



A story of fish production as it applies to Montana
by Vernon E Craig

A THESIS Submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree
of Master of Science in Fish and Wildlife Management at Montana State College
Montana State University
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Abstract:

This paper presents in a simplified manner some of the more important aspects of fish production and management as they exist in Montana. The topics of water temperature, pollution, reproduction, etc. are discussed separately, but all are directed toward one common goal of production.

Illustrations were prepared to supplement the text.

Cartoons and headings have been added to create interest and to stress important points. Depictive drawings have been prepared to provide visual aids for the identification of common plants, food organisms, and fish.

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VERNON E. CRAIG

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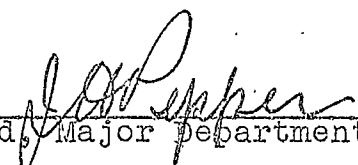
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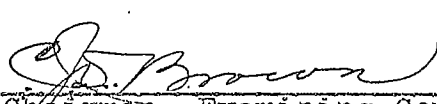
Master of Science in Fish and Wildlife Management

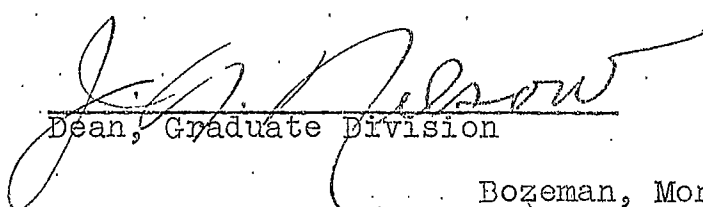
at

Montana State College

Approved:


Head, Major Department


Chairman, Examining Committee


Dean, Graduate Division

Bozeman, Montana
June, 1952

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Table of Contents

Abstract -----	3
Introduction -----	4
Acknowledgements -----	5
Suggested covers -----	6
✓ Soil conservation is water conservation -----	8
✓ Dams and fish -----	11
Irrigation -----	14
✓ Pollution -----	15
✓ Water temperature -----	17
Water depth -----	20
Water movement -----	21
Cover -----	22
Aquatic plants -----	23
Illustrations of some common aquatic plants -----	27
Food organisms -----	45
Illustrations of some common fish food organisms ----	49
Fish combinations -----	59
Illustrations of some common Montana fish -----	61
Predation -----	78
✓ Reproduction -----	80
Improving living conditions -----	83
Regulations -----	86
Selected bibliography -----	91

Abstract

This paper presents in a simplified manner some of the more important aspects of fish production and management as they exist in Montana. The topics of water temperature, pollution, reproduction, etc. are discussed separately, but all are directed toward one common goal of production.

Illustrations were prepared to supplement the text. Cartoons and headings have been added to create interest and to stress important points. Depictive drawings have been prepared to provide visual aids for the identification of common plants, food organisms, and fish.

Introduction

Most of the literature dealing with fisheries management is so technical that it is little understood by anyone without extensive biological training. Non-technical literature dealing with fish management and productivity is found in conservation bulletins, sports magazines, and newspaper articles. Much of the information available, however, emphasizes recreational rather than management aspects of fish production. Publications that do deal with management usually apply to local problems and fail to present a complete picture of fish production. For example, an explanation of the fish planting needs in a state having high fishing pressure would not necessarily apply in states where there is little pressure.

Persons who are not familiar with the problems of fisheries management are less apt to support good management practices. Without public support, a fisheries program has no chance of success.

An attempt is made in this paper to present the layman with a simple and easily understood discussion of the more important aspects of fish productivity as they apply to management in Montana. The material presented should be of value to such groups as sportsmen, 4-H clubs, schools, boy scouts, etc.

Important factors which affect the production of fish are discussed under individual headings. These are, however,

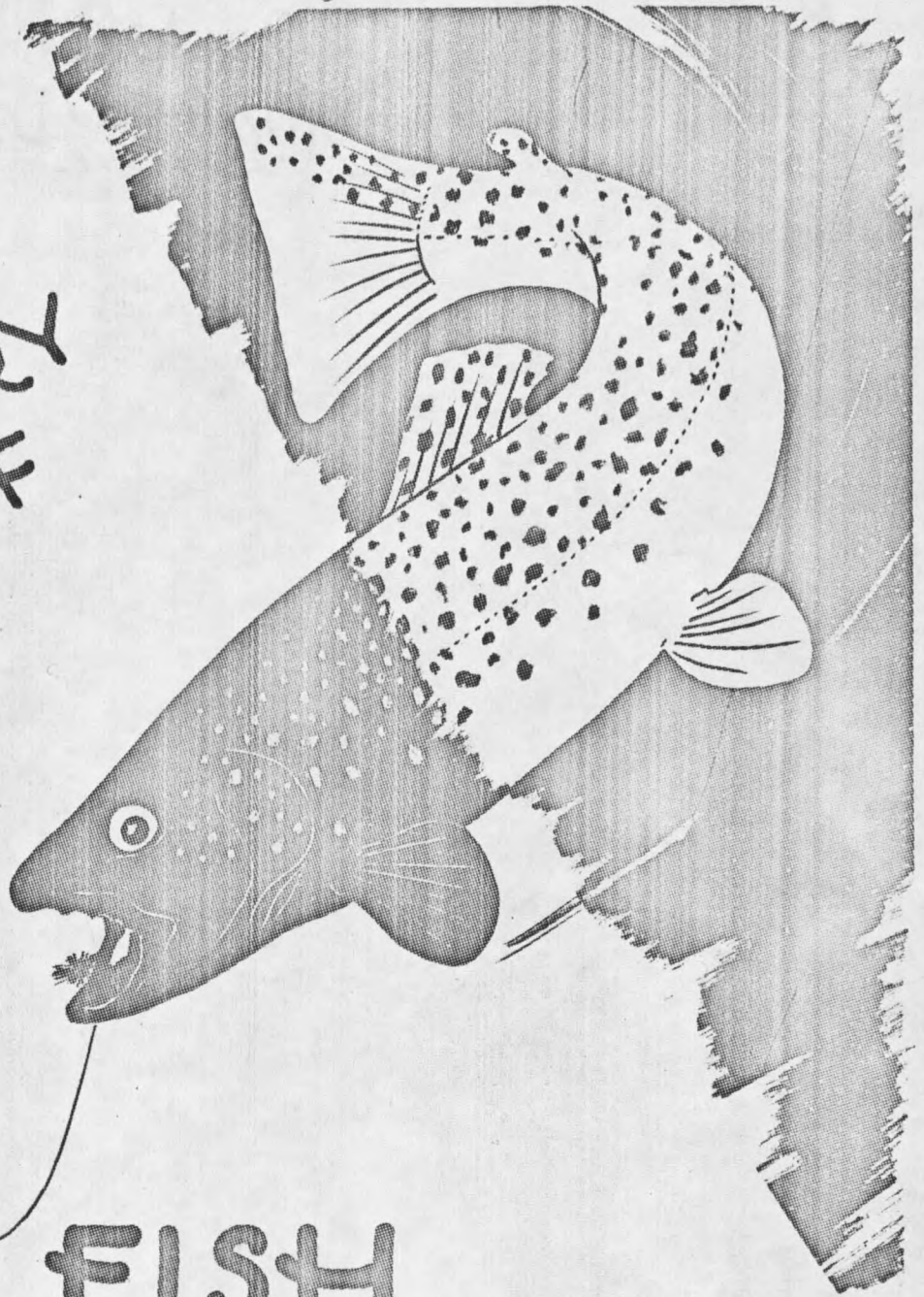
arranged in such a manner as to present the story of fish production and management.

Illustrations have been prepared which should not only make the text more readable, but drive home important points. These fall roughly into two categories: humorous, and depictive. The abundance of cartoons in our magazines, advertising, and movies bears witness to the popularity and value of humor in illustration. Cartoons stimulate the imagination of young and old alike, and often lead the reader through accompanying text. Those cartoons that tell stories within themselves are very effective in selling ideas. In this presentation, continuity between text and illustrations is maintained by placing the cartoons near the text which concerns them. Simplified but depictive drawings of the plants and animals involved in fisheries management supplement descriptive material to facilitate their identification.

Acknowledgements

The writer is indebted to Dr. C. J. D. Brown for counsel and assistance in the preparation of this paper.

A
STORY
OF



FISH
PRODUCTION

PROBLEMS OF



FISHERY PRODUCTION



SOIL CONSERVATION IS WATER CONSERVATION.

"Fertile," is a common word that generally brings to mind rich acres of grain, lush carpets of green pasture, and fields heavy with hay. In all ways, it declares bountiful production. On the other hand, we associate, "infertile," with bleak land, scanty vegetation, and starved crops. Water



1 ACRE OF WATER
- POUNDS OF FISH.



1 ACRE OF LAND
- POUNDS OF BEEF.

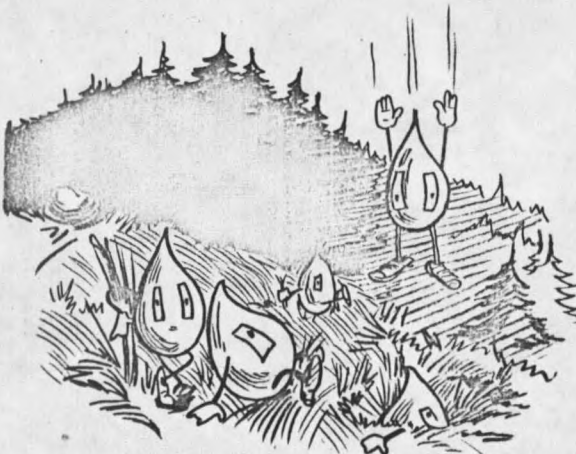
is exactly like land in this respect, yet how many people think of a stream or lake as being fertile or infertile? The same minerals and decayed plant and animal materials that make soil capable of producing good crops of hay and grain are the ones that make streams and lakes capable of producing good crops of fish. Water can be only as fertile as the land from which it drains. The crop of fish that can be raised,

then, depends upon the way we treat our land. Misuse of land means fewer fish.



Three practices in Montana that have contributed most to the destruction of soil, and consequently streams, are excessive cutting of trees, overgrazing, and poor farming practices.

Many forests that once existed have been completely destroyed, and others are still being unwisely cut. Stockmen in an effort to utilize every blade of grass have permitted serious overgrazing of ranges, and farmers tempted by the high prices of grain have broken many acres better suited for range land. In some parts of the state, big-game have done a lot of harm through overgrazing and overbrowsing.



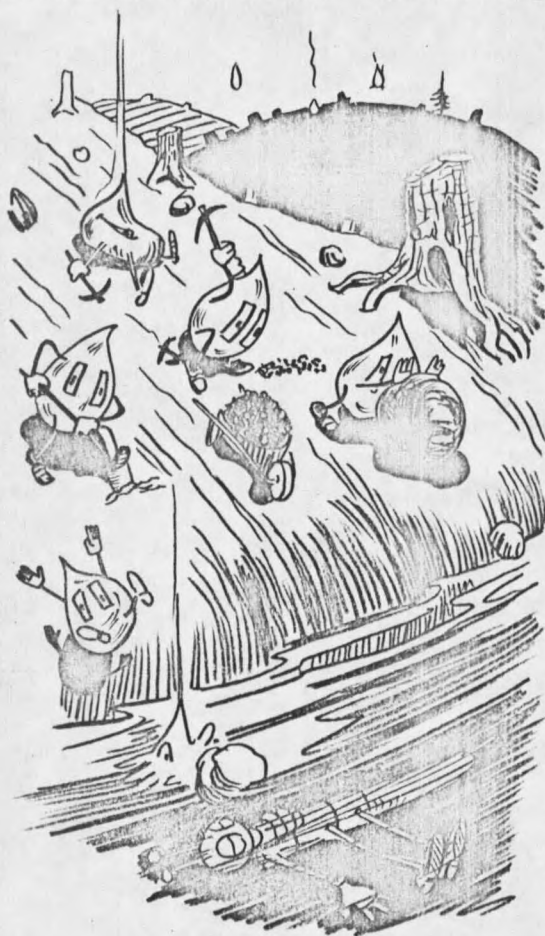
Mountain snow under the shade of trees lingers for a long while after all evidence of winter has gone from open areas. A blanket of grass on range land and leaves in the forest sops up much of the snow water and prevents it from being

evaporated rapidly. Water held in this manner is allowed to seep slowly into the soil instead of running off. Plant ma-

terial manteling the ground cushions the fall of rain and prevents the soil from being churned and carried away. The rain, like the snow water, is held back and permitted to sink into undisturbed soil. Water captured in this manner forms an un-

derground reservoir which replenishes streams throughout the year.

