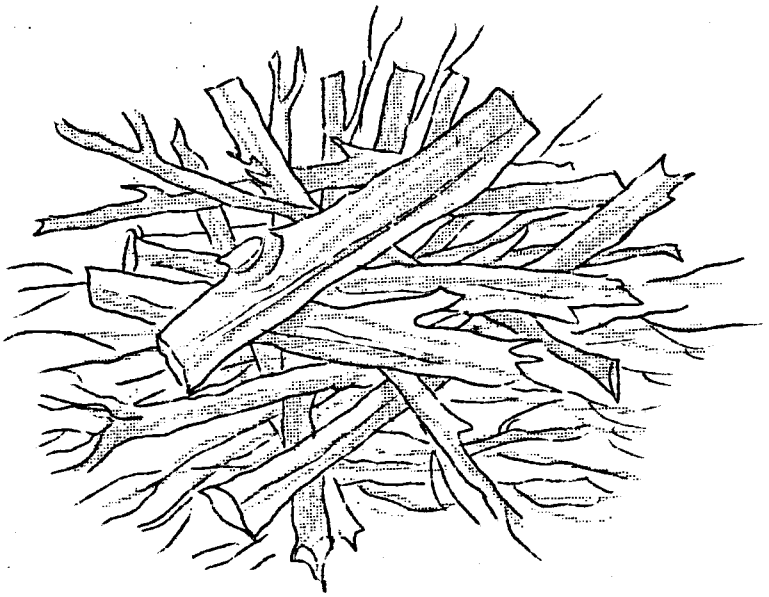


Figure 20
WATER LOGGED SHELTER

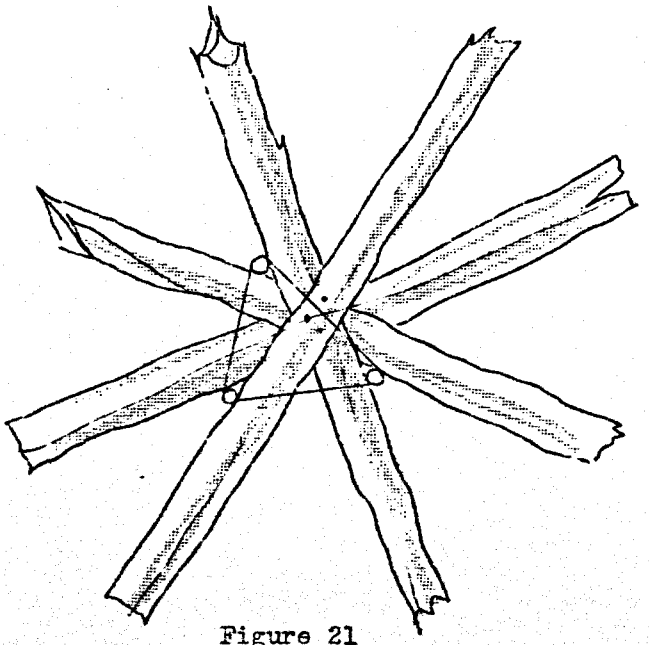


Figure 21
BLUE NOSED MINNOW
SPAWNING BOARDS

TROUT REARING PONDS

Rearing or feeding stations for trout may be built according to the following procedure and limitations after approval of the Regional Forester has been obtained.

Location

The location of these ponds depends on several factors. Chief among these are volume of water flow and temperature of the water. The volume flow should never fall below 200 gallons per minute or the temperature in most cases never rise above 65°F. If the ponds are to be located near springs, water samples will have to be taken to determine the amount of oxygen present. There should be at least six parts per million. It is best to locate the ponds a sufficient distance from springs to allow proper aeration of the waters.

If possible, ponds should be located near roads or in easily accessible country which would necessitate no more than a short truck trail.

These ponds will be the property of the United States Forest Service and must be located on Forest Service land.

A survey of the streams and springs of each forest will expose many suitable locations, the most desirable of which will be investigated and, if found adequate by measurements and analysis, will be proposed for pond construction.

If there is any doubt concerning the volume of flow of water throughout the entire year or concerning the temperatures of the waters, the following steps must be taken on the proposed locations:

Every two weeks during the summer and fall, temperatures of both water and air should be taken at the same time. The volume of flow in gallons per minute must also be determined. Ponds must not be located in streams which may dry up or become excessively warm during the late: summer, as it must be remembered that the trout are growing larger each day and therefore require more water than they did when very young. Just at the time the trout are becoming larger the water supply must not be too warm or too little. Trout can withstand warm waters for short periods if they can gain access to a large volume of water. A lack of both sufficient waters and cold waters, however, will prove fatal.

Usually, the characteristics of the various streams and springs are well known to local residents and forest officers, who should be consulted.

feet. Large stones and boulders can be utilized to stabilize the structures and reinforce them. Floors behind the dams must be made of 3" plank to protect the structure from being undermined by the waters falling over the dam boards. All dams, whether of concrete or log construction, must have sheeting driven into the ground at least five feet to protect them from being undermined and overturned. Three inch planking makes ideal sheeting and must be driven along the face of the dam and behind it.

A slat rack which should be set at an angle of 60° must be placed in front of the upstream dam of each rearing pond. The rack protects the screen from floating driftwood and flotsam. The end dams further downstream do not require this protection.

Rocks may be used to wall the sides of the ponds. These should be fitted together securely. Where the banks are heavily sodded and there is little chance of erosion taking place, the sides of the ponds may remain unlined. It is always best, however, to reinforce the sides by stone. Both unlined and lined ponds must be sloped to a 45° angle.

The upper ends of the ponds should be shallow so that the young trout may find suitable shallow water in which to bask. The deepest place in the ponds should occur near the outlet, where an artificial depression can be made, for here the fish can be caught when the ponds are drained.

The material cost should never exceed 20% of the total cost of the job - CCC labor to be figured at the cost of $1.00 per day. Overhead cost must be included, as well as transportation and other costs.

Operation

Dam boards allow the operator to keep the desired level of water in the ponds. For young fry one-half or one foot head of water is desirable in order to create riffle areas for them. As the trout grow older the level may be raised to three feet. After the raising of the trout and their subsequent release, the ponds should be washed out by the removal of the dam boards. The screens and dam boards must be taken out and stored over the winter and the stream then may course unhindered through the ponds.

When small fish are placed in ponds a #8 mesh galvanized screen should be used, but as soon as possible a #4 mesh may be installed, as it will be more easily cleaned. A #8 screen has meshes 1/8" wide, while a #4 screen has 1/4" meshes.

It takes approximately four pounds of liver to feed 1,000 six-inch trout per day. Feeding should occur at regular intervals

For purposes of sanitation it is best to locate ponds where there is a comparatively rapid drop. Ponds located in such places are easily washed clean, and furthermore the waters are always circulating through them actively enough to carry away refuse, etc. The ponds are most efficient if located in the present stream bed or in old channels of the stream. Gravel areas are best suited for pond locations, as gravel must line the bottom of the ponds. It can be hauled in if not found naturally.

Ponds should not be longer than 60 to 75 feet. A 100 foot pond may be divided in two by a dam containing a screen, on which no dam boards are necessary. Widths should not exceed 12 feet, unless there is a large volume of water flowing.

A by-pass must be provided for each pond system, large enough to take care of maximum flood waters. The by-pass and its location are shown on Figure 18. A dam at the head of the by-pass can be used to regulate the waters flowing through the ponds.

Construction

The current can be diverted from the main channel of the stream by means of diversion ditches or tile. Very often old stream channels can be utilized for diversion ditches. Dams can then be built without the influence of running water to hinder their construction. A simple log and sod dam thrown across the stream above the site of the dams will divert the current into the diversion channel. The diversion channels can be plugged and the water sent through the rearing pond when the structures are complete. Very often it is desirable to construct double rearing ponds, or a series of parallel ponds. If this is done the gallon flow per minute will have to be quite large.

Ponds may vary in width and length according to the local conditions of each stream. There should always be a free movement of water through them, and they should not be so wide that the waters tend to become ponded or stagnated.

Dam construction must be sufficiently strong to withstand intense water pressure and should be well made. Concrete dams of a 1:2:4 mixture are the most permanent. They should be high enough to hold a three foot level of water in the ponds. Various conditions and different streams require their own special dam construction for rearing ponds, and to build the most desirable structure, specialists should design the work. When using cement, suitable wire screening should be used for reinforcing.

Log and board construction can be used to make the dams, but they should be soundly constructed so that they will not be washed away. Piling should be jetted or driven into the ground three

Shade should be provided over one-quarter of the total area of the ponds. Lattice work or tar paper racks may be used. Slabbing can be used advantageously for lattice work.

Standardized signs will be placed at the rearing ponds, which will inform fishermen that these ponds were built by the United States Forest Service with CCC labor. The signs are illustrated in Figure 24. They have green lettering on a white enameled background and must be placed on white cedar posts six feet above the ground. Other signs must be placed in such a position so as to inform fishermen that there will be no fishing around the ponds. State Conservation Departments or the Bureau of Fisheries will furnish these signs.

Reading Material

It is suggested that supervisors, rangers and technical men interested in the development of fish life become more fully informed by reading books and pamphlets dealing with fish life. (Refer to "Bibliography, " Wildlife Handbook.)

and from two to four times every 24 hours. The food must be of a size readily taken by the smallest fish. For fry it must be so finely ground that it causes the water to become murky when placed in it. It may be ground coarsely when the trout reach a larger size. Feeding by the pan method is the best way to feed the fish. A pan of liver is weighted down on the bottom of the pond by means of a rock and the trout then given their leisure to feed. Ponds will not become dirty or contaminated by using this method and neither will the food be wasted. Trout kept in Forest Service ponds must be fed in this manner.

Mush may be mixed with meat by adding one part of mush to four parts of meat, beef liver being the most desirable meat to use, although beef heart, sheep liver and fresh fish are fed. Some European fish culturists feed natural animal life, such as insects, crustacea, etc.

Bureau of Fisheries Doc. No. 955 adequately discusses the amount of food necessary for trout on pages 50, 51 and 52.

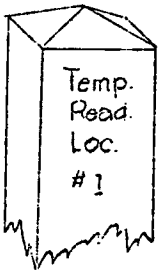
Fry can be obtained during the spring from Federal or State hatcheries and deposited in the ponds, care being taken to accustom them to the change of water from the hatchery to the rearing pond by gradually changing the transporting water to that of local waters. (See "Handling Fish in Planting," Wildlife Handbook.)

Removal of the fish should be done in late fall after the fishing season. Soft muslin or gunnysack nets and dippers should be used. Never use nets with a noticeable mesh. Fish are liable to be killed or hurt by catching their fins or gills on the meshes. A small boat or dug-out which possesses a live box can be employed to transport the fish to various portions of the stream. Water from the stream can readily circulate through a wire screen in the bottom of the boat into the chamber in which the fish are kept, and then the fish may be dipped out and liberated wherever it is desired to release them. Small oil drums with a floating live box fastened to them can be used to advantage.

Six-inch fish should be grown in seven months and if these fish are then released they will have the entire winter and portion of the spring to grow, so that by the opening of the following fishing season the fish will be at least seven or eight inches long. Under favorable conditions their length will be much more.

Protection

Protection must be afforded young trout from predators, such as herons and kingfishers, but the extermination of the predators will not be countenanced. The ponds may be screened with chicken wire if it is impossible to otherwise guard them; however, it is always advisable to have a caretaker continually on the ground, and his presence will afford ample protection.



Posted Temperature Reading Point.