When blocks of forest are cleared, and when grass has been burned or grazed from the range, the protective covering is gone. The sun can then beat down with full force and evaporate moisture from the earth. With no cushion to break its fall, rain can stir the soil and carry it away. Soil carried into streams is dropped in the quieter water, covering fish spawn and food-producing areas.



Unable to get needed oxygen

through the blanket of dirt, the spawn and food organisms are readily destroyed.

Man has learned, to some degree, the folly of tree destruction. Through cutting regulations, reforestation programs, and fire-fighting systems, progress has been made in forest conservation and consequently the protection of the

watershed. The damage caused by overgrazing is also recognized, but in many places little is being done to correct this practice.



For some reason, many people believe that our game fish take long trips up and down streams in order to secure food and to spawn; consequently, we hear a lot about the damage done to fish by blocking streams with dams. Damage may be done when fish are cut off from spawning areas, but since most of our streams have abundant suitable spawning and feeding areas all along their courses, fish movement is very limited.

When a dam is built across a stream, the life caught in the impounded area, including fish, which requires flowing water suddenly finds its home unsuitable, and as the stream organisms die or move out, those suited to live in quiet water move in. As the reservoir rises and creeps over new areas, flooded vegetation and soil give up rich materials to the water. If the submerged soil is fertile and covered with vegetation, the reservoir becomes rich and the numbers of fish

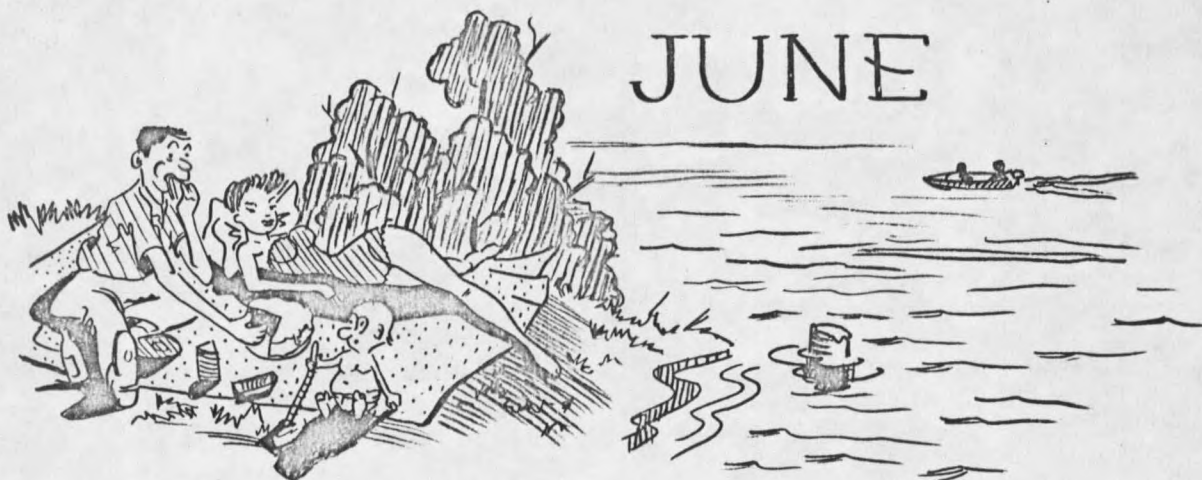
will increase and grow rapidly in the new environment. However, the rich materials given off by the flooded land and vegetation are used up in a relatively short time, and a decline in fertility results. With a decline in fertility, there is also a decline in the number and pounds of fish.



When trout streams are dammed, a large surface of water is exposed directly to the heating action of the sun. This water, especially in shallow areas, may become unfavorable for trout and other cold-water fish. Coarse fish, such as chubs, carp, and suckers, find the changed conditions very favorable and take the place of game fish.

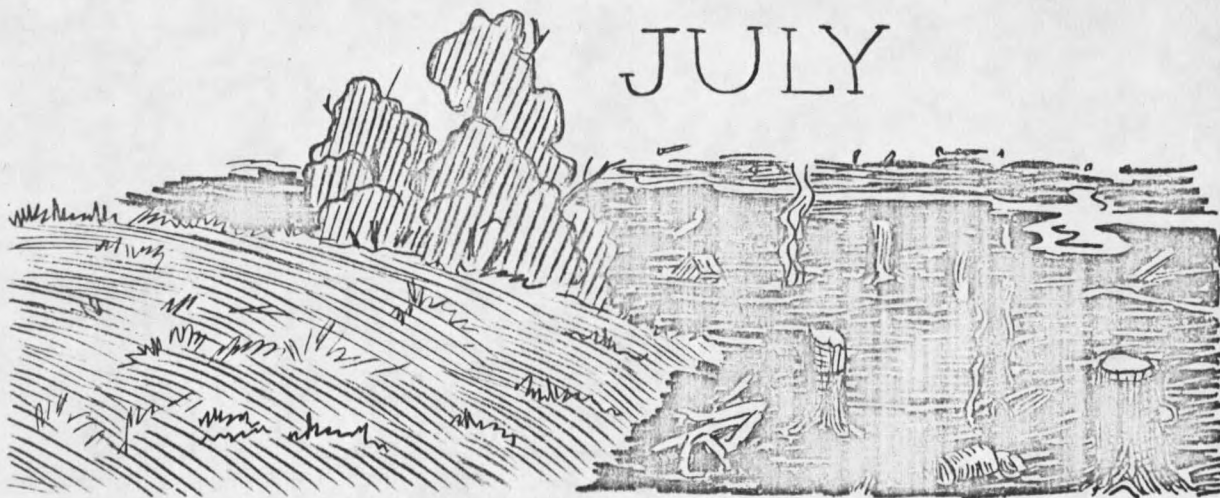
We can not judge an artificial reservoir by the way it appears when filled with water, for the next time we see it there may be only a pool or trickle of water framed by soggy stumps and mud flats. Such is the case with most irrigation and flood control reservoirs and, to some extent, reservoirs designed for power. Most plants and fish foods become established in the shallow areas, and these are destroyed when left high and dry by a drop in the water level. Those that get a foothold when the water is low are destroyed when the lake is

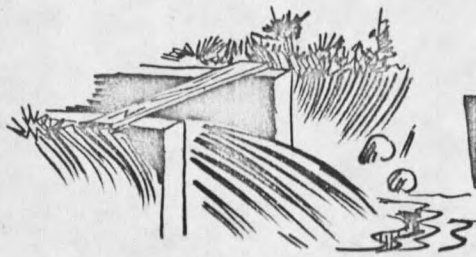
JUNE



again filled, for they can not live in deep water. Under conditions of constant water fluctuation, there can be little fish production. A lake that is dry for one week might as well be dry the entire year as far as fish are concerned. Streams below reservoirs may benefit if a steady flow of water is maintained during the entire year, but in many instances streams are dry during periods when the water is being impounded.

JULY



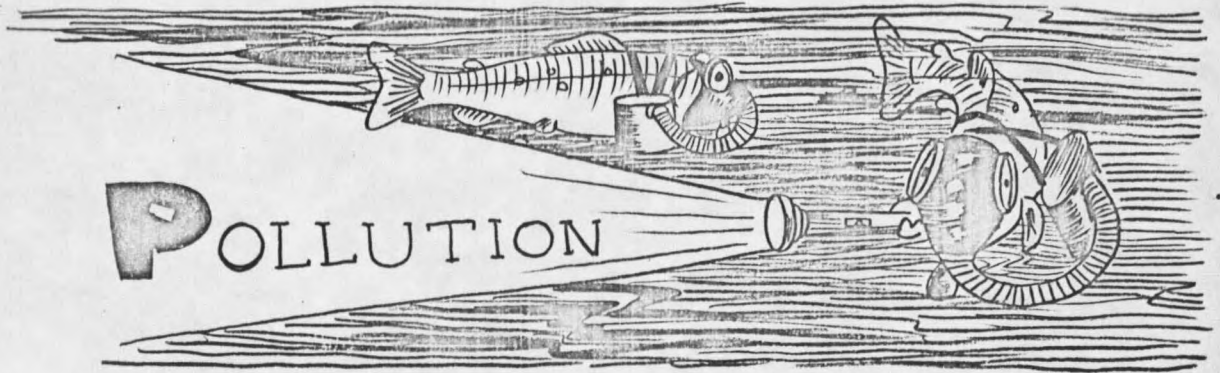


IRRIGATION

The full significance of fish loss in irrigation canals is not known. Those lost may represent a surplus over and above the population that can be carried by the streams they leave, and we have no assurance that fishing would be improved if game fish were kept from entering the canals. For reasons yet unknown, certain canals attract more fish than others. Studies are now being conducted that should provide the reasons why. Some of the fish which enter the ditches return to the streams when the water level drops. Because fish concentrate in pools when ditches are turned off, the loss may appear greater than it actually is. The loss of fish in West Gallatin River canals was estimated to be to be 2,835 legal size trout and whitefish (Clothier, 1952). The destruction of fish foods and spawning grounds in streams that have been lowered or dewatered through irrigation probably represents a far greater loss to fishing than the loss in ditches themselves.

A lot of work has been done in an attempt to devise methods to prevent fish from entering canals. So far nothing has proven wholly satisfactory. Electric screens have been tried without much success, and while mechanical screens will work

if properly installed and maintained, they are very expensive and require regular attention. Only when the fish loss is very great can they be justified.



There has always been a certain amount of natural pollution from such things as eroding soil, mineral deposits, and potash of forest fire areas, but the damage to fish from natural sources is not great when compared with that resulting from improper land use, pollution from industry, and from domestic sources. Some of the more important existing and potential sources of industrial pollution in Montana are metal refining plants, oil refineries, wood pulp mills, sugar beet factories, and meat packing houses. Domestic sewage is also a detriment to fishing in parts of this state.

Sediment from metal refining plants, fibrous material from pulp mill wastes, and sludge from sewage blanket stream and lake bottoms and smother fish food organisms, ruin the spawning beds, and even suffocate the fish by clogging their gills. Some sediments are carried many miles by streams and

may remain suspended in lakes for weeks or even months. These materials darken the water and prevent the normal growth of aquatic plants.

Wastes that result from metal refining plants, oil refineries, pulp mills, and other industries may irritate the delicate gill or other body tissues of fish. Others make streams and lakes unsuitable for proper growth and development of fish because they are disagreeable to their taste or smell.

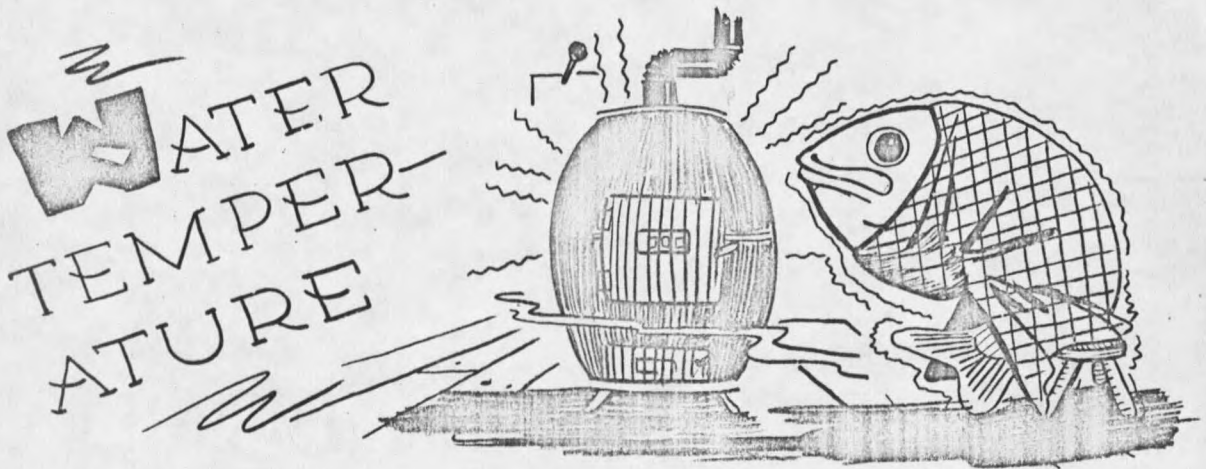
While small amounts of organic material entering streams and lakes may act as a fertilizer and be beneficial, large quantities that may be dumped in by wood pulp mills, sugar beet factories, packing houses, and city sewers are very detrimental. Organic materials require much dissolved oxygen when they decay, and with dissolved oxygen reduced or completely removed, the fish and fish food organisms can not live. Certain waste organic chemicals actually poison fish.



Water that is heavily polluted becomes quite useless. It is unfit to drink and may be unfit for irrigation. Industry upstream may ruin the water for others located downstream. Domestic pollution even in moderate amounts may

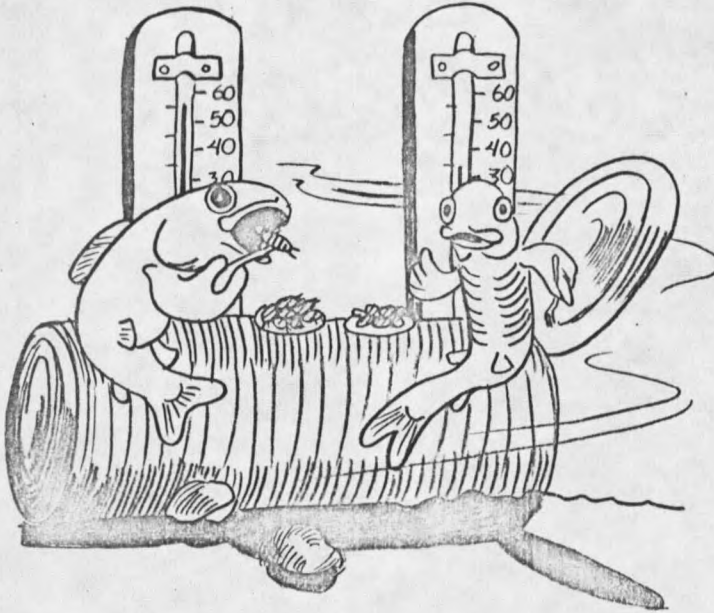
ruin areas for recreation. Who cares to spread a picnic lunch beside a stream that is foul with wastes, and what fisherman cares to wade or dip a fly in such water?

This does not mean that cities, industries, and good fishing can not exist together if proper treatment and disposal of wastes are practiced; however, experience has taught us that towns and industries fail to provide adequate treatment unless forced to. To protect water resources, and consequently their recreational values, it is necessary to have pollution laws. The laws should be fair but firm enough to insure the proper treatment and disposal of all wastes.



The body temperatures of fish and associated food organisms are not constant like those of warm-blooded animals such as man, birds, etc. Instead, their temperatures closely follow that of the water. In such animals, changes in water temperatures speed up or slow down body activities. Because of this, there is probably no other single environmental fac-

tor more important to fish than the temperatures in which they live.



Trout are better suited to live in cold water than are bass, bluegills, crappie, etc., but contrary to popular belief, very cold water is not conducive to good growth and reproduction of trout. These fish do not eat as much, and the

food they do consume is only partially digested when temperatures are too low. Under very cold temperatures, food organisms have been noted to pass completely through the digestive tracts of fishes without being killed. Trout living constantly in cold water become stunted, even though they appear to be healthy.

Water is heaviest at about thirty-nine degrees fahrenheit, and becomes lighter as the temperatures increase or decrease from this point. When the water of a lake cools down to this temperature in the fall of the year, it sinks to the bottom and causes complete mixing of all water in the lake. In the spring, there is also mixing when surface water warms up to thirty-nine degrees fahrenheit. The mixings are known

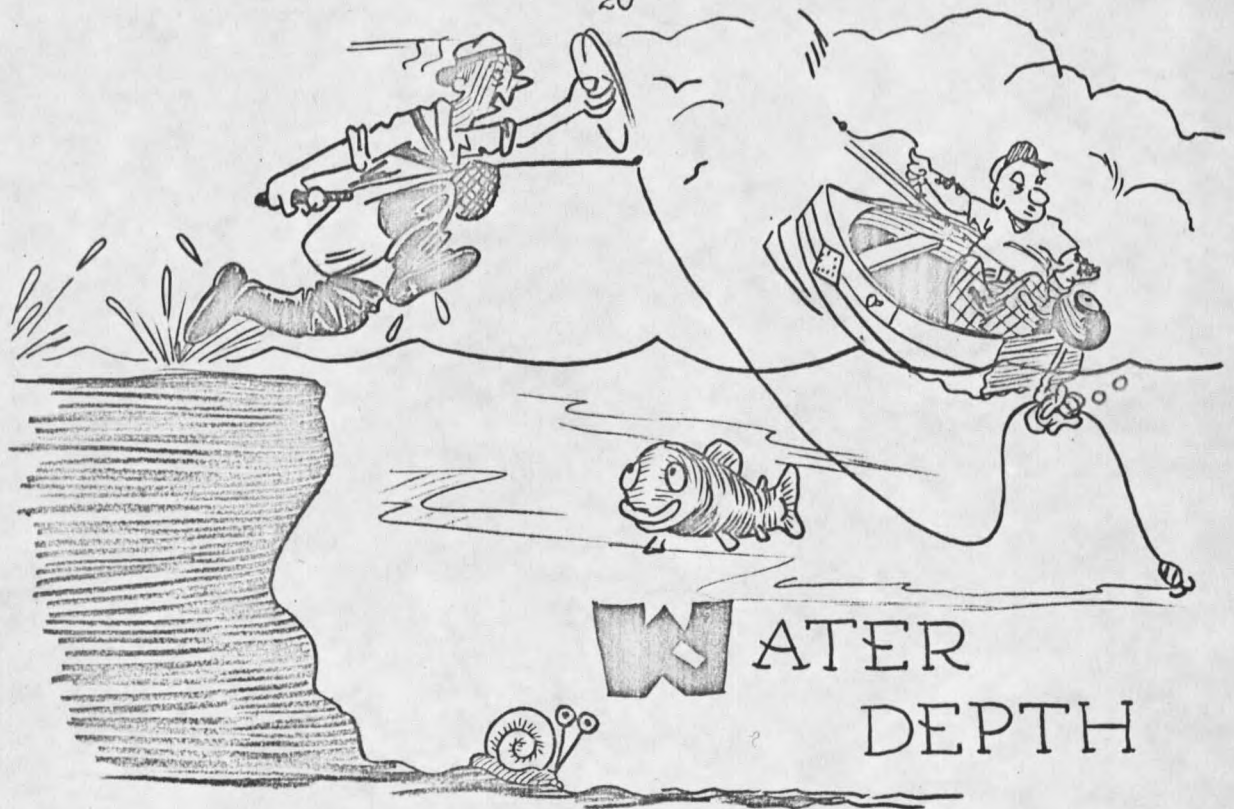
as spring and fall overturns. Between overturns, some lakes have layers of water with different temperatures. In Montana, conditions are such that layering of lakes is not as pronounced as in areas with hotter summers.

Lakes and ponds may also be layered chemically. Dead plant and animal materials use up dissolved oxygen in the process of decay, and may so deplete oxygen in the deeper waters that fish cannot live there. The upper layers are replen-



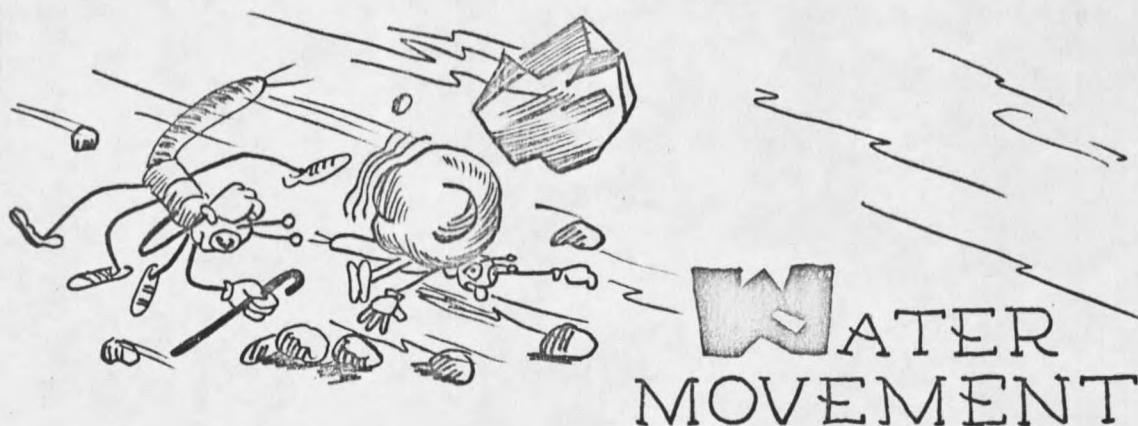
ished with oxygen from the air, and during periods of sunlight plants add to this supply. When the water is covered with ice it is cut off from an oxygen supply, and ponds that contain large quantities of decaying

plant material may lack sufficient oxygen to carry fish through long winters. This is one reason why many of our ranch ponds are unable to maintain fish. Warm water generally contains less dissolved oxygen than cold water, because it is unable to hold as much, and because higher temperatures stimulate decay of organic debris.



Shallow water will generally produce more fish food and, consequently, more fish than will deep water. One reason for this is that light usually penetrates only short distances into water, and light is necessary for plant life and growth. Shallow water is also a more favorable place because it becomes warmer, and aquatic animals grow more rapidly at the warm temperatures.

Although shallow water is most productive, deep areas are necessary in lakes and ponds that freeze over, for they provide space and oxygen during this critical period. Some fish, like the lake trout, will not thrive in shallow water.