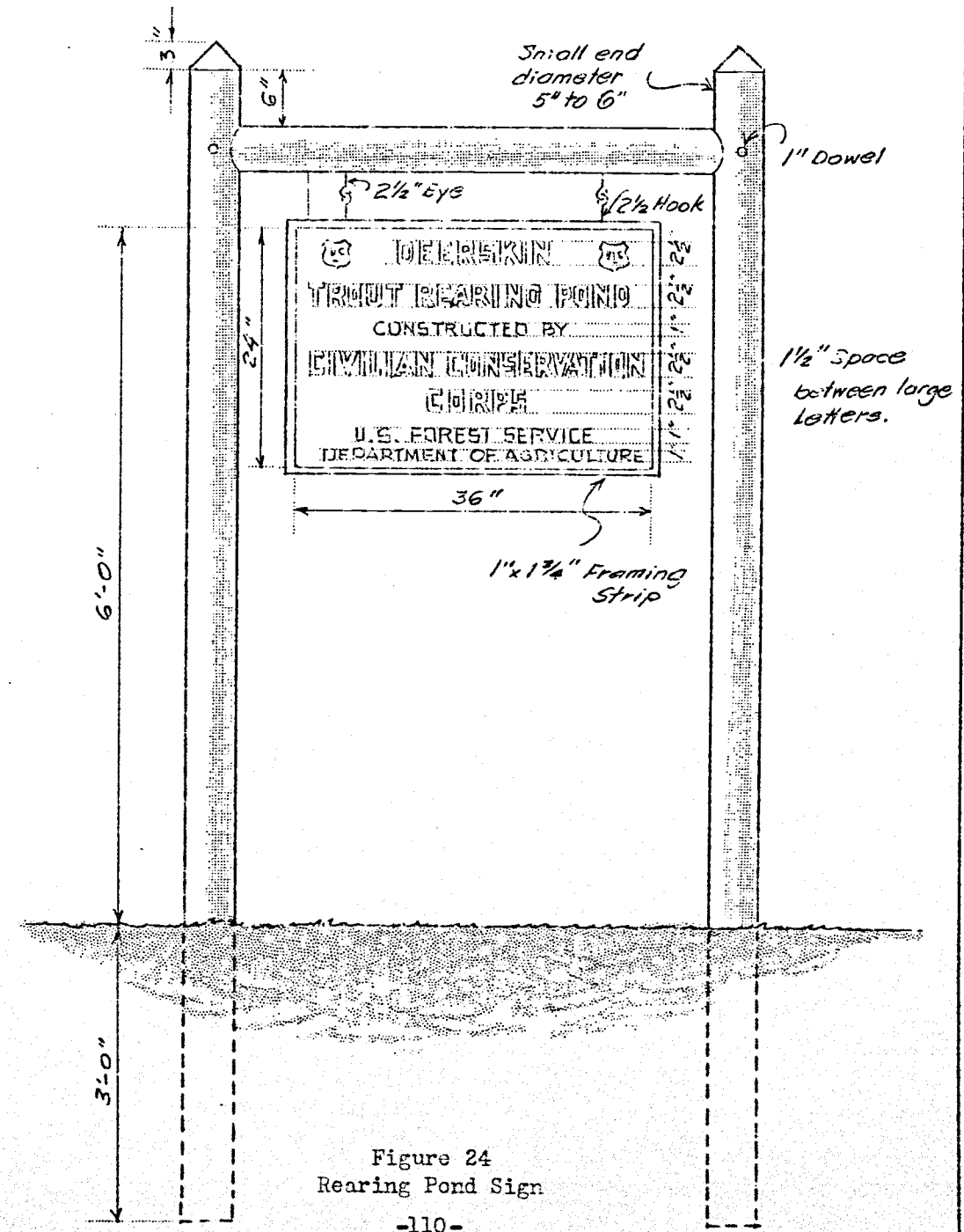


Figure 24
Rearing Pond Sign

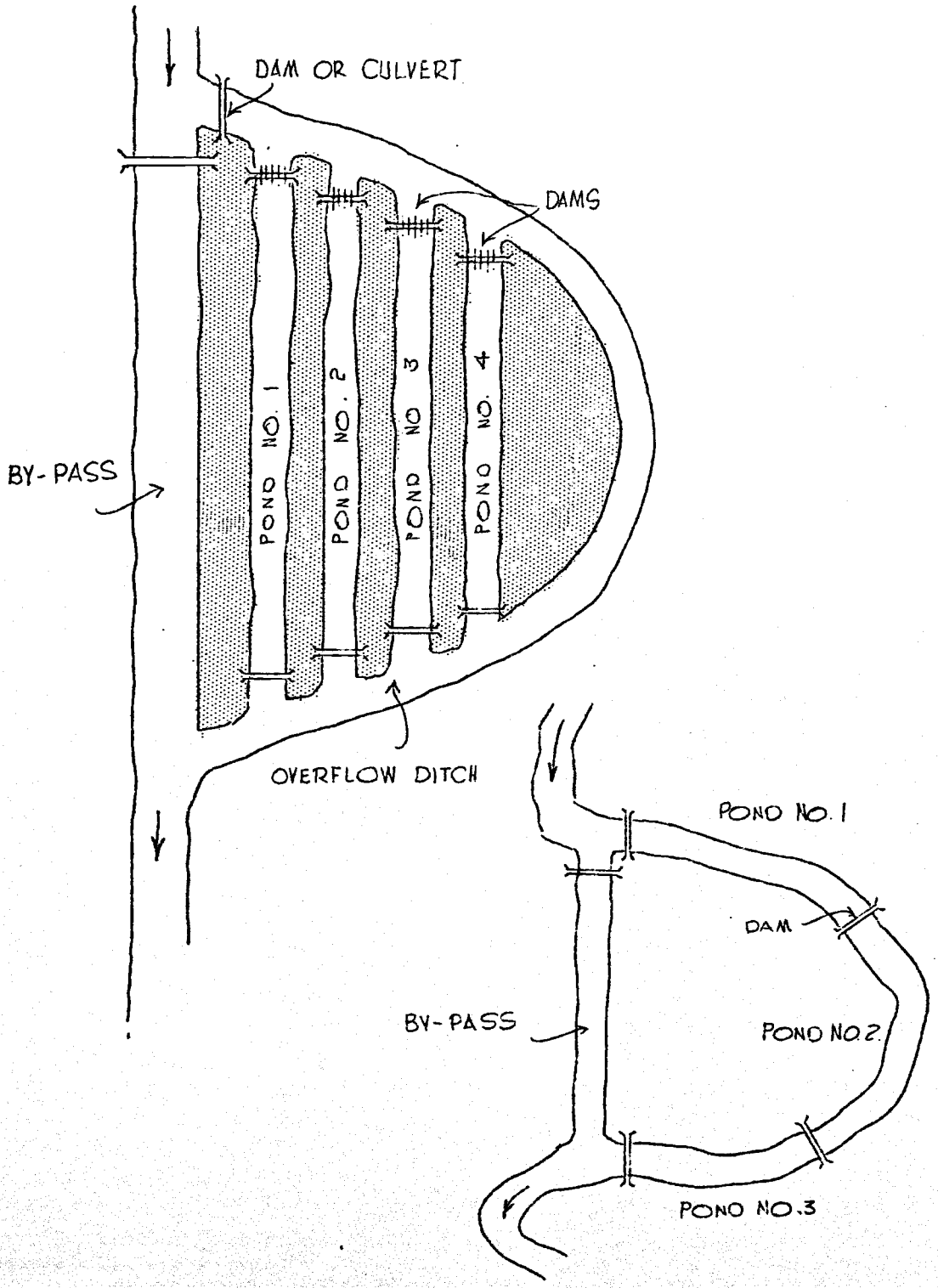


Figure 23
- Typical locations of Rearing Ponds for Trout

REARING PONDS FOR PONDFISH

Ponds suitable for the rearing of bass, crappie, sunfish etc., are much in demand within the Forests and it is, therefore, desirable to locate and construct as many of these as are needed to supply the lakes and streams. Properly located and constructed ponds, with minor supervision and operating expense, will produce fish year after year. One hundred rather heavily fished bass lakes can be supplied by a ten acre pond.

Fish which can be successfully raised in ponds are:

1. Large-mouthed bass
2. Small-mouthed bass
3. Crappie
4. Calico Bass
5. B lue-gill Sunfish
6. Pumpkin-seed sunfish
7. Warmouth bass
8. Bullheads (A. melas) (A. nebulosus)
9. Catfish

All of these fish possess a high maternal instinct and take excellent care of their eggs and young. The male pan fish, such as the bass and sunfish, make nests and guard them diligently. Male bass will escort their young around the pond for three or four days, but at the end of that time the family breaks up into small groups and disappears. These smaller detachments will sometimes travel together for several months or until they are about two or three inches long. Young bullheads are cared for in the same manner. and can be seen swarming around the parent fish.

If natural enemies are not evident and food conditions are good, the care and shepherding of the young by the male parent makes it possible to raise between 100,000 to 125,000 six months' old bass in a ten acre pond under optimum conditions.

Requirements of Location.

1. Protection - A temperature drop to 58°F or below being fatal, ponds are best located if sheltered from north or northwest winds, because eggs and fry are rapidly killed where water temperatures drop rapidly. Ponds located in depressions surrounded by hills are usually safe from rapid temperature changes. Sixty-three degrees Fahrenheit is the temperature which will induce egg-laying.

tion of any of the pan fishes, although the bullhead will thrive under such conditions.

To guard against silting where it occurs, catch or settling basins must be provided above the pond on the creek or spring supplying the water, so that turbid, dirty waters may be led into these basins and allowed to drop the silt in suspension before entering the pond.

7. By-pass or storm ditch - If it becomes necessary to locate a pond where flooding is liable to occur, a storm ditch or by-pass should be constructed along one side of the pond to take care of all excess waters during flood periods. The bottom of such a ditch should be on a level with the desired water level in the pond.

8. Fertility - If there is a choice, always locate a pond on a rich loam soil. Clay, although impervious to water and useful as a liner for ponds, is quite sterile and will not support a plant or animal population necessary for full development of the fish. Where clay is present or must be used to line ponds it will be advantageous to place a foot or more of rich loam on the bed of the pond to assure proper plant and animal growth. Ponds with insufficient food material produce little or no fish, because the young bass, etc., resort to cannibalism when hungry.

Construction of Dam and Drain

The dams are more easily made and less costly if composed of earthen fill. A cut-off wall or sheeting is always necessary to stop undermining and underground seepage, and it is desirous to place a core of planking through the center of the dam, so that muskrats, etc., will be prevented from destroying the dam.

The drain box can be made of cement or timber. There are several types which can be used, and all are well fitted for the purpose of handling the overflow and draining the pond. However, there is one type which has worked out very satisfactorily in all instances where it has been tried. Dam boards are used to hold back the desired head of water, and all excess flow of water over the dam boards escapes underneath the dam by means of a drain pipe. A screen eight or four meshes to the inch eighteen inches in front of the dam boards will prevent fish from escaping. (See drawing of drain box.)

Screens

A number 8 galvanized screen must be used on outlet and inlet dams up to the time the young bass reach a length of 2", which will be about three months after they hatch, when a number 4 screen may be installed. This larger screen can be kept clean easier as its

3. Water Supply - To insure a constant water supply, ponds are best located tributary to springs or small creeks which carry a constant flow of water. Creeks with a stable flow of from 200 to 400 gallons per minute will supply a ten acre pond if care is taken to stop excessive seepage losses. Streams subject to floods by rain or melting snow are undesirable, but the heads of spring-fed creeks, etc., which are not subject to overflow, will present in many cases suitable pond sites.

The optimum volume of water flow entering a pond should compensate for the loss due to seepage and evaporation. Where a by-pass is used, only enough water should be let into the pond to take care of this loss.

In order that a pond will be carrying its maximum water supply before ice forms and covers the waters, all available water should be utilized in refilling the pond.

To avoid disruption of nesting activities and the covering of eggs or fry by shifting sand, silt or mud, no noticeable current should be present in ponds used for rearing any of the pan fishes. Research studies have shown that such foods as plankton forms are available in greater amounts in still waters.

Ponds from 10 to 15 acres are desirable units to handle, and in no case should be less than two or three acres in extent, as the cost of operating a small pond is practically the same as operating a large one.

4. Levels and Preliminary Survey - Levels must be run on the proposed pond site to determine the height of the dam and the level of the shore line. A contour map of the area should be made, using one foot contour intervals. A depth of ten feet should be maintained over one-third of a bass pond located north of the 42nd north latitude, in order that the fish will not freeze to death or be smothered during the winter. The deepest portion of the pond should be located at the outlet, the remainder varying between one and three feet in depth.

5. Location of Dam and Drain - Dams must be so located and outlets so placed that every drop of water can be drained from the ponds and the area left dry for a period of time if desired. A location where there is a flat bowl-like meadow surrounded by highlands and drained by a small stream will usually be a desirable site for a pond, as a dam may be economically placed from one bank to another, and long, costly dikes will then be unnecessary.

Ponds must not be located on sites carrying waters heavily laden with silt and refuse, which if dropped on the eggs and newly hatched fry will destroy them. Waters which are easily roiled or become turbid due to heavy rains, etc., are not suitable for produc-

Temporary Retaining Kettle

It may be worthwhile to place a temporary retaining pond of small dimensions just below the outlet pipe to receive the brood fish which are caught when the ponds are drained. A basin 50 feet long, 50 feet wide, and two feet deep, with a temporary screen at inlet and outlet, will carry over 400 brood fish for several days, during which time the main pond will be filling up. If this temporary retaining kettle is placed just below the outlet pipe, operators can quickly lift, by means of a large mesh net, the brood bass over the dam and deposit them in the retaining kettle. Where ponds have a steady flow of water feeding them from a stream, such kettles are unnecessary, as the brood bass can be kept in the old stream channel in which the water is running, provided the gallon flow is 200 gallons or more per minute. Metal watering troughs, often used in holding brood bass when ponds are drained, are best placed below the outlet and water siphoned into them from the pond. A coarse burlap sack covering which will allow the air to reach the waters should be kept on the troughs at all times.

Procuring Brood Fish for Ponds

The cooperation of the State Conservation Department through local conservation officers should be sought in obtaining by net the necessary brood fish for Forest Service ponds.

Never use gill nets or nets with a mesh wide enough to catch fish by the gills and hurt them.

If impossible to gain the use of nets for catching brood fish, use hook and line. Either use a barbless hook or file the barb from an ordinary fish hook. Fish caught in the mouth by barbless hooks, or hooks from which the barb has been filed, are seldom fatally hurt unless they are handled roughly when released. Fish which are bruised or have their scales knocked off are often attacked by fungi and other diseases. If fishing from a boat, a large wash-tub containing 14 to 18 inches of water and covered with coarse burlap should be used to retain the fish when caught. The water should be changed completely every ten minutes or whenever the fish seem to require fresh water.

Never keep fish in a wire live box or other receptacle in which they will be beaten about by waves or bruise themselves endeavoring to escape. Under no consideration will the use of stringers be allowed.

If fish must be held at the lake or stream where they are being obtained, a shallow depression may be excavated along a bank and water led into it by means of a narrow channel. A pool 25' long and 25' wide with a two foot depth will accommodate 200

larger meshes do not become as easily clogged as the finer meshes of the number 8 screen. Each mesh of a #8 screen is 1/8 of an inch long, while themesh of a #4 screen is 1/4" by 1/4".

Leveling and Contouring Bottom of Pond

The bottom of the pond should be so leveled that all the waters can be drained toward the outlet, where there may be a slight depression in which the fish can be caught.

To facilitate drainage of the pond, all stumps, rocks and uneven places which will hinder the complete drainage of all the waters must be removed. The slope of a pond should be to the middle and toward the outlet, ao waters can move slowly and unhindered toward the outlet when the pond is to be drained. It has been found by the Bureau of Fisheries that to facilitate complete drainage of a pond and easy handling of the fish, a central ditch with a system of collateral ditches about two feet wide and one foot deep should be cut, to guide the direction and facilitate travel of the fish when the pond is lowered.

The inlet to a pond can be made similar to the outlet, either of wood or cement. Where supplied by a small spring-fed creek, log cribbing capable of holding two sizes of screen should be installed on each side of the bank, to prevent fish from escaping upstream. These screens should be protected by a slat rack as shown in the accompanying diagram.

Fertilization

Where ponds are located on sterile clay or sandy soils, as much as 800 pounds of decomposed stable manure per acre should be added to the waters during a twelve-month period. Care must be taken to add the fertilizer evenly in the shallow water along the shore.

Ponds which are well fertilized, due to a rich bottom or rich lands draining into them, may require only between 300 and 400 pounds of manure per acre each year.

An excess of algae, such as blue-green water scum during dog-days and early fall, and the accumulation of attached algal forms which cover and choke up the littoral regions, is an indication that fertilization is being carried too far and should stop immediately.

Fertilization should be heaviest as soon as the ice leaves in the spring, or may be placed on the ice during winter months and allowed to sink slowly into the pond as the ice melts, but none should be placed in the water during late fall where ice forms in ponds and remains there during the entire winter.

tile or hollow logs placed in ponds in about two feet of water will make excellent nesting sites for any of the catfish. Do not put these objects, however, where seining operations take place, as they will obstruct the nets from being pulled to the shore.

Boards laid flat along the bottom of the pond in shallow water will make suitable places for bullheads to spawn. They will burrow under these boards to make their nests.

Harvesting Crop

From one to two-thirds of the water in the ponds should be drawn off before seining operations start. Water should be let out slowly so that the fish have sufficient time to follow the receding waters without being trapped in weeds, etc.

All vegetation and other obstructions must be removed where seine hauls are to be made. Any wading or paddling which unnecessarily disturbs the bottom should be guarded against, as roiled or muddy waters are liable to kill the fish, and will in every case lower their vitality.

A net with meshes $1\frac{1}{2}$" wide should first be used to get the larger brood fish from the pond. Do not try to get both young and old fish from a pond at the same time, for the bigger fish will roll and thrash about in the nets and kill many of the smaller ones. The crop of young fish should then be taken from the pond by means of long minnow nets for distribution to the various lakes which are to be stocked. Advance plans must be made in order to know which lakes are to be stocked, and arrangements made for transporting the fish.

The young fish must not be held in ponds all winter, but should be planted during a cool period of weather in the fall, at which time the loss from suffocation and disease due to handling will be minimized. The fish are not very active during air temperatures from 60°F to 50°F, and are less liable to hurt themselves or use up all the available oxygen in the transport can on account of their activity.

An approach for trucks should be made close to the site where the fish are to be taken from the pond, and enough man power present to handle the fish. Have ten gallon cans ready and filled with water to receive the young fish. Enough trucks should be present to carry away the cans as soon as they are filled. Know where each truck is going and give written instructions on where to plant the fish.

large bass if there is a constant change of water provided by a small outlet or inlet.

Put brood fish in rearing ponds as soon as the ice leaves the waters in the spring so they may have time to accustom themselves to their new habitat and become paired for mating. Three hundred and fifty brood fish will stock a ten acre pond.

In procuring brood fish, take only those individuals which are mature. Size and weight are good characteristics by which to go. Get as large and healthy looking brood fish as possible. The sex cannot be readily differentiated, but the chances of obtaining a 50-50 sex ratio when catching large numbers of fish are good, and for all practical purposes indiscriminate hauls will suffice.

Transporting Fish

Brood fish are transported long distances safely if enough room is given them to rest at full length along the bottom of a receptacle. They should not be confined in small crowded containers. Water temperatures must be kept around 60°F, preferably 55°F, and plenty of oxygen admitted to the water by means of a pump.

Young fish taken from the ponds should be handled carefully. With proper care one hundred 3" or 4" fish may be transported safely long distances in a ten-gallon milk can. See "Handling of Fish in Planting," Wildlife Handbook.

Spawning Beds

Bass prefer gravel upon which to spawn, although if none is present they will use marl, muck or sand on which to deposit the eggs. The male fish constructs the bed by fanning and assorting the gravel with the caudal fin, or even carrying pebbles in his mouth. The sunfishes possess the same traits, while crappie will either make beds on the bottom of the ponds or spawn on logs, sticks, etc.

Gravel can be introduced in patches along edges of ponds which lack this material.

Care should be taken in introducing gravel that is well distributed along the edges of the entire pond. Bass, when spawning, are prone to annoy one another if the spawning beds are too close. If gravel is to be found naturally only on one end of a pond, it will be good practice to haul gravel and place it in other portions where it is not found.

Bullheads and catfish will not spawn on a bare bottom, but require logs, boards, etc., under which they can burrow. Hollow

The best development of these food animals occurs where pondweeds and other aquatic vegetation has become established. Hyalella is seldom found anywhere but in dense patches of Myriophyllum and Ceratophyllum or other dense patches of aquatic plants. A pond should be stocked with the suitable pondweeds, etc., as soon as it is made, in order to quickly establish the necessary food elements.

The various aquatic plants can be raked from the bottoms of lakes, and transported to rearing ponds. Such plants must be kept continually wet and cool during transportation, and can be dropped to the bottom of the pond by enclosing their root systems in mudballs or by pushing them into the bottom by means of a forked stick.

Predators

Herons and kingfishers prove to be insistent poachers in ponds unless their activities are discouraged. While it is often possible to watch over trout rearing ponds and scare such predators away or protect the ponds from their depredations by screenings, large ponds cannot be so guarded, and if these birds become too annoying, drastic steps must be taken to eliminate their presence. If it is necessary to shoot them, consult local game wardens and obtain permission to use firearms. Often these birds may be successfully driven away by long range shooting without killing them.

Mergansers, cormorants, grebes and loons are obnoxious and may, during migrations, consume many fish in the ponds, but are easily scared away with boats. Under no circumstances may any species of duck, loon or grebe be shot on Forest Service ponds, even though State laws permit such practices.

Propagation of Ducks on Fish Ponds

In fact, many desirable ducks such as wood ducks, teal and mallards can be raised on fish ponds with no harm resulting from their presence. On a ten acre pond, at least three wood duck nesting boxes° should be installed and ample protection given to the birds. Decoy mallards can be placed on ponds and used to entice wild birds to stay and nest. Of course, such ponds should be both fish and game refuges and hunting banned at least 500 yards on all sides.

°See "Construction of Nesting Boxes for Wood Ducks, Wildlife Handbook.

Drying Out Ponds

Once in every three or four years, ponds, after drainage in the fall, should be allowed to remain dry over winter. This will destroy any disease or other unhealthy conditions which may have developed. If other ponds are nearby, brood bass from a pond being dried over winter can be kept there; otherwise the fish should be liberated in some lake and a new batch of brood fish caught the next spring. It is desirable to have one or more ponds, however, into which brood bass may be kept temporarily over winter when their ponds are drying out.

Bass produce better and are healthier if fed flesh in the form of minnows, crayfish or frogs. Crayfish should be introduced into every pond, but care should be taken in procuring the right species, as some of the burrowing forms are inaccessible to bass. Minnows form a large share of the food of adult bass, and access to such food will form healthy, vigorous brood fish, and result in less cannibalism. Fifty thousand minnows deposited in a ten acre pond each year will provide enough forage, if there is present a sufficient amount of other foods, such as crayfish, water-fleas, plants, etc.

Care must be taken, however, to introduce the right species. Any of the sucker-mouthed minnows may be used, but under no circumstances should the following species of fish be introduced or allowed to exist in ponds:

1. Golden shiner
2. Bullheads (unless pond is managed for bullheads)
3. Carp
4. Chubs
5. Sticklebacks

The golden shiner, as well as the chubs, is carnivorous. Bullheads or horned pout are spawn eaters. Carp, in time, will destroy all aquatic vegetation and create waters so muddy and roiled that nothing but bullheads and themselves can exist. Desirable minnows are more easily caught in large quantities during the spring below dams or other similar obstructions.

Studies have shown that the amphipod, Hyalella, is fed upon extensively by young bass from one to four inches in length. The water-flea (Daphnia pulox) has been reared in some ponds to a length of 3/16 of an inch, and will provide excellent food for young bass. This large strain is the result of a correct amount of fertilization.

Copepods are also sought after by small fish and will be found in abundance where waters are fertile.