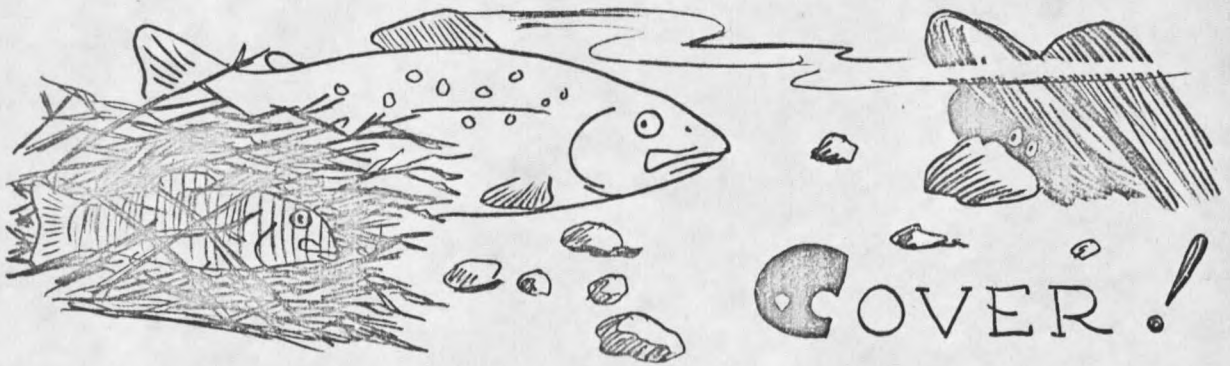


When waves boom against lake shores, or flood waters scour the land, we become fully aware of the power in moving water. The results of movement under ordinary conditions are less spectacular, but its existence has a definite effect on fish production.

In lakes, water movement is generally confined to the upper few feet. Waves jostle the sand of shore and shoal areas so that plants are prevented from taking root, except in protected areas. Opposite sides of lakes and reservoirs may have entirely different appearances because one is exposed to wave action from prevailing winds while the other is protected.

During much of the year there is relatively little movement of stream bed materials, but the high water of spring runoffs and freshets may set even the larger boulders into motion. When the streams are high and swift, fish are unable to resist mid-stream currents for any length of time, and seek

shelter in the quiet water near the banks or in the eddies behind boulders and other objects. The small fish are especially in danger of being swept away. Sand, gravel, and boulders grind together, and as they move along the stream bed they tear loose and often destroy large numbers of fish food organisms. The scouring prevents plants from taking root in streams, and about the only place they can become established is in quiet inlets and backwaters.



Rocks, brush, weeds, and overhanging banks provide shelter where fish may rest and find protection. Such shelters are collectively called cover, and are an important part of the fish's environment. Young fish, especially, need hiding areas, for if there is no place for them to hide they soon fall prey to their larger, cannibalistic relatives.

While sufficient cover is present in many lakes and streams, there are instances where additional cover enables the water to produce more fish. This is particularly true

in trout streams. Warm-water fish produce so many young that they rarely need added protection. The ideal situation is to have only enough cover for protection of fish that can be adequately supported under existing conditions.

The title 'AQUATIC PLANTS' is written in a serif font. A decorative branch with several feathery leaves arches over the text, starting from the left and ending with a small flower on the right. The letter 'A' is partially obscured by a leaf.

Without plants there would be no fish; indeed, there would be no life as we know it today, for plants alone are able to combine materials of air, water, and soil into matter that can be utilized by the animal body. Not only are they important as an ultimate food source for fish, but they also provide shelter. Plants are, then, a necessary part of a fish's environment, and their abundance or scarcity is a limiting factor in fish production.

Millions of small plants (algae) are found in nearly all waters. These are the basic food supply for fish foods, and are even eaten directly by fish, especially the young fish. Algae are of many shapes, sizes, and colors. Some are one-celled and exist singly or in colonies. Most of the one-celled types are so tiny that they can not be seen without the



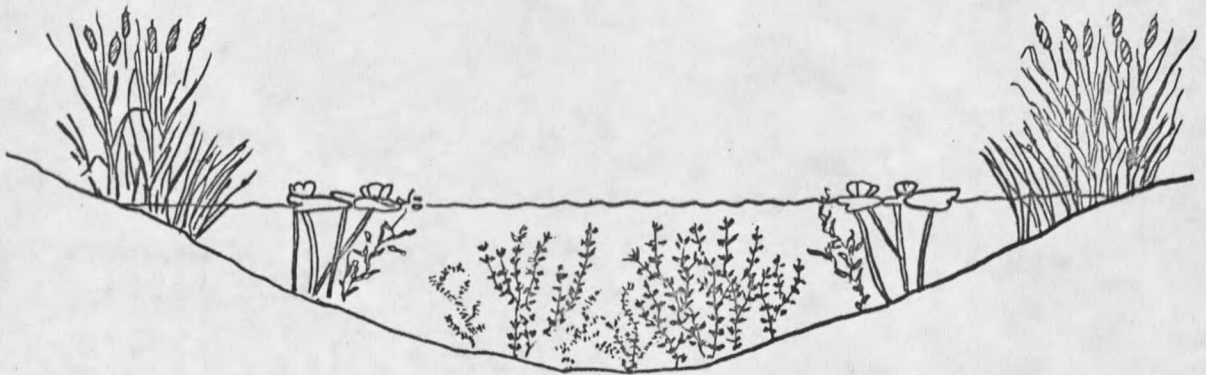
aid of a microscope, and many thousands may be contained in a spoonfull of water. Others are joined end to end like a string of weaners, long and hair-like, branched, etc., and are easily seen. Countless algae form the scum you see upon ponds, the water bloom in lakes, and the slippery coats upon sub-

merged rocks that often make acrobats of wading fishermen.

Most algae in flowing water are attached to submerged objects so they will not be swept away. These attached plants and associated animal organisms are collectively called periphyton. Some of the same kinds found in streams are also found in lakes. Many float about freely in ponds and lakes. These free-floating kinds are called phytoplankton. If you look at these tiny plants under a microscope, you may see some of them move and suspect they are animals. Many one-celled plants and animals are very much alike, and even the experts can not agree on just how to tell them apart.

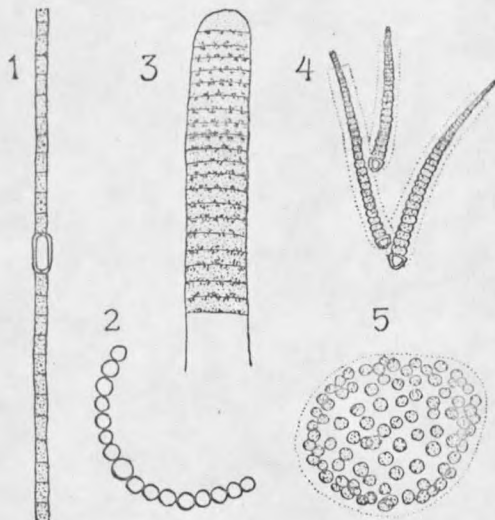
The higher water plants furnish cover for fish, and when they decay fertility is added to the water, making conditions better for further growth of all water organisms.

Each kind of rooted water plant will grow in water of only a certain depth. For instance, in shallow water one

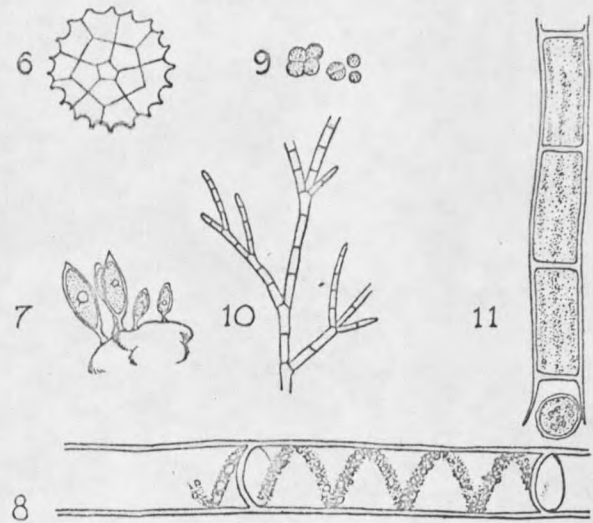


finds cattails, bulrush, etc. (emergent plants). As the water becomes progressively deeper, cattails give way to water-lilies, some pondweeds, etc. whose leaves float upon the water surface (floating plants). In still deeper water, milfoil, elodea, etc. grow entirely under the water surface (submerged plants). The distribution of plants according to water depth is known as zonation.

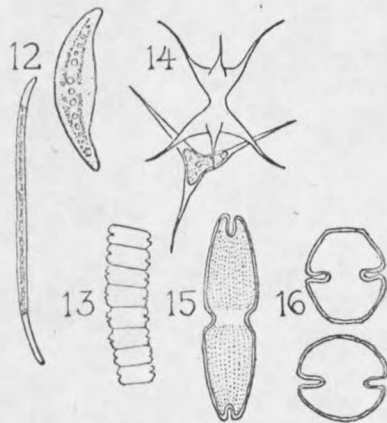
In order to grow, plants must have light, and so we find them only at depths where there is effective light. Suspended material cuts down light penetration so that plants are not found in very muddy or turbid water.