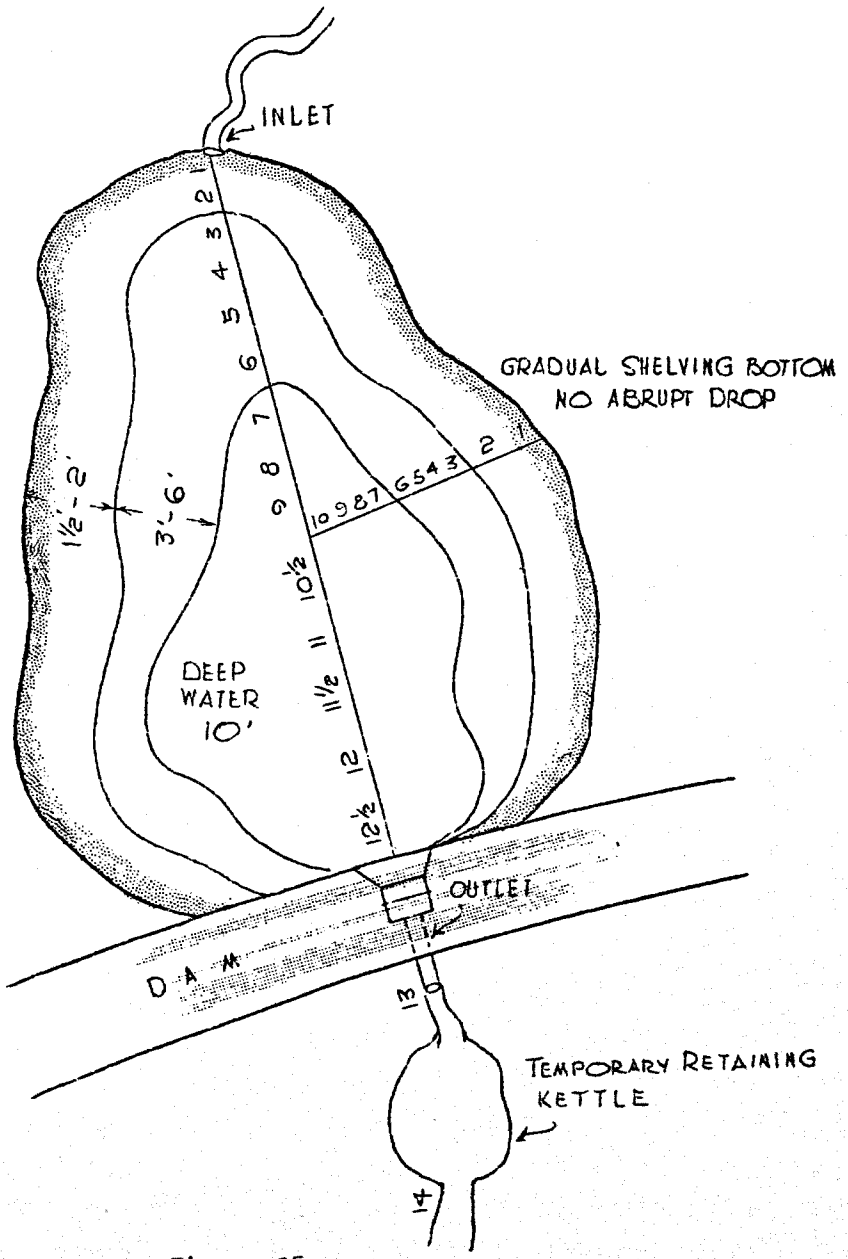


Figure 25

LOCATIONS OF VARIOUS DEPTHS OF WATER

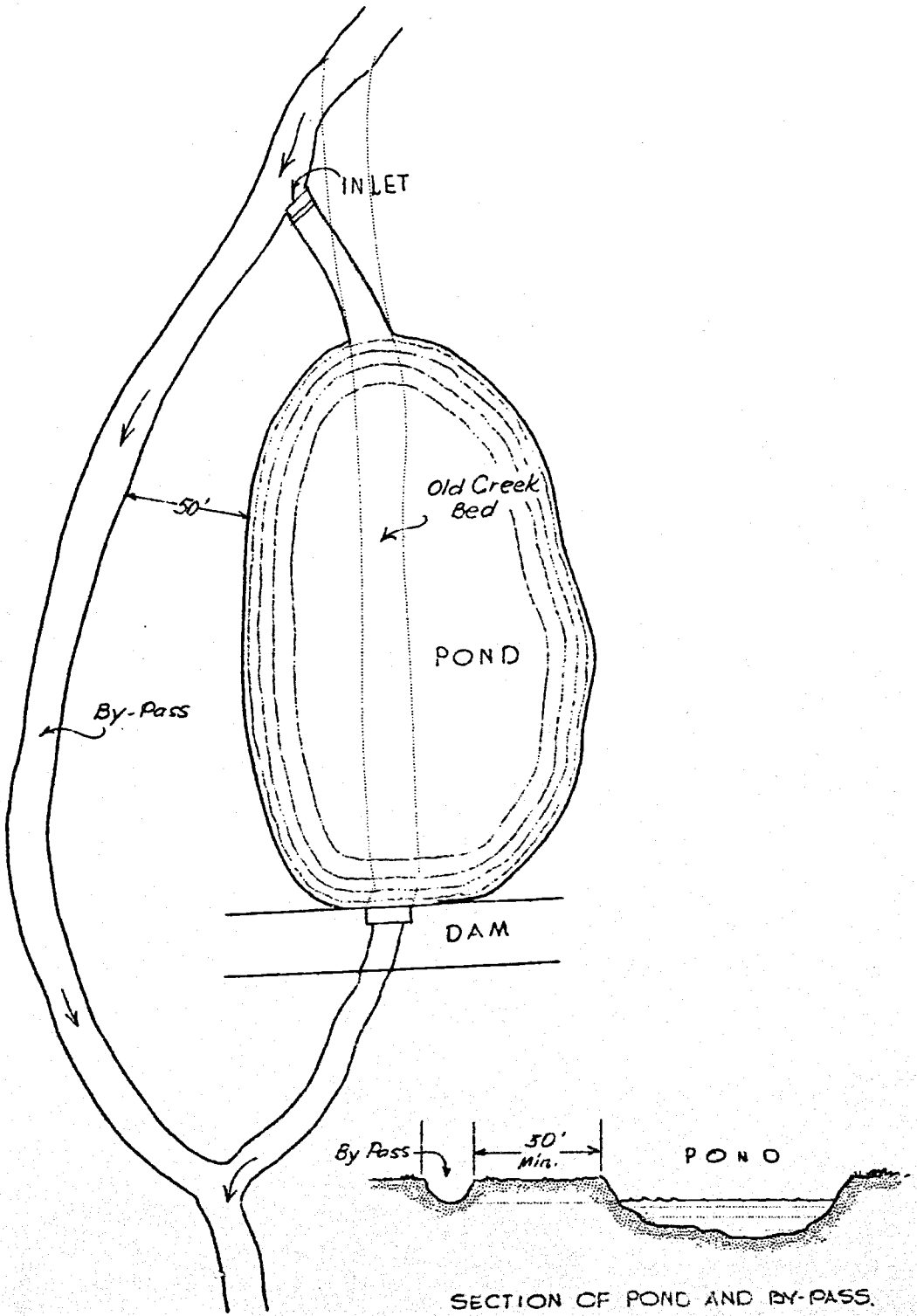

INLET
50'
Old Creek Bed
POND
By-Pass
DAM
By Pass
50' Min.
POND
SECTION OF POND AND BY-PASS.

Figure 27

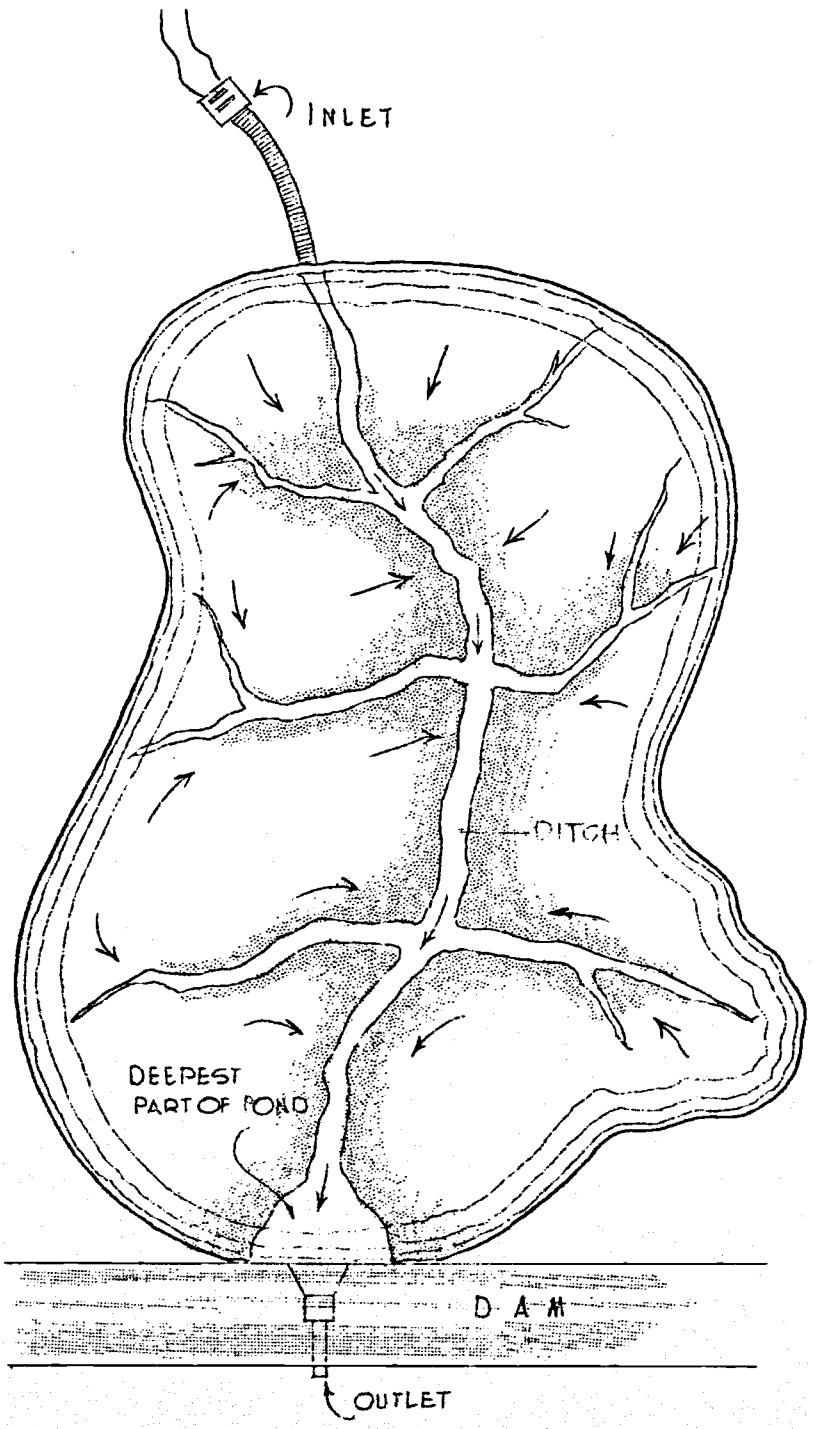


Figure 26

ARROWS INDICATE DIRECTION OF FALL

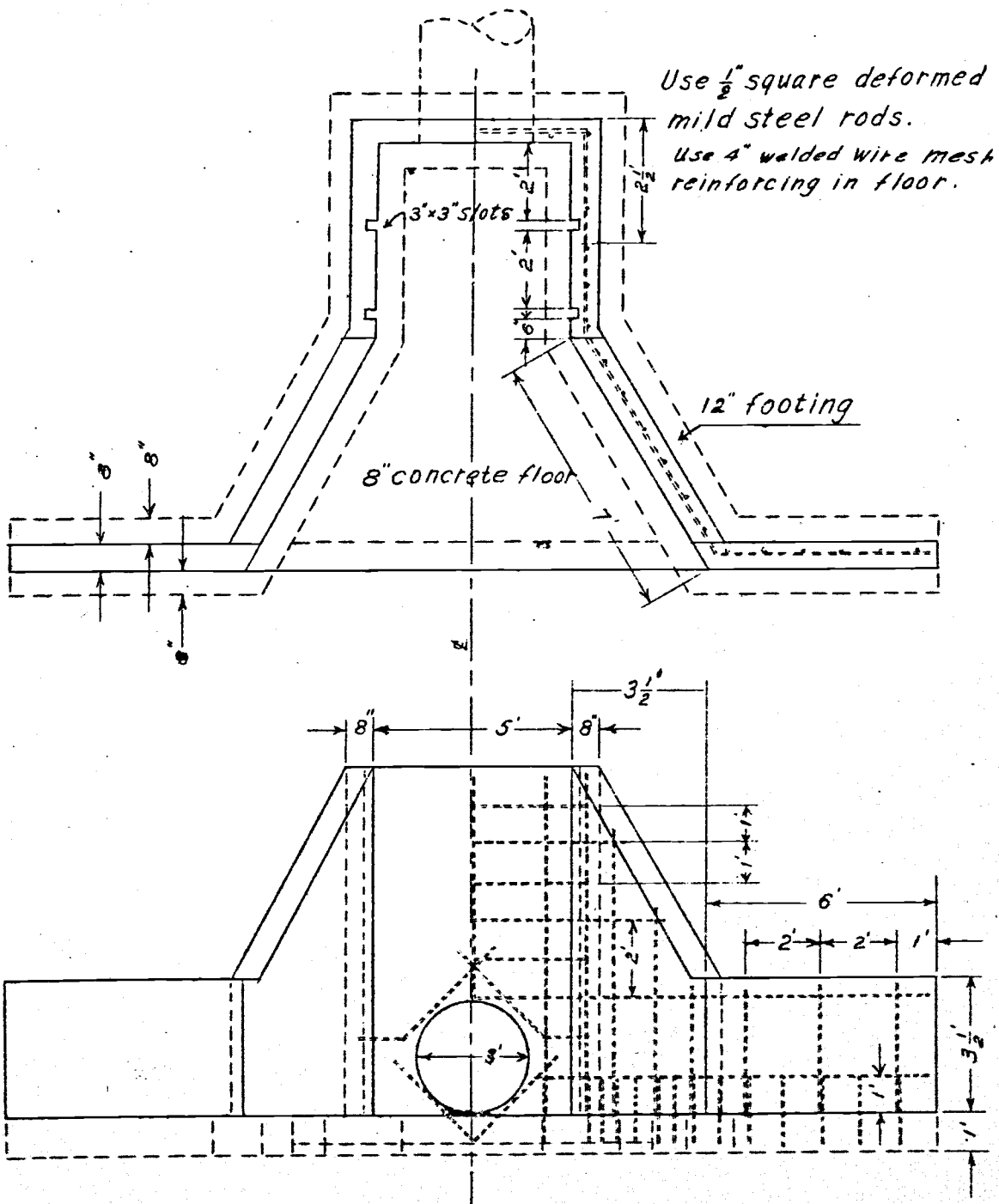
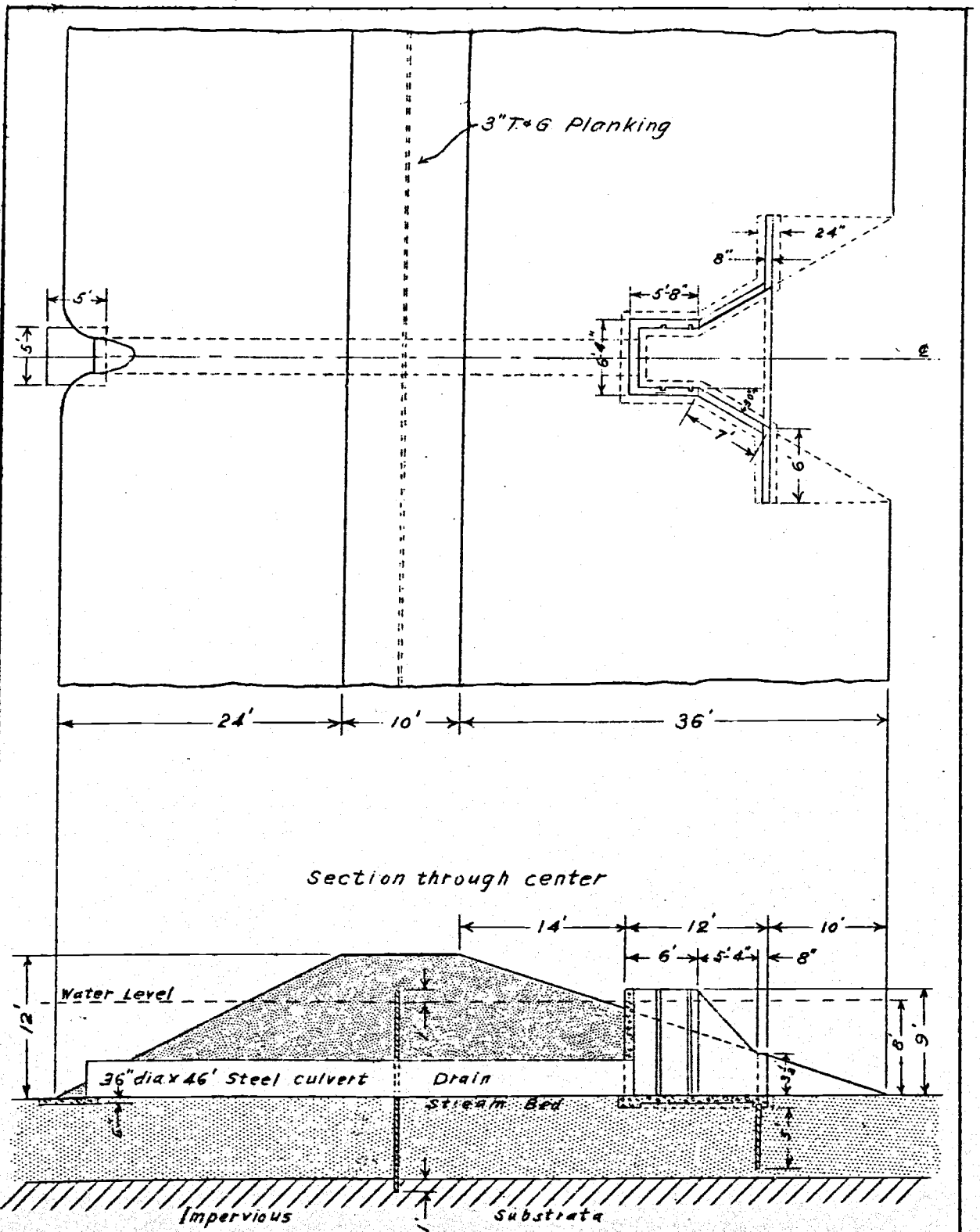


Figure 29

Footing to be poured first and 20" dowels to be placed one foot apart after initial set.
DAM TO BE OF 1:2:4 CONCRETE.