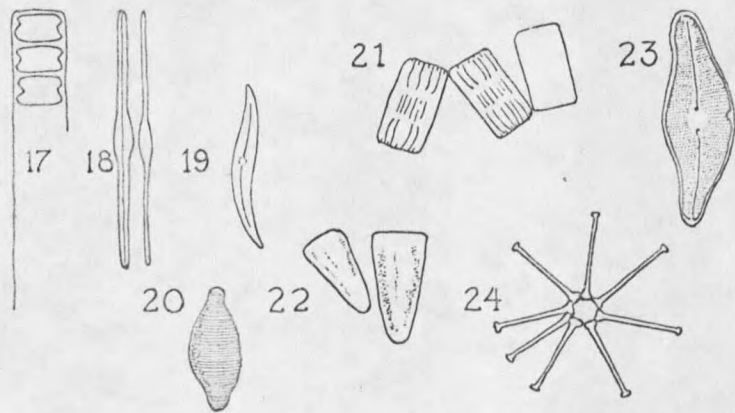
BLUE - GREEN ALGAE



GREEN ALGAE



DESMIDS



DIATOMS

1. APHANIZOMENON

2. ANABAENA

3. OSCILLATORIA

4. RIVULARIA

5. COELOSOPHAERIUM

6. PEDIASTRUM

7. CHARACIUM

8. SPIROGYRA

9. PLEUROCOCCUS

10. CLADOPHORA

11. TIIBONEMA

12. CLOSTERIUM

13. DESMIDIUM

14. STAUSTRUM

15. TETMEMORUS

16. COSMARIUM

17. MELOSIRA

18. FRAGILARIA

19. GYROSIGMA

20. NAVICULA

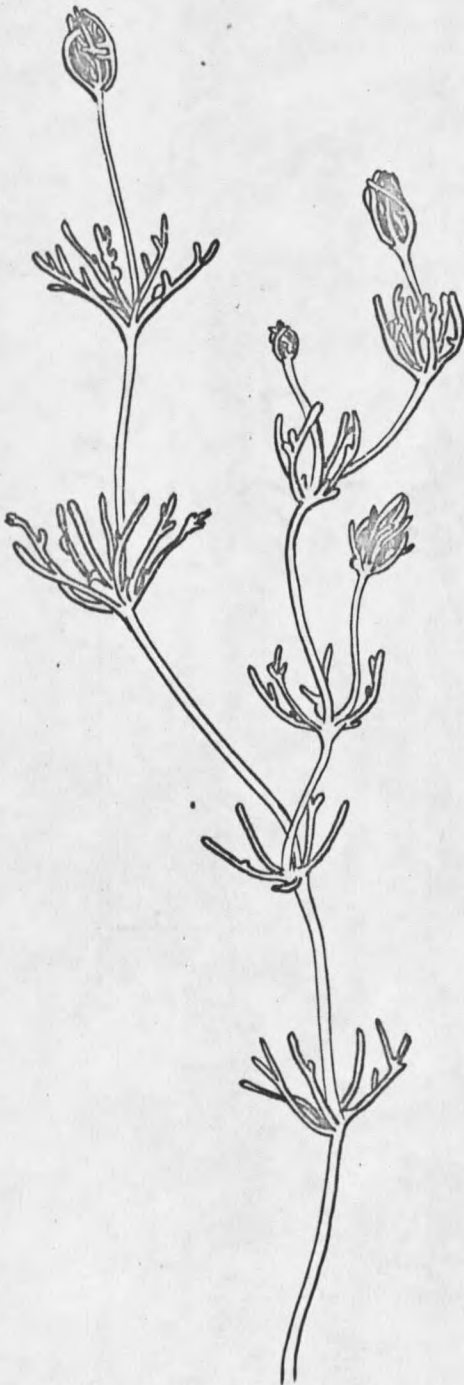
21. TABELLARIA

22. GOMPHONEMA

23. CYMBELLA

24. ASTERIONELLA

CHARA

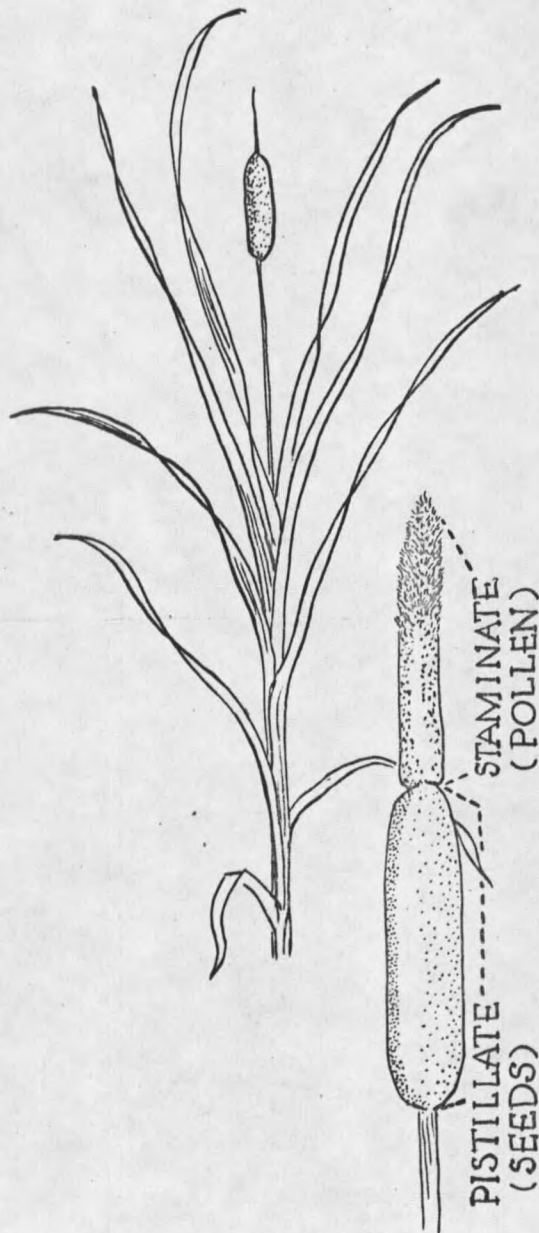


Chara (stonewort, musk-grass), Chara vulgaris, is generally classed with the algae, but strongly resembles the higher plants in appearance. The stems, from one to two feet high, are hollow and often covered with a lime coating that gives the plant a brittle, gritty feeling. When crushed, green chara often gives off a marshy odor.

Chara prefers hard, limy water and may be found in either shallow or fairly deep areas.

Beds of chara furnish cover for fish and harbor some food organisms. It often clogs small, spring-fed brooks and ponds, and may do more harm than good.

BROAD-LEAVED CATTAIL

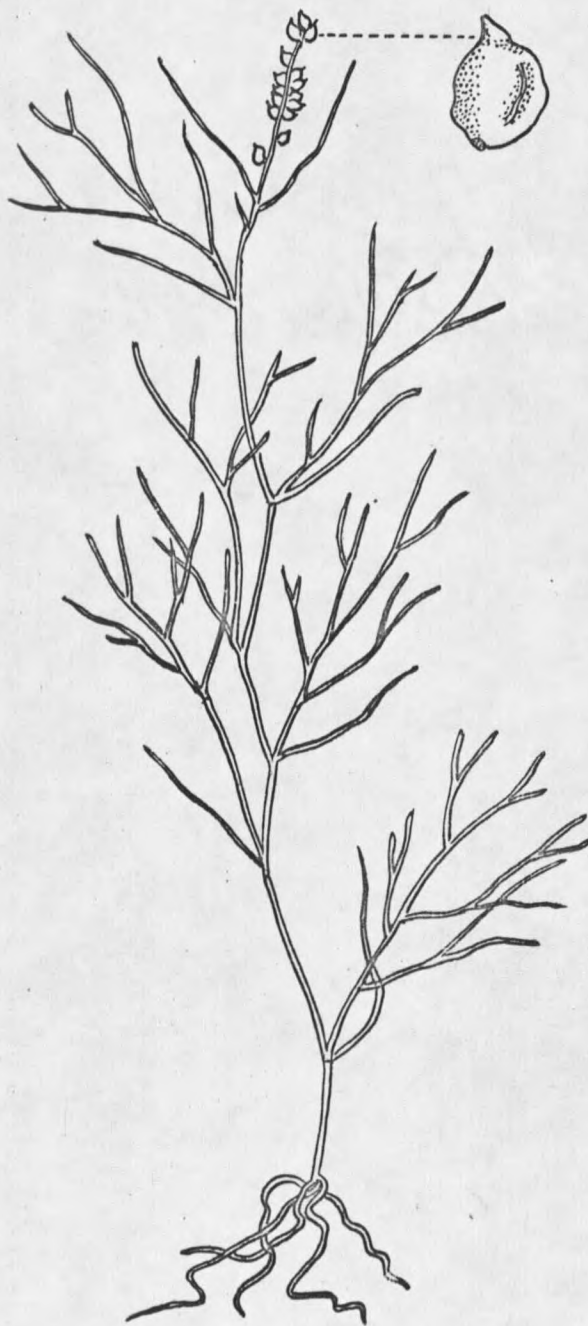


The broad-leaved cattail, *Typha latifolia*, ranges from three feet to a height greater than that of a tall man. Long ribbon-like leaves grow from the base of the plant. The spike, head, when mature contains a mass of seeds covered by brown fuzz. When seeds loosen from the spike, the fluffy fuzz with seeds attached is lifted by the wind and scattered over large areas. In full flower, the spike is divided into two parts: the upper which produces pollen, and the lower which produces seeds. The pollen-producing part soon withers and falls, leaving a pointed stem extending above the seed spike.

The cattail is typically a plant of marshy areas and pond borders.

Cattails are of little value to fish. They may offer some cover for small fish, but often become a nuisance by growing so thickly in shallow water areas that fishing is made difficult.

SAGO PONDWEED

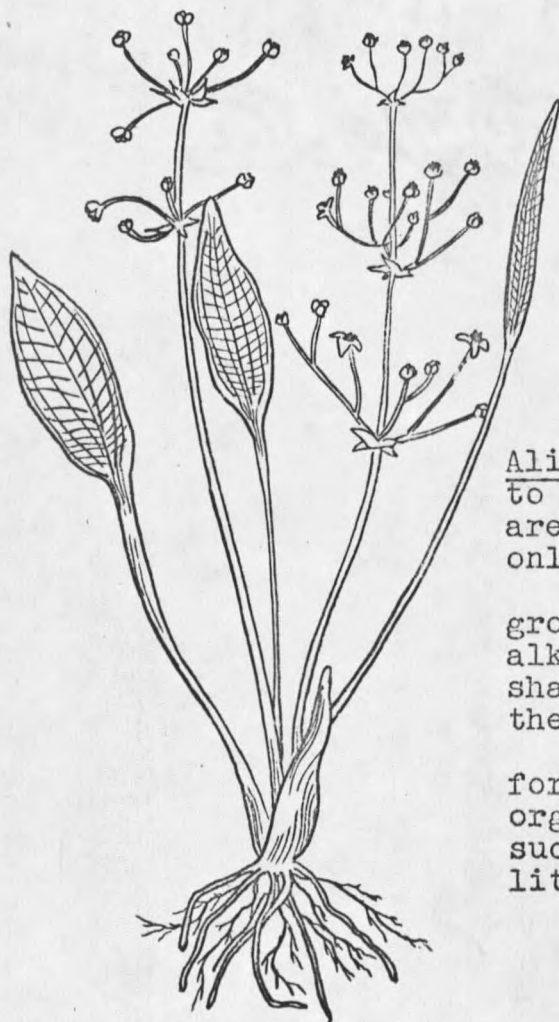


Sago pondweed, Potamogeton pectinatus, is a slender plant that may reach a length of several feet. Leaves of this plant are thread-like and fan out at the water surface.

It grows in ponds, slow streams, and the shallow protected waters of lakes. This pondweed thrives in alkaline waters and is very common in the ponds of eastern Montana.

Pondweeds are extremely important to fish, for they harbor many food organisms which feed and lay their eggs upon their leaves and stems. Small fish find protection from their enemies among the entangled stems. This protection is desired in trout ponds, but in ponds that contain warm-water fish, such as bluegills, the young may become so numerous when protected from larger fish that they become stunted from lack of food.

NARROW-LEAVED WATER-PLANTAIN

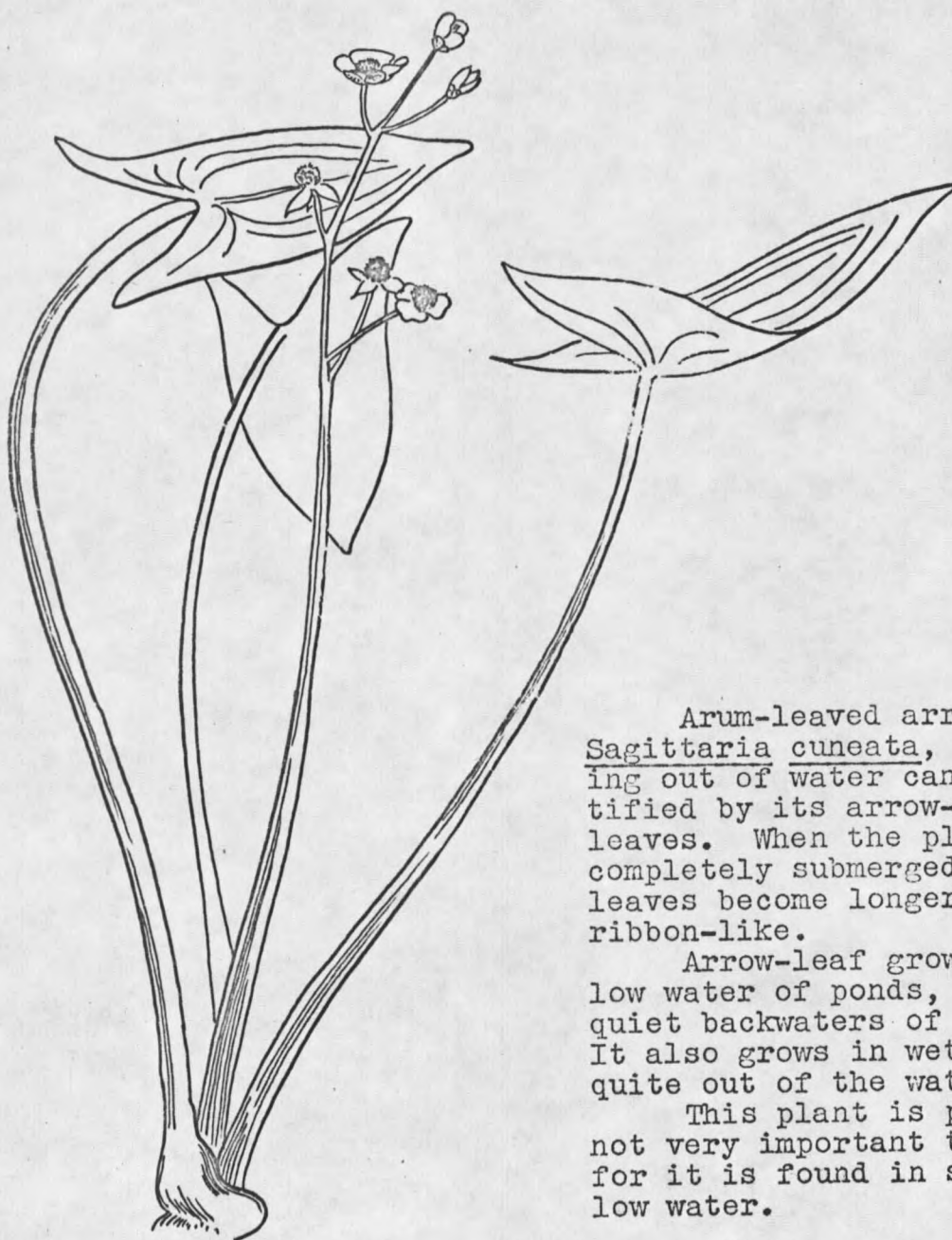


Narrow-leaved water-plantain, Alisma gramineum, grows from two to ten inches high. The flowers are exceedingly small and contain only three pink or white petals.

This plantain generally grows in water that contains much alkali or lime. It is found in shallow ponds, marshes, and in the mud along sluggish streams.

It may furnish some cover for fish and support fish food organisms; however, it grows in such shallow water that it is of little importance.

ARUM-LEAVED ARROWLEAF

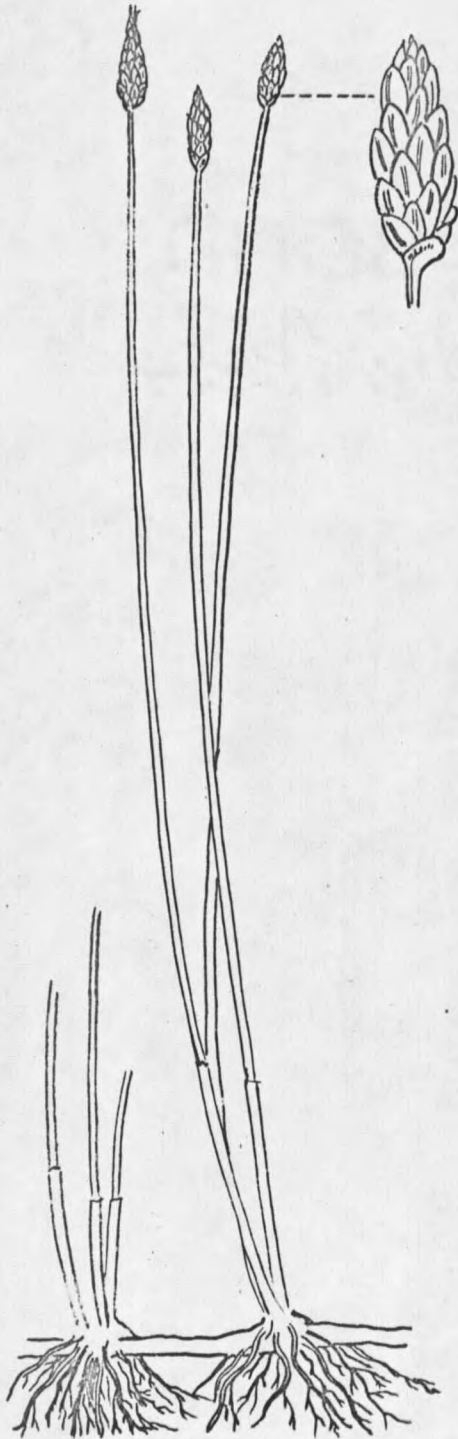


Arum-leaved arrowleaf, *Sagittaria cuneata*, when growing out of water can be identified by its arrow-shaped leaves. When the plant is completely submerged, the leaves become longer and more ribbon-like.

Arrow-leaf grows in shallow water of ponds, lakes, and quiet backwaters of streams. It also grows in wet soil quite out of the water.

This plant is probably not very important to fish, for it is found in such shallow water.

SPIKE-SEDGE

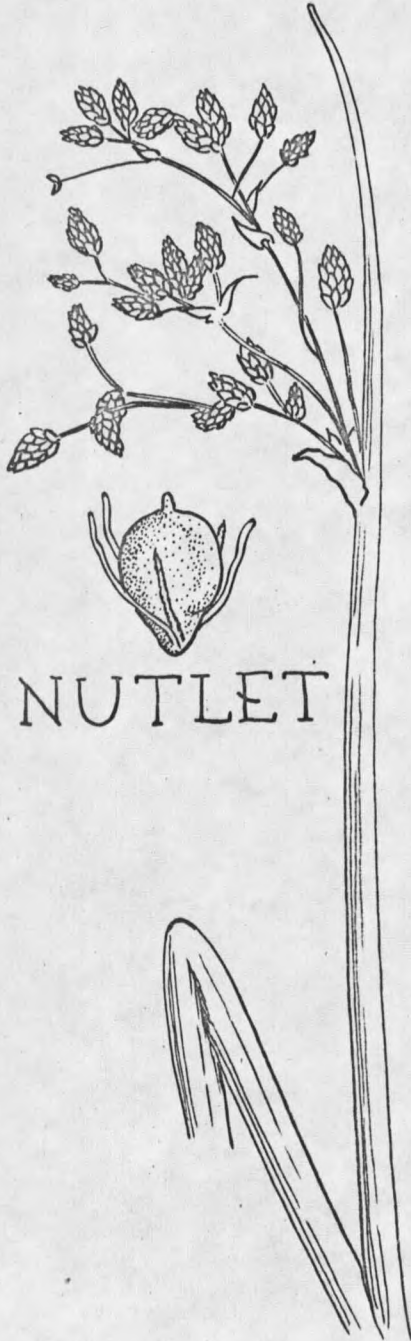


Spike-sedge, Eleocharis macrostachya, grows from one to four feet long and bears seeds at the very tip of the stem. The stem is enclosed by a sheath for a short distance above the ground.

Spike-sedge is common in shallow water of lakes, ponds, and sluggish streams, and in marshy areas.

Like the arrow-leaf, it is not important to fish.

GREAT BULRUSH

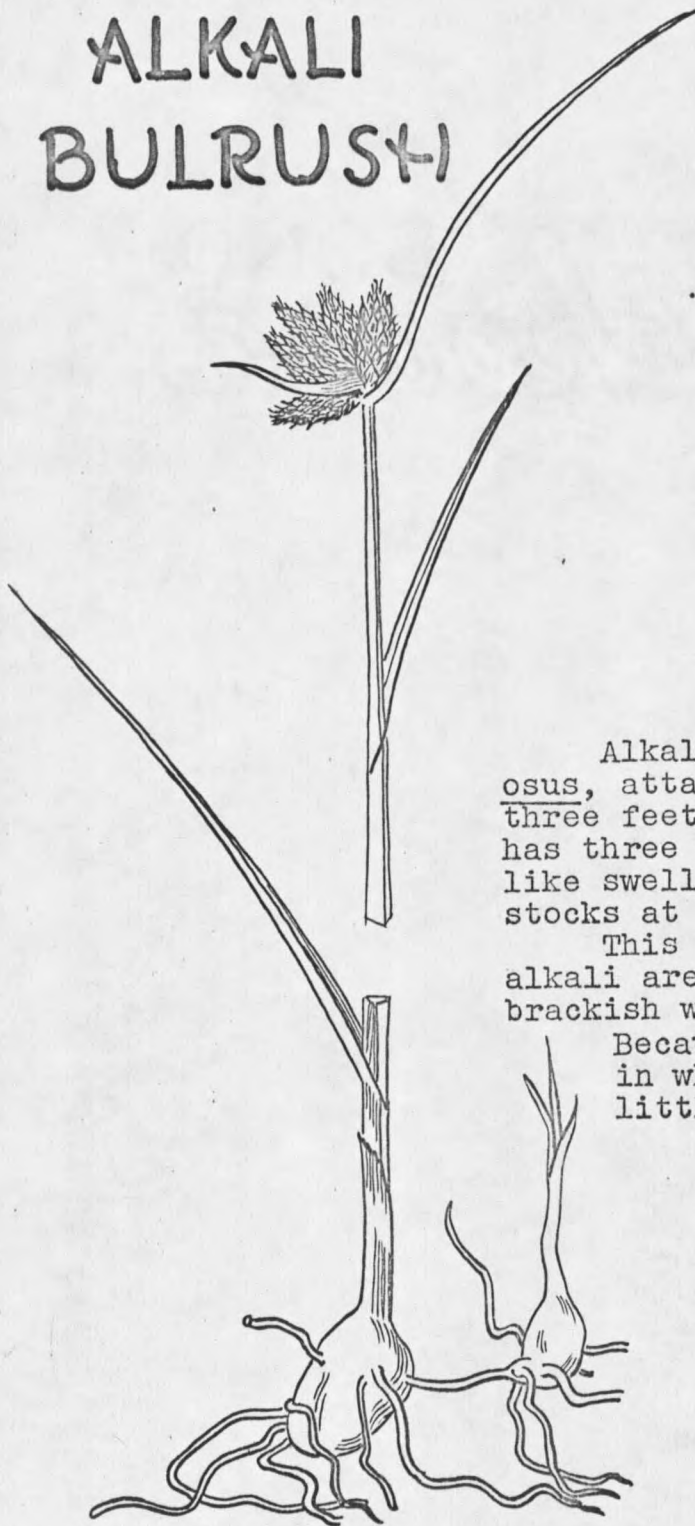


Great bulrush, Scirpus validus, has round, green, easily bent stems from two to six feet long. The seeds are in brown spikelets within a few inches of the tip of the stem.

Because it is soft and easily beaten down by wind, this bulrush is often found growing in sheltered areas. It likes fresh water and grows in shallow ponds, on wet stream banks, and in marshy areas.

When growing in ponds, the stems may furnish shelter for fish and harbor some food organisms. Like the cattail, it may clog waterways and become a nuisance to fishermen.

ALKALI BULRUSH

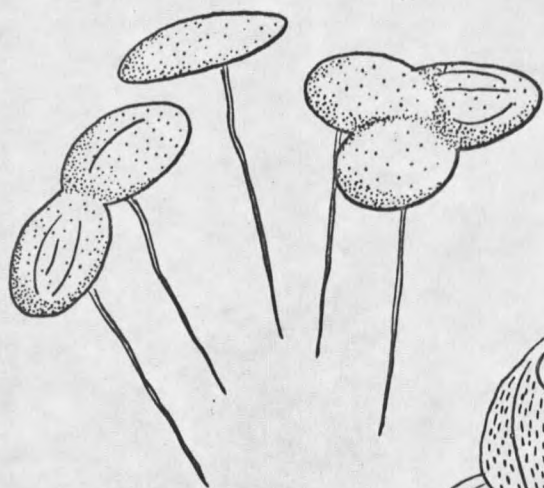


Alkali bulrush, Scirpus palud-
osus, attains a height of about
three feet. The stem is rigid and
has three flat sides. Large, bulb-
like swellings are found on root-
stocks at the base of the plant.