CONCRETE CONSTRUCTION FOR DAM FOR FISH POND



DAM FOR FISH POND

Figure 28

F.J.M.

HANDLING FISH IN PLANTING

Fish coming from hatcheries usually arrive by train during the night. Night shipments are most desirable during hot weather as nights are cooler and loss of fish is minimized. If you are meeting a train, arrive early with enough men to quickly transfer fish from car to trucks. Always be sure of the time, place and station where you are to meet the fish, as too often men have arrived late or have gone to the wrong place. Once you miss a shipment of fish, neither State nor Federal hatcheries will send you any more.

Arrive in plenty of time to inquire of the station agent regarding track location and shipment, and about where the baggage cars will be stopped. Then you can arrange your men and trucks in the right position for action.

Loss of fish in planting may be kept at a minimum if the individuals who are given the responsibility of planting or handling them have informed themselves as to the correct porcedure and have then carried out the operation carefully with proper attention to details. In the past as high as 90% of some plantings have been lost thru ignorance or carelessness. A number of details must be kept in mind in the shipping of fish.

Icing°

Keep the metabolic processes of the fish at about as low an ebb as possible. There are two means of accomplishing this, and one must be coordinated with the other.

1. Cool the waters by placing chunks of ice in the cans; 500 pounds of ice for 50 cans of fish when travel distance is 50 miles and speed of trucks 20 miles per hour.

2. Throw wet gunnysacks around the cans to keep the ice from melting too rapidly, as the sacks act as insulators. Also place a tarpaulin over the cans while transporting fish during the day time. Do not, under any circumstances, allow the tarpaulin to lie directly on top of the cans and so prohibit aeration of the waters.

Aeration°

Air may be given fish by means of dippers or auto tire pumps whenever it is felt that they are suffering from a lack of oxygen. This is especially desirable when fish are not being transported. Equipment such as pumps or dippers must be provided and enough men taken to administer air to the fish.

Fish cans are usually supplied with screen tops or tops which are bored with holes. Never use tops which will not admit air, as the waters are aerated thru the mouths of the cans by the movement of the truck, during shipment. The combination of cool waters made possible by the ice and wet gunnysacks and the supply of oxygen furnished by a pump or dipper and truck movement, will in all cases keep the fish in good condition. On warm, muggy days, during which time the respiration rate of the fish is apt to be great, waters in the cans should not be

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DAM FOR FISH POND (Inlet)

Use $\frac{1}{2}$" square deformed steel rods.

Footing to be poured first and dowels placed after initial set.

Dam to be of 1:2:4 concrete

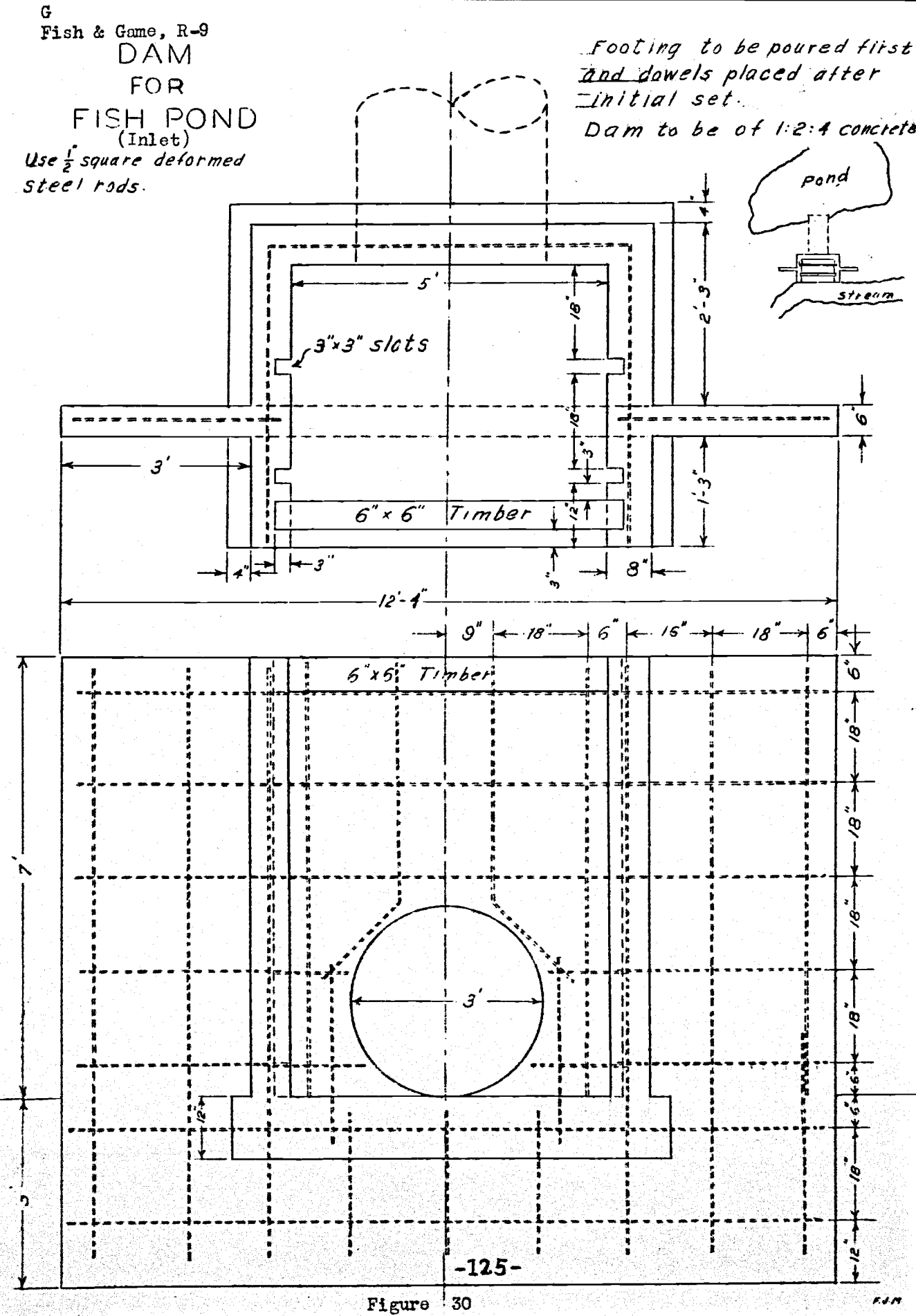

Figure 30

provided the waters are not suitable to trout. Wall-eyed pike are found as far south as Missouri and are very common in the Ohio and Upper Mississippi river.

Bass - Pickerel - Muskie

Plant all of these fish in sheltered bays where weed beds are available for cover and natural foods are abundant.

Trout

Do not put the brook trout in waters best suited to brown trout or browns in water suited to brook trout. The brook trout is an inhabitant of cold streams preferring a temperature of around 62°F. Brown trout can withstand temperatures of 75°F very welland should be planted where streams are exposed and are warmed beyond the requirements of brook trout. Rainbow trout prefer swift, rocky streams and will withstand slightly warmer waters than the brook trout. They never do well, however, where waters become too warm or where they are subject to long stretches of quiet sluggish currents.

Lake trout, and in fact, all trout planted in lakes, should be liberated over the natural spawning grounds of these species, and it is safe to assume if natural reproduction is successful, there must be sufficient food present for the use of the young fish. Therefore, liberate over those areas which are natural reproduction grounds.

Never plant trout in a lake not known to contain them naturally until oxygen and temperature determinations have been taken of the bottom waters during mid-summer. In lakes where the oxygen content of the lower bottom waters falls below six parts per million or the temperature rises above 60°F, do not plant trout.

° ° When transporting fry of pike, whitefish, trout, etc., the water should not be aerated by means of dippers or pumps, and neither should they be cooled by placing ice directly into the cans. Ice, however, can be packed around the cans and the waters kept at a low temperature.

allowed to become warmer than 45°F for trout and 55°F for pan fish, pike and pickerel. Extra ice must always be taken in order that there will not be a shortage.

Planting

1. Know where fish are to be planted. Have a plan of action made out in advance. Know where you are going.

2. If anyone is to help you, be sure they have been informed and are waiting at the right place at the right time. Always give written instructions to those helping you.

The method of planting fish is very simple, but according to observations few people practice the right principles and procedure.

3. Do not place all the fish in one hole or location, but scatter the planting along the stream or lake to be stocked. There may be several roads to a lake or stream by which different parties may arrive to stock waters. At any rate, diffuse the planting as much as possible.

A satisfactory planting of trout can be made by distributing the contents of one can of 200 fingerling trout every one half mile along a stream.

4. Plant fry of fingerling trout in small streams or pools where they will not be taken by large fish. Give them a chance to grow without being harrassed by carnivorous members of their family. In large rivers where there is no chance to put the young trout in safe places, portions of the main stream can be screened off with brush for protecting the small fish. Young pan fish and bass are best planted in dense weed patches where they will find ample protection and food.

5. When placing the fish into the stream or lake to be stocked, the greatest care must be taken in liberating them slowly and not until temperatures in the transport cans are the same as the stream temperatures. A thermometer should be in use at all times to determine when the waters are equal in temperature.

Upon arriving at the desired place, put the cans in the water. Next, take a dipper and start changing the water in the cans with river water. This process of changing the waters should be done slowly, as a too rapid change may prove fatal to the fish. When the thermometer indicates the water in the cans to be the same temperature as the river or lake water, the cans should be turned slowly over on their side and left submerged for several minutes so the fish may work their way out of the cans at their leisure and have ample time to accustom themselves to their new environment.

Wall-eyed Pike

In planting wall-eyed pike fry, plantings are best made far out in an open lake where they will not be beaten to death by wave action or taken by large fish. Do not plant pike in natural bass lakes. Pike are naturally found in the lakes having connections with other lakes thru rivers. Rivers are also suitable pike habitats,

WATERFOWL

Policies and Objective

The abundance of waterfowl depends upon the condition of the water, food and protection which can be given them. Under favorable conditions two ducks can be produced per acre. See "Duck Lakes"-Wildlife Manual.)

Every lake and river in which conditions are suitable for the development of wild duck foods should be investigated and planted. All of these areas must receive absolute protection from grazing animals, summer tourists and poachers. If a portion of a lake is desirable for a duck-breeding ground, fishermen, campers, etc., must be warned against using motor boats within 1/4 mile of the area and grazing must not be allowed within three hundred yards of the shore. Some lakes will be suitable for waterfowl propagation only in portions. These portions must be protected.

The largest duck breeding grounds in North America lie in our prairie States and through the prairie regions of Canada. The area can be mapped from Great Slave Lake in Canada to Nebraska in the United States and as far west as the Rockies and east to the Mississippi River Valley. Once this vast prairie region was dotted by innumerable lakes and pot holes which afforded wonderful breeding grounds for waterfowl. Drainage, drought and farming have practically destroyed ninety per cent of these areas in the States, while drought alone has dried up untold numbers of lakes and sloughs in Canada. The National Forests in Region 9 are located in or near this breeding range of waterfowl. Water areas should not only be planted and protected but more lakes and marshes should be created. One of the purposes for which the National Forests were created was to conserve the natural resources and to develop all possible land uses. Where duck breeding grounds do not now exist they should be created; where food is lacking, it should be planted; where waterfowl needs protection, The National Forests should contain refuges.

Each National Forest area must have inviolate refuges for waterfowl where the birds cannot be persecuted during hunting seasons. A system of refuges and public hunting grounds should be established. Refuge areas must possess sufficient cover and food to serve as feeding and resting areas for the birds. The public hunting grounds must also prove attractive for ducks. Each forest will have to plan and establish its own network of refuges and hunting grounds, and a balance reached in the number of hunting and refuge areas so that the shooting public is well served as well as affording protection for the birds.