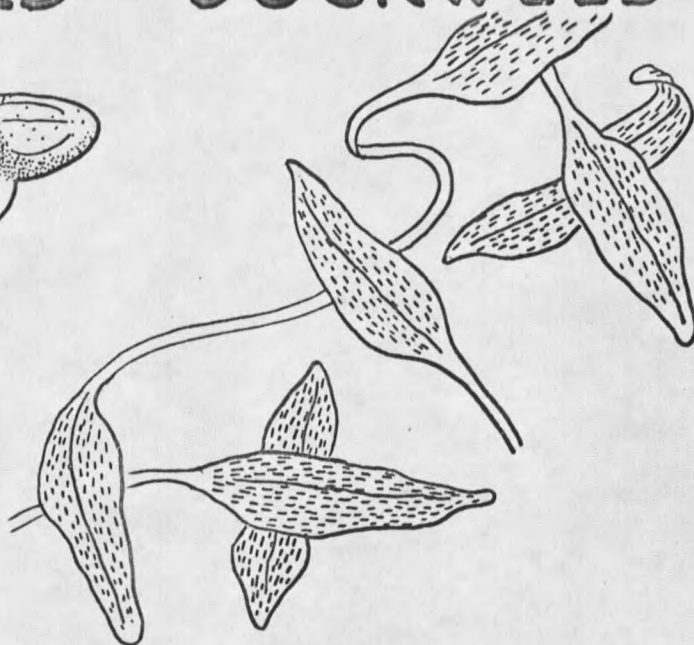
This bulrush is found in
alkali areas growing in shallow,
brackish water and marshy areas.

Because of the type of water
in which it grows, it is of
little value to fish.

COMMON DUCKWEED



STAR DUCKWEED



Common duckweed, Lemna minor, is a small, flat plant about one-eighth inch wide. Tiny, white rootlets extend into the water from each green, oval-shaped plant body or (thallus).

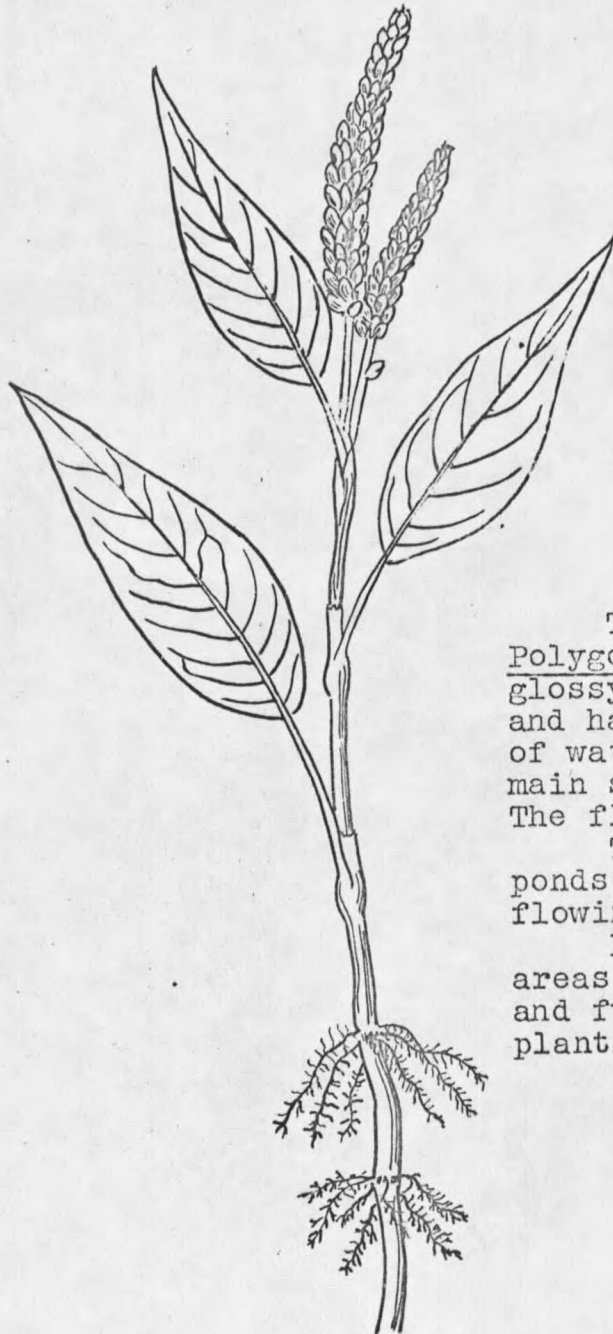
Star duckweed, Lemna trisulca, grows two or three times larger than common duckweed. The plant bodies of star duckweed are often connected to each other.

Both of these duckweeds are found in quiet ponds and in sluggish ditches, especially in stagnant situations. Common duckweed floats upon the water surface, while star duckweed is generally submerged.

These duckweeds give cover for fish, but sometimes grow so thickly that plants below them die from lack of light. In this way, they may be injurious to fish.

SMARTWEED

(SWAMP KNOTWEED)

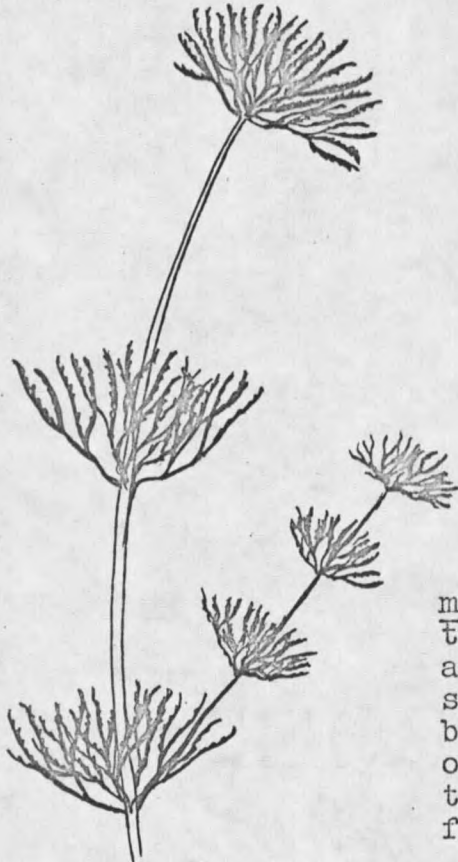


This smartweed (knotweed), Polygonum coquimbense, has smooth, glossy leaves when growing in water and hairy leaves when growing out of water. A sheath surrounds the main stem above the leaf joints. The flowers are pink and numerous.

This plant grows in shallow ponds, marsh areas, and in slowly flowing streams.

Beds of smartweed furnish areas in which fish may take cover, and furnish food for animals and plants that they eat.

COONTAIL



Coontail, Ceratophyllum demersum, may reach a length of around two feet. The thread-like leaves are arranged in whorls upon the stems, and each leaf is separated by three distinct splits. Leaves of water milfoil appear much like the leaves of coontail, but are feather-like instead of three-split.

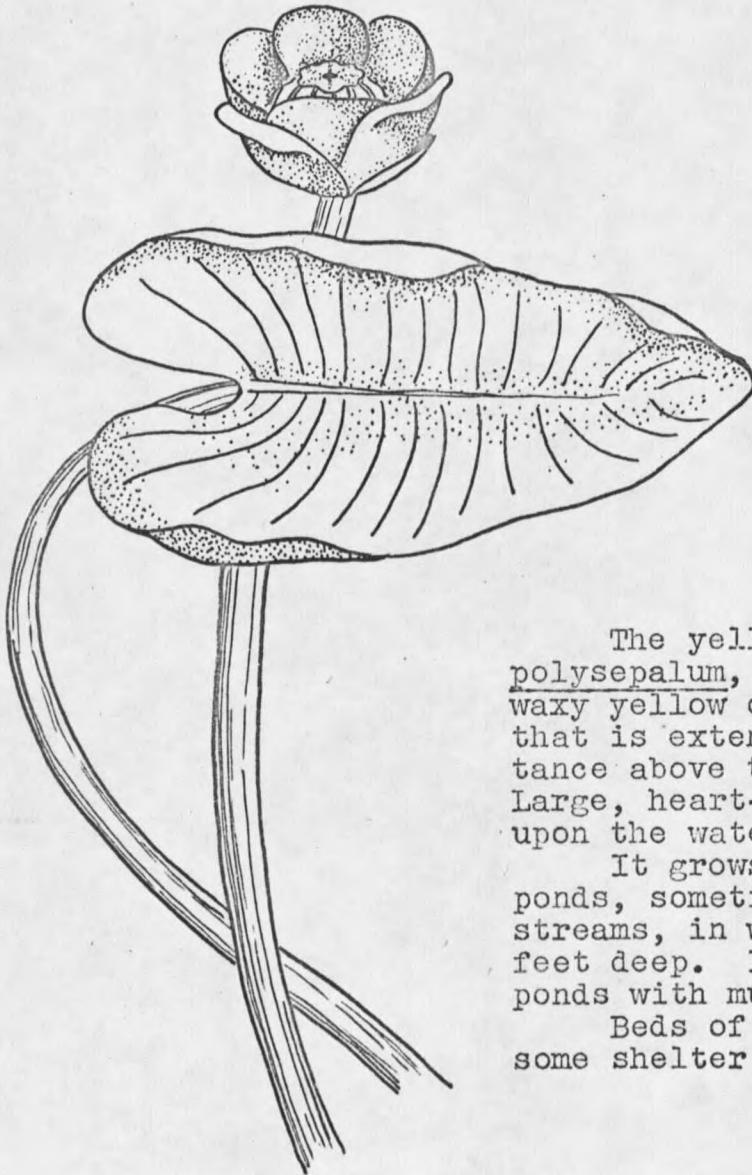
This plant generally grows in fresh water ponds and slow streams. It floats freely or is submerged, sometimes sticking in the bottom soil but not rooted. As it requires little light, it often grows in very deep water.

Coontail is important to fish because of the abundance of food it harbors and the shelter it provides. Sometimes it becomes so thick that people take methods to control it.



LEAF

YELLOW POND-LILY

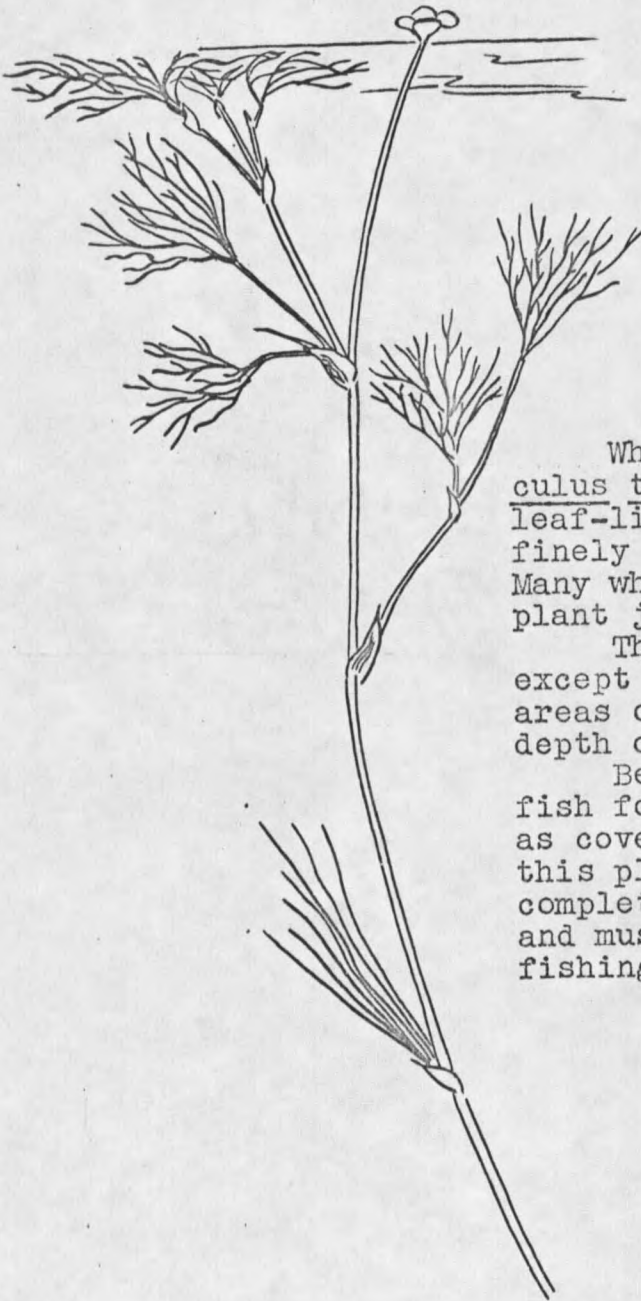


The yellow pond-lily, Nuphar polysepalum, displays a large, waxy yellow or yellow-green flower that is extended for a short distance above the water surface. Large, heart-shaped leaves float upon the water surface.