Ducks are divided naturally into two classes - the divers and the puddlers. The diving ducks comprose the following species:

Name of Forest Chippewa National Forest

Supervisor J. M. Walley

Post Office Cass Lake, Minnesota

Telegraph Office Cass Lake, Minnesota.

U. S. FOREST SERVICE

REQUEST FOR FISH

Date

(Due September 1 of each year)

Name & Section of Stream or Name of Lake	Species of Fish Required	Area of Lake or Length & width of Stream	Degree Fished	Place Fish should be delivered	Allotment		Shipment		Date & by Whom Delivered	Individual or agency Responsible for receiving and planting the fish		
					Number	Size	Number	Size		Name	Post Off. Addr.	Shipping Addr.
North Twin Lake	Black Bass	569.37 Acres	Heavy	Cass Lake	10,000	Fry				John Doe	Cass Lake	Cass Lake Minn.

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tions, but it is our duty to raise a surplus of ducks above the natural wastes and shooting drain. It is then imperative that management for the ducks that nest in the forests be considered.

Breeding areas for ducks must have:

1. Sufficient, clean, stable water areas
2. Food
3. Freedom from disturbing factors, as:
    a. Man
    b. Predators
    c. Grazing animals
4. Cover

The food of the diving ducks differs somewhat from that of the puddlers, and the food of one species may differ slightly from another. Food for the puddle ducks must be within two feet of the surface so they can reach it by "tipping." Such foods as duck potato, wild rice, duck weeds, pond lilies and insect larvae prove very attractive to these ducks. On the other hand, the divers will go to great depths to reach food beds. They feed chiefly on celery, sago pond weed and chara, although they will feed extensively on wild rice where they are not molested. Scaups are very fond or rice and will often forsake the open waters to reach rice beds.

Small sloughs partially filled with a rank growth of cattails, marsh grasses and rushes are the most suitable locations for breeding prairie ducks. The water must be stable and clean. The natural vegetation must remain unmolested by grazing animals or farming activities.

The ducks which nest in the forested part of the Lake States require a slightly different habitat than those which nest on the prairie.

Large rice beds are their favorite type of habitat. Low bushy shore lines and numerous small pot holes in the near vicinity make ideal surroundings. Small inland pot holes, which are nearby, serve as ideal nesting sites, but the families soon migrate to the abundant cover and food found in the rice beds. Black ducks and mallards are very prone to move into larger bodies of water as soon as the young can fly.

See -- Paul L Errington and Logan J. Bennett.
"Iowa Duck Studies." Iowa State College, Ames Ioa.

1. Lesser scaup (little bluebill)
2. Greater scaup (greater bluebill)
3. Canvasback
4. Redhead
5. Golden-eye
6. Ruddie
7. Ring-neck
8. Buffllehead
91 Morganser

These ducks dive to considerable depth for their food and require fairly large bodies of water for feeding grounds during migrations. However, they nest abundantly in the small grassy sloughs of the prairies. These birds all possess a flap on the toe of each foot. The puddle ducks do not.

The puddle ducks are:

1. Mallard
2. Black duck
3. Blue and green-wing teal
4. Baldpate or Widgeon
5. Gadwall
6. Pintail
7. Shoveller
8. Wood Duck

With the exception of the golden-eye, most of the diving ducks breed in the prairie regions. East of this prairie belt, which is the breeding range of canvasbacks, redheads, bluebills, ruddies, baldpates, pintails and gadwalls, are many suitable lakes and marshes where the mallard, black duck, golden-eye, wood duck and teal breed. Although the mallard and teal are found breeding on the prairies, they also frequent the wooded areas of Minnesota, Wisconsin and Michigan. The black duck outweighs in predominance all other ducks within the National Forests of Wisconsin and Michigan as a breeder. It is practically never seen west of the Red River Valley, but east of this point increases in numbers.

Lakes and streams surrounded by forests prove very attractive to golden-eyes and wood ducks. As these species nest in hollow trees and snags, none of these should be cut within five hundred yards of lakes and streams on the National Forests.

Most of the Forests of Region Nine (9) lie either on the edge of the prairie breeding grounds or within the breeding range of the black ducks, mallards, teal, golden-eyes and wood ducks. The greater percentage of our land lies wholly within wooded areas of the Lake States. The lakes, streams and marshes should be managed for the propogation of these ducks that frequent them for breeding purposes. The other species which feed but do not raise young on our forests should be cared for during migra-

RICE BED

Many water areas on the National Forests of the Lake States can be developed into real beds such as is shown above. Huge rice fields already exist on the Minnesota Forests. Many others should be developed there and elsewhere.

DUCK LAKES

A duck lake must possess sufficient clean and stable waters in connection with accessible food beds, cover and ample protection from vermin and man. It is the purpose of this discussion to outline the limitations found in many of our lakes which make them undesirable for wildfowl, and to discuss typical duck lakes where birds can breed and rest.

Clean, stable water areas are the first prerequisites of duck lakes, for fluctuating water levels prove disastrous to duck foods and to duck nests. Receding waters are harmful because water plants left on dry land cannot perpetuate themselves. High waters are also destructive to rice and other desirable duck foods. Nests are covered and ruined by floods, and when silt is deposited by flood waters, duck food may be buried and killed. Floods or suddenly rising waters are very disastrous to the propogation of waterfowl.

Lakes or streams suitable for duck propagation must possess a low, grassy, irregular shore line. Coves, nooks and small bays in which the waters run among stalks of rushes, cattails, etc., are very desirable. The area from the water's edge to high ground should contain this type of shore line for a width of about three chains and should extend over at least one third of the lake or stream shore line. Small islands of rushes or cattails scattered throughout the lake make favorable nesting sites for the divers.

Many lakes possess a low, marshy shore line, but due to deep waters adjacent to the banks, little or no duck food is grown or is available. About seven-tenths of a lake should be shallow enough to support plant life in order to be suitable as a duck breeding area and feeding ground. Waters over 12 feet deep will not support great quantities of plant life unless the waters are very clear.

Puddle ducks such as mallards, teal, widgeon and pintails prefer to get their food by "tipping" and require very shallow waters for feeding. Seldom will they dive for food, but when they do, they cannot reach below a three foot depth. Black ducks and mallards driven from good feeding grounds by excessive gunning have been known to exist on deep waters, but most of their food at such places is usually gleaned from what the diving ducks bring to the surface. At least one-fifth of a lake should be less than two feet in depth if it is to be suitable for the puddle ducks.

Aquatic insects are one of the principal foods for ducks and comprise nearly one hundred per cent of the food for ducklings. Lake and stream studies have shown that most of the aquatic insect forms are absolutely dependent on plants for their development - not only for food but for attachments to crawl upon. Loose mud or shifting bottoms are unsuitable for most insect species to develop. Many of the adults of aquatic insects emerge from nymphal stages which must climb up stems of rushes, etc., to cast their nymphal skins, and where sticks or aquatic plants are not available, these forms of insect life

Tall trees, overhanging banks or coves of lakes in which rushes and other emergents have taken root make the most ideal breeding sites for these ducks. Most of the streams and rivers in the forests are adaptable for the propogation of these waterfowl. (See "Wood Duck", Wildlife Handbook.)

The gradual disappearance of the buffle-head and wood duck has not been so much due to the hunter as to the destruction of their habitat by logging, fires and farming activities; therefore sufficient snags and hollow trees within 500 yards of the shore line, to supply the required nesting places, should remain uncut.

Potholes

The pothole, or small pond, is the principal breeding site of the ducks, whether it be found on the prairies or in the northern wooded forests. Teal, mallards, pintail and all of the diving ducks use them extensively for breeding and only after the young have become strong enough to fly do they migrate to larger bodies of water.

Potholes used by waterfowl must have a suitable shore line. A constant water supply is very desirable, but due to droughts, many of the small ponds are temporary and dry up during the latter part of July and August, forcing the ducks using them to move their families before the young can fly to more stable water areas. But if such stable waters are not near by, a dry period coming in June and July will destroy thousands of birds.

The ideal duck producing territory will possess one permanent large duck lake surrounded by many small ponds not more than one-half a mile away, so that spasmodic droughts cannot affect the duck population.

By the installation of dams in small creeks, ponds which will not be subjected to temporary droughts can be formed. Beaver, , in many localities, have made excellent ponds of this type, and it is a rather simple procedure to make their dams permanent. See "Relation of Beaver to Ducks", Wildlife Handbook.

Prairie Lakes

Ducks inhabiting the prairies require a different type of lake for nesting sites than do waterfowl breeding in the forests. Birds on these bodies of waters can see for a long distance, as nothing is present to obstruct the horizon save a few grasses, which may be the reason that the prairie lakes and sloughs are sought after by certain of our ducks. The prairie sloughs are usually quite shallow and small-some are alkaline-but some of them are of fresh water and support abundant duck foods. Fresh water prairie lakes possess abundant sago pondweed, milfoil and coontail, which are fresh water indicators. (See Technical Bulletin #221-a U.S.D.A. publication).

cannot develop successfully. Not only do the rotting and living aquatic vegetation of ... lakes and streams produce food for insect life, but they form a basis for attachment of the insects which otherwise would be smothered in muck.

As other duck foods such as snails and small fishes are also dependent on the cover, protection and food supply offered by the aquatic vegetation, it is apparent that the food of ducks is primarily dependent on aquatic plants, and lakes without such vegetation are practically useless for wildfowl propagation.

There are three conditions which are <u>not</u> advantageous to duck population in some of the lakes:

1. Deep lakes (Over 15')
2. Shallow lakes with bare mud or sand bottoms possessing no vegetation
3. Lakes possessing no grassy shore lines.

It is desirous to have some deep water in the duck lakes in order that wave action will be developed and emergents will not grow too rapidly and eventually fill up the lake; also to keep the lake in a healthy condition so that putrification effects will not be noticeable. Deep waters are safeguards against drought, and have proven very advantageous to duck life when marshes begin to dry up, as evidenced during the periods of drought from 1931 to 1934.

All of the puddle ducks and geese require mud or sand bars on which they can preen their feathers and sun themselves. Low bars which are just above the water surface prove very attractive to ducks. Muskrat houses often serve a similar purpose, and it is not at all uncommon to see several ducks sitting on a single rat house.

Mallards and teal desire the safety of the cover and shade afforded by rushes, and marsh grasses along a lake shore. Such cover to be effective and readily accessible must be in contact with the water.

Most of the Class I, II and III lakes in the forests are undesirable for propagation of waterfowl except in restricted bays or along limited stretches of shore line, but ducks of the following species could be induced to nest and use the more open bodies of water if a nesting box for every ten acres of water was supplied along the more heavily wooded shore lines.

1. Wood duck
2. Golden-eye
3. Buffle head
4. Hooded merganser

of food and the poor quality of water makes these lakes almost useless for propagation or feeding areas.

Muskeg lakes are poor duck producers and should be disregarded for production purposes. Lakes of this type are often improved when a drainage into and out of them can be effected, so that rice and other duck foods will become established.

Deep, Rock Lakes

Class I lakes possess little or no inducement for nesting waterfowl. Outlets, inlets and shallow bays sometimes found in these lakes may be productive, but due to their limited area, these deep, rocky lakes can be disregarded when the question of propagation of any of the puddle and most of the diving ducks is discussed. Golden-eyes and mergansers are the only ducks using these lakes, and if nesting boxes are placed along protected coves and bays where shallow waters are partially protected by rushes,etc., the population of these ducks will be increased considerably. However, in the Superior National Forest, where many of these species breed, small potholes or streams beside the larger lakes are used more extensively for breeding sites, and families when grown move into larger water occasionally to feed and play.

These barren, rocky lakes are low in fertility and not only produce few fish per acre of water, but support little or no food for waterfowl consumption, but if the forest cover is protected, thereby increasing the fertility of the surrounding land, these lakes in time will become more productive of fish and other forms of life, and produce, no doubt, more of the species of ducks which are to be found there now.

Favorable results have been obtained in planting rice on several of the swampy inlet and outlet rivers of rocky lakes in the Superior National Forest. Black ducks and teal have already taken advantage of such places, and it is hoped further plantings of duck foods will make this forest and other forests in similar lake regions more productive in the fiture.

Pollution

Refuse emitting from factories, sewers and creameries has destroyed the productivity of many streams and lakes. Wastes which use oxygen in their decomposition prove disastrous to animal and plant life of the waters when the oxygen content falls below two parts per million. Where this has occurred, fish, pondweeds and most of the aquatic insect larvae and nymphs are smothered. Ducks must leave lakes where their food supply has been destroyed in this manner.

Disgusting and obnoxious as pollution results are, there exists a general apathy on the part of the public to support adequate control methods for the disposal of sewage and industrial wastes. Wherever such conditions occur vigorous steps must be taken to insure clean breeding places for ducks and fish.

Alkaline sloughs of the prairies are capable of supporting ducks if the saline conditions do not become too intense. Widgeon grass, algae and sometimes sago pondweed are found growing in such lakes. The widgeon grass extends to a depth of six feet in the water, and is a definite indicator of saline conditions.

Before the advent of the farmer, the prairies were well supplied with lakes and marshes, but drainage, drought and grazing have practically ruined 90% of these areas today, and there is only a remnant of the fine waterfowl breeding grounds once possessed.

A typical prairie lake, to be suitable for breeding purposes, should possess, in addition to sufficient food, a low marshy shore line well clothed by grasses, rushes and cattails. Grazing and farming activities must not be allowed to disturb this shore line if it is to be used for duck breeding purposes. Redheads, bluebills, canvasbacks and ruddies make their nests among groups of these plants growing in water, and very often redhead nests are found in clumps of cattails standing in a foot of water.

River Lakes

Ox-bow lakes and other river lakes appeal to many of the wildfowl. In the Central States most of the good duck lakes are of this type, producing local ducks and feeding great numbers of migrants, because of the supply of abundant food found in and bordering these lakes. Pond lilies, duck potato, duckweeds (Lemna), rushes, chufa, are all very common, and most of the pondweeds grow luxuriantly in these waters. River lakes make their appearance mainly on the lower courses of streams where valleys have been widened sufficiently for a meandering current to cut back and forth, creating ox-bows, etc. They are usually well fertilized and their waters capable of producing an abundant animal and plant food supply, due to the organic material and salts in solution being brought down by the river. The succession of watera has already gone a long way toward the climax when a river lake is formed.

Blue-winged teal, mallards and shovellers breed in these lakes and use them extensively during migrations. The states of Iowa, Missouri, Illinois and Oklahoma have several fine lakes of this kind and could create more by cutting off ox-bow bends and installing dams.

Muskeg Lakes

In the northern forests of the Lake States are many small potholes bordered by a dense mat of Labrador tea, Sphagnum moss, bog birch and black spruce. Such lakes are in the process of filling in with peat along the edges, but are usually quite deep adjacent to the shore. Their waters appear dark, and are very often so acid and stagnant that they are prohibitive to good animal and plant growth, and the only plant growth noticed in many is a scattering of spatterdock (yellow pond lily). Ducks may use such lakes as resting grounds and for seclusion and protection during hunting seasons, but the deficiency

REFUGES FOR WATERFOWL

Inviolate refuges for the protection of waterfowl during their fall migration must be established. Such refuges are indispensible for the following reasons:

1. The birds must have unmolested recourse to food, rest and shelter. They cannot be persecuted from every lake and stream and be expected to maintain their numbers.

2. Migratory waterfowl are not only the possessions of the United States, but belong to several nations. It is our duty to see that they are sufficiently cared for and protected while in our hands.

3. Baiting and kindred abuses by private individuals will be somewhat nullified if natural feeding grounds for the ducks and geese are afforded to them under absolute protection.

4. Refuge areas will prove to be production areas also, and must be protected from man and animals during the nesting season.

Sanctuaries must be established as permanent Federal refuges, never to be opened to hunting. It is desirable to have these refuges for waterfowl under Federal supervision in that migratory game birds are already under Federal protectorship. As the years pass the birds will become more and more accustomed to those refuges. It would be taking unfair advantage of them to open such waters to hunting after years of protection. A refuge for waterfowl should be made with the purpose of keeping it permanent.

What Constitutes a Refuge Area.

Refuges must be established where constant water levels can be maintained. Lakes which are apt to dry up during dry seasons and lakes controlled by individuals or companies which require the waters for commercial purposes are unsuitable for sanctuaries. Provide refuges which will be a constant source of food supply to the birds. Dams may be installed to regulate the water levels and insure a stable supply of water.

A refuge lake must possess the follwoing characteristics to be satisfactory:

1. Clean, stable water areas.
2. A low, grassy shore line surrounding at least 1/3 of the lake. This strip to be not less than three chains wide.

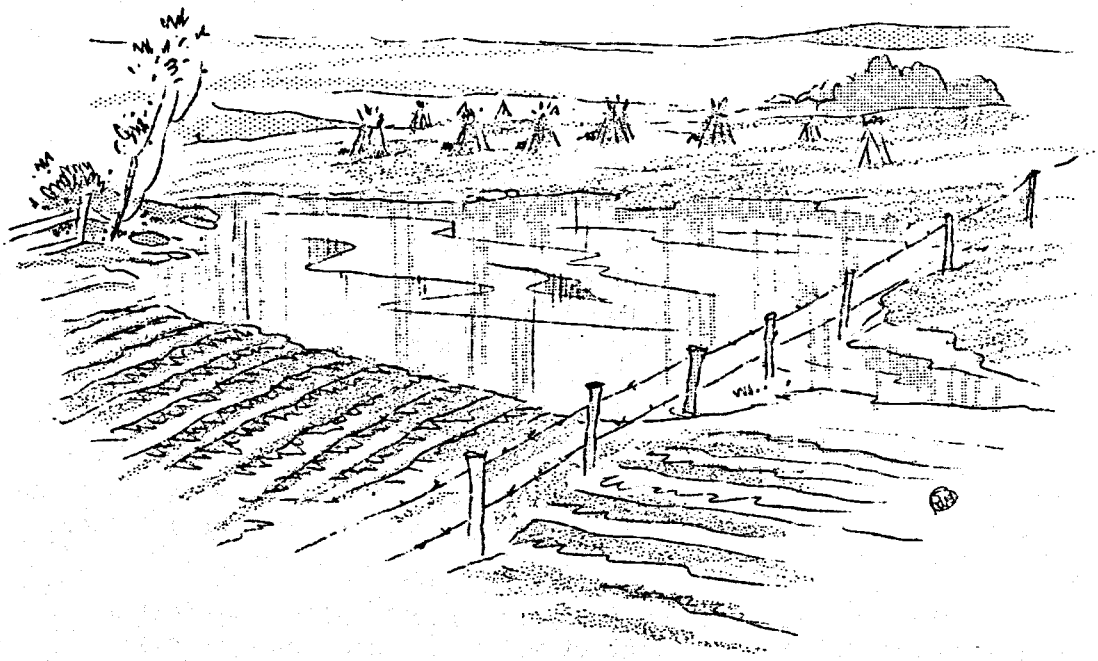


Fig.31. Duck Lake Ruined by Farming

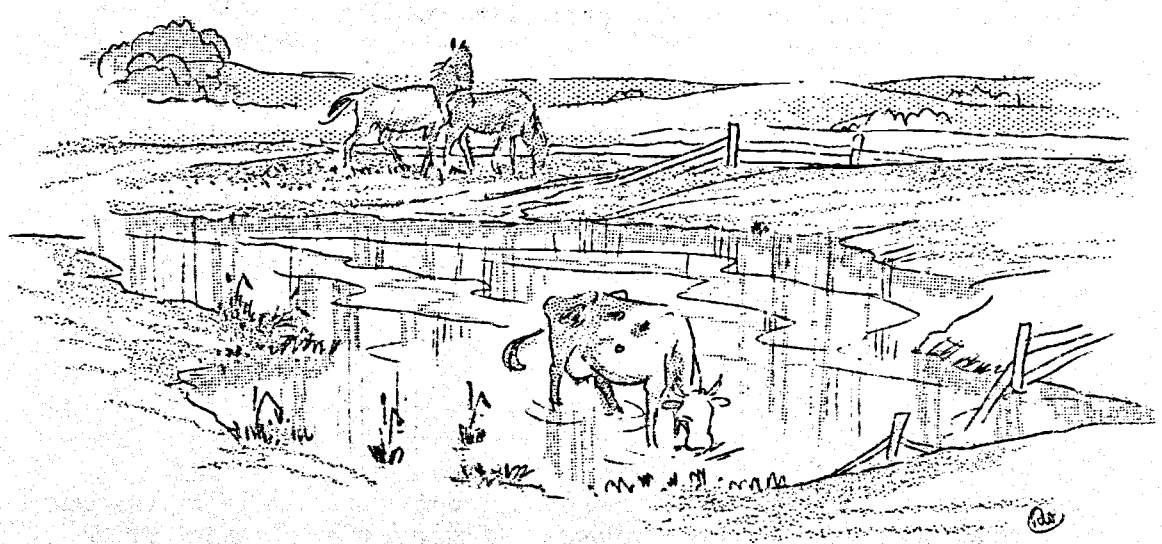


Fig.32. Duck Lake Ruined by Grazing

Lakes 1 to 15 are duck lakes on a National Forest*, we will say. Lakes 1, 8 and 12 should be made into refuges. These lakes must possess ideal food conditions, resting areas and clean and stable water levels.

Portions of large lakes may be made into refuges with good effects, provided these areas are large enough to allow the birds freedom of movement. The remainder of such lakes can be open to hunting. Land surrounding such refuges should be closed to shooting 500 yards back from the shore.

Marking of Refuges

Refuges must be marked by number nine wire four feet above the ground. The area should be posted with Federal refuge signs, and a brushed out line twenty-four feet wide (24') should surround the refuge on land, while in the water the refuge may be marked by posts.

Treapassing

No trespassing, whether with gun or not, will be allowed on duck refuges during the hunting season except by written permission of local forest or conservation officers. Any disturbing factors which will drive the birds into the hunters' guns must be outlawed. This will mean the cessation of fishing from refuges during hunting. Disturbances during nesting seasons are also harmful and must be stopped.

Control of Predators

Where there are concentrations of game birds there will be a corresponding increase in the vermin which prey upon them.

During the nesting season the following animals destroy the young and the eggs of our wildfowl:

1. Crows
2. Rats
3. Mink
4. Weasels
5. Skunks
6. Raccoons
7. Foxes
8. Coyotes
9. Turtles

Crows are especially injurious to young ducks and duck eggs. They must be controlled by shooting or trapping and destruction of their nests.

The mink, skunk, etc., can be controlled by trapping.

* (See "Duck Lakes"- Wildlife Handbook.)

3. Emergent vegetation such as bulrushes, reeds, rice, cattails, etc., should extend into the waters from the grassy shore lines. Clumps of these emergents appearing throughout the whole lake will be advantageous.

4. One-fifth of refuge area no deeper than three feet.

5. One-half of the remainder of the lake shallow enough to support potamogetons, or other plant life.

6. There should be a minimum of farms and clearings and similar human activities adjoining the lake.

7. Areas should be so located that they may be under easy management and protection from violators.

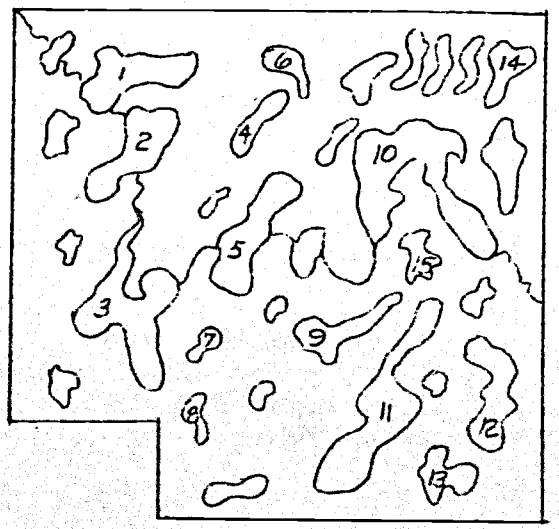
System of Location

A system of refuges must be worked out and put into effect on each forest. One refuge on a forest is not satisfactory and may prove disastrous to the birds, because of large concentrations of ducks which may be attracted to it. Concentrations may be so great that all the available food supply will be eaten and the area practically ruined. But a greater danger is the havoc wrought by disease, such as the "duck disease," also called botulism, resulting from putrid unhealthy conditions. Wherever huge numbers of waterfowl exist in congested areas, this dread disease is likely to occur.

The refuges should be so placed and sufficiently numerous that the danger of local concentrations of ducks will be minimized. None should be less than 200 acres in extent.

Ten to twenty percent of the total duck waters should be in refuges. This percent will be more effective and useful if scattered over the forest, and not clustered together. Reasons for this have been explained previously.

The following diagram shows a hypothetical arrangement of lakes with the location of the waters suitable for refuges indicated:



GREEN-WINGED TEAL
(Nattion carolininse)

The green-winged teal is one of the smallest ducks. It breeds, from the west to the east coast, and from Alaska to the northern portions of the Lake States.

Small potholes prove to be suitable nesting sites. Families have been found in small ponds of less than one-eighth of an acre, In flight its actions are somewhat snipelike, due to the erratic progress of the bird. Fall migration of the more northern breeding fowl reaches the United States by the 15th of October, but birds making their homes within our borders may migrate south much earlier, accompanying the blue-winged teal on their early migration.

The number of these ducks in the National Forests can be greatly increased by providing many small potholes. Beaver dams, in many instances, have created ideal nesting sites, and many small creeks can be improved for these ducks by the construction of dams.

The green-winged teal, if given ample protection from natural enemies and afforded good breeding conditions, will be one of our most numerous ducks.

BLUE-WINGED TEAL
(Querquedula discors)

The blue-winged teal is found quite commonly in all Lake States Forests, and if provided with small marshy sloughs breeds abundantly.

It is one duck that can be easily managed, as it does not require absolute seclusion which other species find necessary. The blue-wing has been found nesting within the limits of large cities, and is often seen on ponds used for watering barnyard stock. If unmolested by poachers this duck becomes quite tame and will stay close to the habitations of man.

Rice and rush-choked marshes appear to be its most favorable habitat. As the hens are very selective when breeding and nest some little distance from the lake in well hidden clumps of marsh grass, grazing animals and haying operations destroy many birds each year. A rank growth of shore vegetation should be present a distance of three chains around each lake or marsh being used by these ducks for breeding purposes.

The blue-wing is the first duck to migrate south in the fall, and usually leaves the Lake States between September 15 and October 1, although some individuals remain much longer where protection and food are excellent.

The duck hawk is very often disquieting to ducks and is capable of destroying many valuable birds. Hunting of these birds and disposal should be done by competent men who know the various kinds of hawks and will not kill harmless species. (See "Competitors and Predators of Ducks."Wildlife Handbook.)

Food in Refuges

Refuges must be made where there is abundant natural food. Such places will be attractive to the birds and the refuge will function as it should. Do not establish refuges where there is no chance for a duck to feed or rest.

NOTE

Plans for a system of refuges for waterfowl should be carefully made on each forest. The refuge sites will be checked by the Regional Office and the necessary arrangements started for making the suggested areas into Federal Refuges. Plans should be completed if possible before May 1, 1935.

WOOD DUCK
(Aix sponsa)

Small woodland potholes and creeks are sought by these ducks for nesting sites. They nest in hollow stumps and trees from four to forty feet above the ground, and are found in all the forests of Region Nine.

Due to logging and fires, many home sites of the wood duck have been ruined and this is no doubt the cause of its decline in numbers the past two decades. Closed seasons will help save the remaining stock, but steps should be taken to establish new homes wherever possible.

Wood duck nesting boxes should be placed along wooded streams and small woodland lakes. They are best placed beside the shore on some tree or snag which overhangs the water. Use only trees and snags which are sound and not apt to windthrow. Each camp should make from fifteen to fifty nest boxes each winter and have them nailed or screwed in place before the ice leaves in the spring. Nesting boxes may be placed from ten to forty feet from the ground, and often may be attached close to human habitations, and if the birds are unmolested they will become as unconcerned about the presence of man as barnyard fowl. It is desirable that we place some of the nesting boxes around recreational areas if suitable water is present.

Hollow cedar logs may be used for nesting boxes, provided they are the same dimensions as in the accompanying diagram. A board back and a board front with a six-inch diameter entrance hole must be placed over the ends of hollow logs.

A backboard fastened to the back of the nesting box should be provided so the boxes can be nailed to the trees. Nailing nesting boxes for birds to trees is permissible.

HOODED MERGANSER
(Lopnodytes cucullatus)

GOLDEN-EYE
(Glaucionetta clangula americana)

BUTTER-BALL or BUFFLEHEAD
(Charitonetta albeola)

These ducks possess habits similar to the wood duck. They nest in hollow stumps and trees in the Lake regions of all our Northern Forests, but unlike the wood duck are not found in the Illinois and Missouri Forests. Many of the nesting boxes for wood ducks will be used by these species, but as they are desirable

MALLARD

(Anas platyrhynchos platyrhynchos)

The Chippewa National Forest in North Central Minnesota contains many fine lakes and marshes wherein the mallard breeds in great numbers.

Nests are frequently located one mile from the water, making it difficult for observers to determine if the mallards are nesting until the young broods appear on the water. Often as many as twelve young are successfully reared to maturity by one mother.

The plantings of rice in many of the shallow lakes has provided suitable mallard lakes, where none existed before. Rice fields are especially attractive to the mallard and he will often travel 100 or more miles a day to reach such feeding grounds. Wherever food and protection is to be found the mallard will stay and breed, being a rather cosmopolitan bird.

The mallard is more common in the western part of Region Nine than in the eastern forests, where the black duck, a close relative gains the predominance.

The restoration of drained and drought affected areas will increase the mallard population immeasurably, as now perhaps more than twopthirds of their former breeding range has been destroyed. Grazing and unnecessary human intrusions, such as motor-boating and camping adjacent to our duck lakes should be discouraged.

BLACK DUCK

(Anas rubripes tristis)

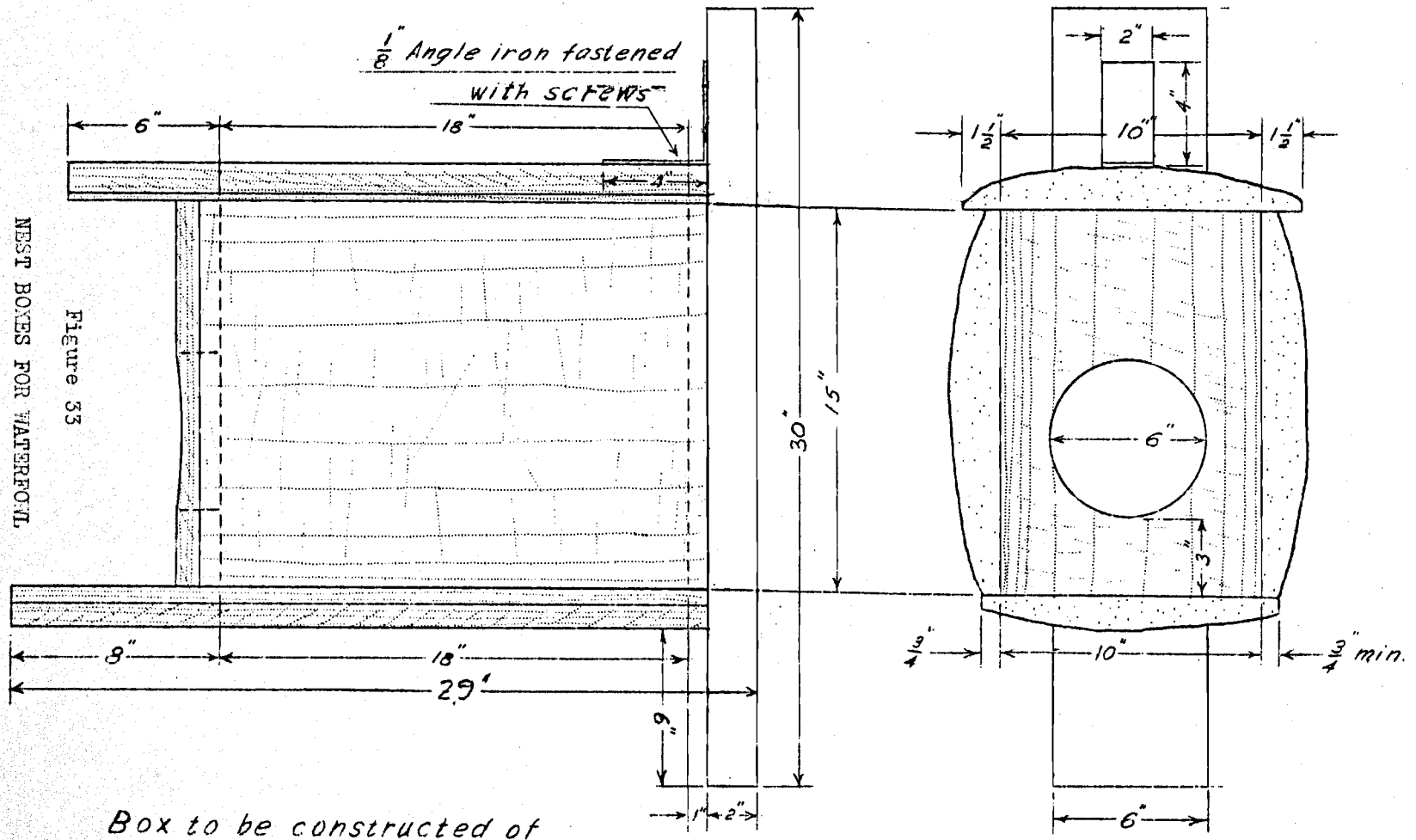
This is an eastern relative of the mallard, and is more common than the mallard along the wooded lakes and streams. Old beaver flowages prove attractive home sites for the black duck, and the small shallow coves along large lakes are often used. They seldom nest south of the Lake States, or west of Minnesota.

Rice fields are used extensively by the blacks and often mixed flocks of mallards and black ducks can be seen flying to and from those breeding grounds.

The black is perhaps more canny than the mallard, and before daylight arrives, promptly leaves marshes where hunters are waiting and goes to open bodies of water where they can keep watch. Mallards, of late years, have been adopting the same principle of self-preservation, but are not always as punctilious in leaving marshes before day-light as the blacks. Both the mallard and black duck come into feeding beds long after sundown where there is hunting.

NEST BOXES FOR WATERFOWL

Figure 33



Box to be constructed of slabbing with bark.

Top and bottom to be fastened with screws.

WOOD DUCK BOX
SCALE 1" = 6"

F.J.M.

ducks to propagate they should be unmolested. Although the hooded mergansers are fish eaters and also to some extent the golden-eye, they will not prove to be a nuisance on the lakes and rivers, and under no consideration should any of these ducks be shot out of season on National Forests.

PROTECTED DUCKS

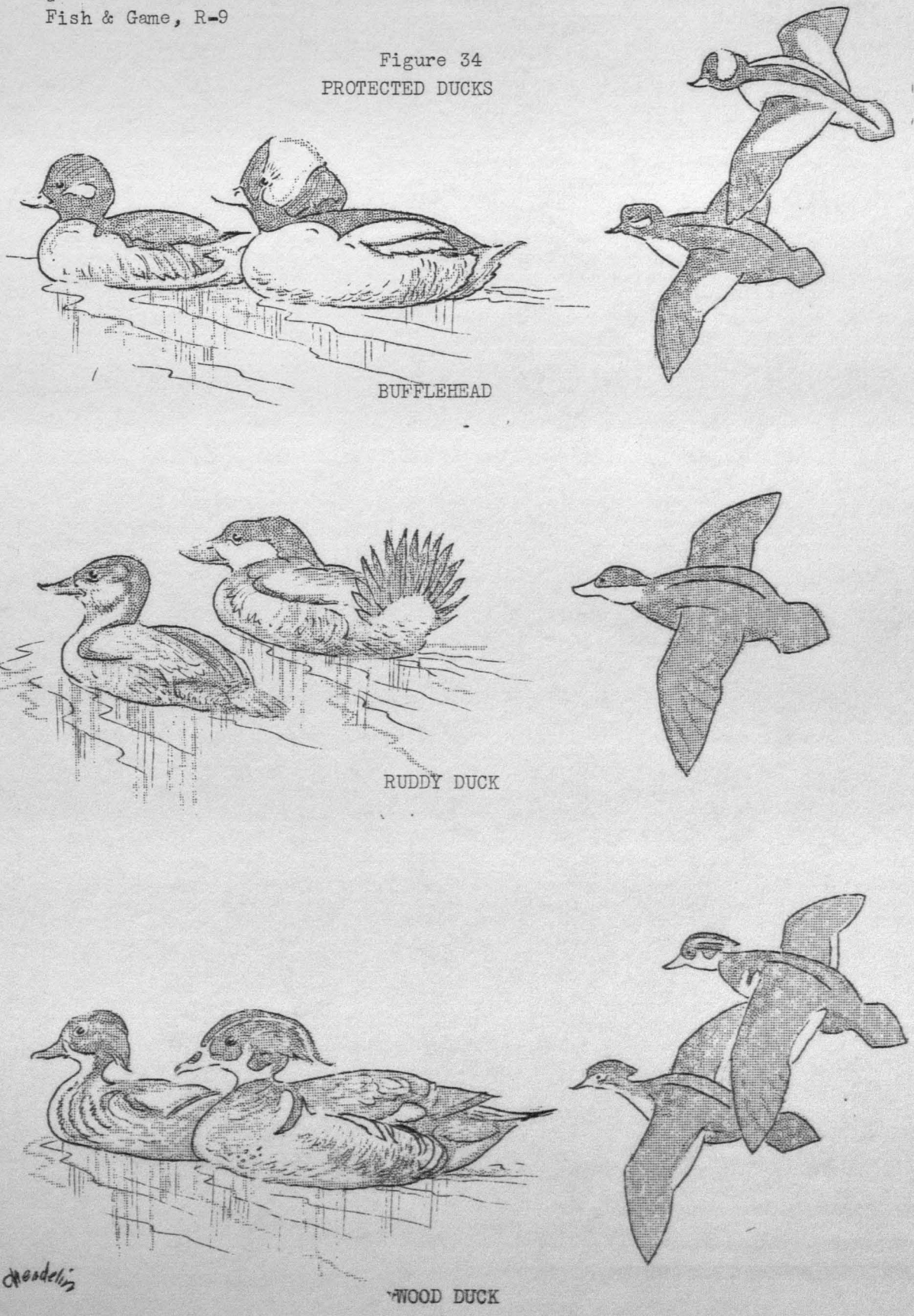
Three ducks have been placed on a protected list because it is known that they are so reduced in number that their extinction is evident unless shooting them is stopped.

1. Wood duck
2. Buffle head
3. Ruddy

The first two birds have suffered greatly due to logging and destruction of the forest. Both species nest in hollow stumps and trees and their decimation has been due to the destruction of their habitat, rather than to overshooting. Drought and drainage has affected the ruddy duck during the last few years and seriously reduced his numbers.

It is necessary that forest officers acquaint themselves with these birds and act as missionaries in disseminating their information to sportsmen so that all those who go afield may know these ducks apart from others. Wherever possible, those who are qualified should explain and point out to sportsmen the defining characteristics of these birds.

Figure 34
PROTECTED DUCKS



BUFFLEHEAD

RUDDY DUCK

WOOD DUCK