It grows in the quiet water of ponds, sometimes lakes or slow streams, in water of around six feet deep. It especially likes ponds with muddy, fertile bottoms.

Beds of pond-lilies furnish some shelter for fish.

WHITE WATER BUTTERCUP



White water-buttercup, Ranunculus trichophyllus, has a short, leaf-like stalk that supports finely divided, thread-like leaves. Many white flowers blossom on the plant just above the water surface.

The buttercup grows submerged, except for flowers, in shallow areas of clear ponds and lakes to a depth of around four feet.

Beds of buttercup harbor many fish food organisms and may serve as cover for fish. In many places, this plant becomes so thick that it completely clogs lakes and streams, and must often be controlled if fishing is to be maintained.

CURSED CROWFOOT

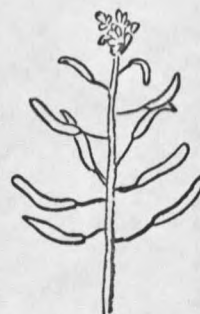


Cursed crowfoot, Ranunculus sceleratus, contains leaves that are distinctly divided into three major parts as illustrated.

This plant grows in marshes and sloughs of both fresh and brackish water.

Because of the areas in which cursed crowfoot grows, it is not important to fish.

WATERCRESS



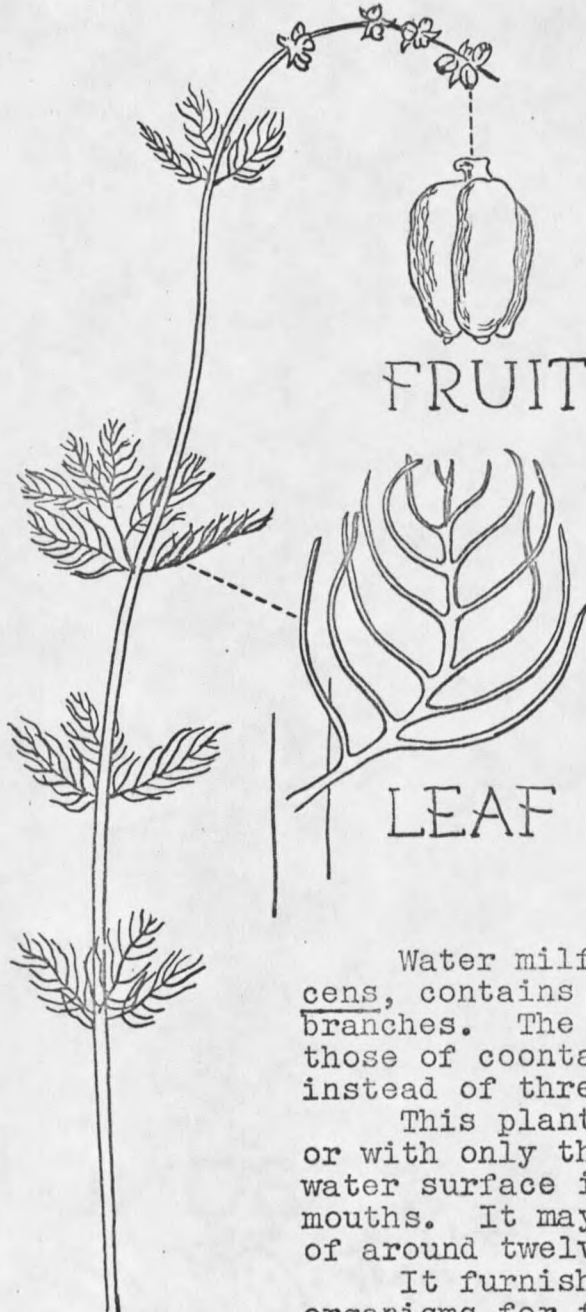
PODS

Watercress, Rorippa nasturtium-aquaticum, contains seed pods much like mustard pods. The flowers are small, white, and four-petaled. Stems of watercress may branch out during the summer and take root.

This watercress is found in cool springs, brooks, and spring-fed ponds.

Much food and cover is furnished by this plant. Sometimes, it becomes so rank in small brooks that it interferes with fishing.

WATER MILFOIL

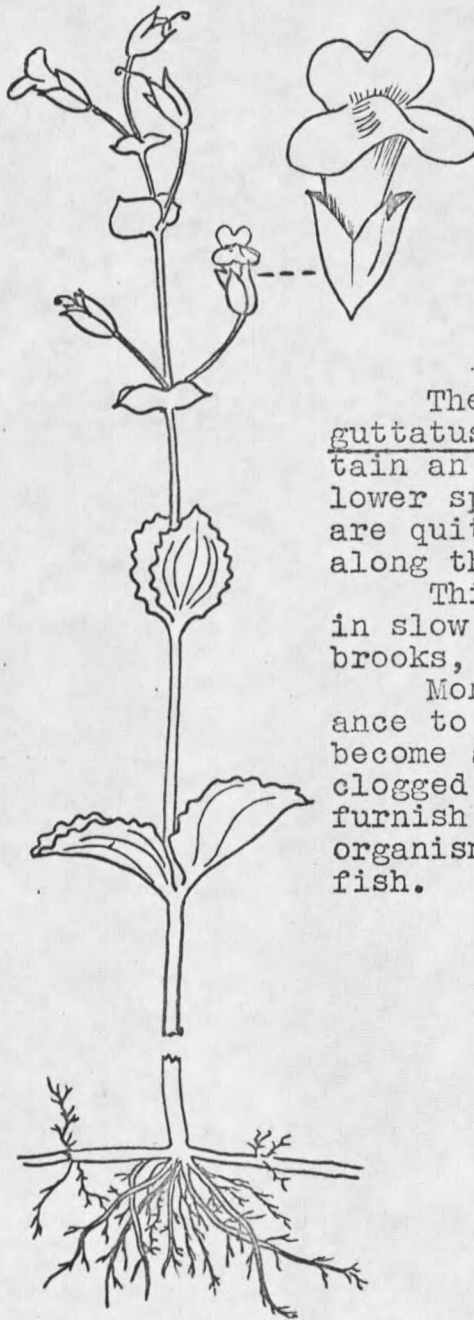


Water milfoil, Myriophyllum exalbens, contains slender stems with few branches. The leaves appear much like those of coontail, but are feather-shaped instead of three-split.

This plant grows entirely submerged or with only the tips extending above the water surface in ponds, lakes, and stream mouths. It may be found growing in depths of around twelve feet.

It furnishes both shelter and food organisms for fish.

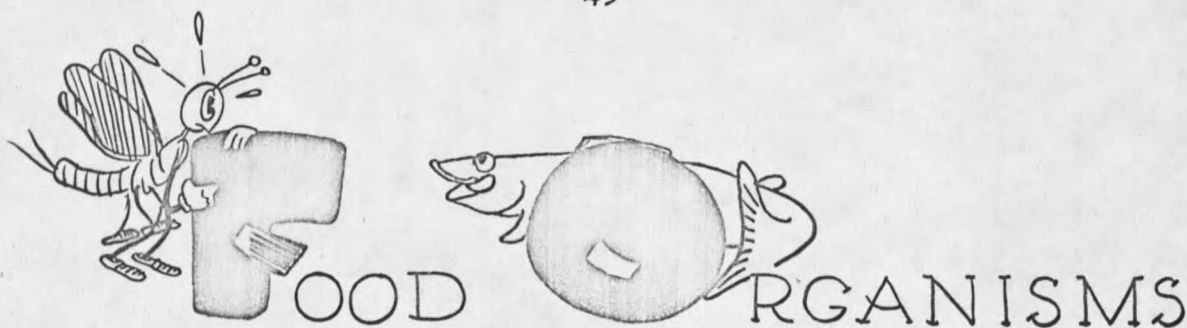
MONKEY FLOWER



The monkey flower, Mimulus guttatus, bears flowers that contain an upper erect lip, and a lower spreading lip. The leaves are quite short and are serrated along the edges.

This plant is generally found in slow streams and spring-fed brooks, sometimes in great numbers.

Monkey flowers are a hindrance to fish and fishing when they become so thick that streams are clogged with them; otherwise, they furnish a pasture for fish food organisms and furnish cover for fish.



A few land animals such as grasshoppers, bees, and even mice fall into water and are eaten by fish; however, by far the greatest number of organisms eaten are those which live in the water.

A large variety of animals thrive in great numbers in water, especially in warm lakes and ponds. Like the algae, some are one-celled and live either singly or in groups. Those in streams are mostly attached to rocks, sticks, etc. so that they will not be swept away. Many of their relatives in lakes and ponds, such as water fleas and rotifers, are freely suspended or float in the water. The latter are called zooplankters.

The tremendous numbers of tiny animals produced make up for their small size. Thousands may be found in a single cupfull of lake or pond water. They feed mainly upon small plants and the decaying tissues of animals and higher plants. These minute organisms serve as food for aquatic insects and the young of many fish. They are also a direct source of food for some of the larger fish such as lake whitefish, kokanee, and paddlefish. Large fish secure them by straining water

through their long, comb-like gill rakers.

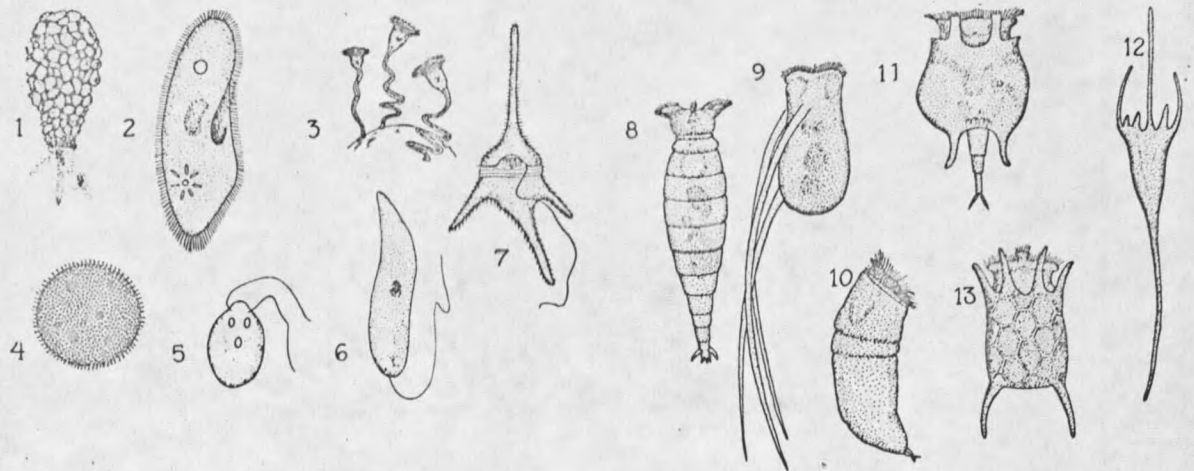
Aquatic insects are the most important direct source of food for our game fish. They are usually available because they spend the greater part of their lives in water. Even after leaving the water, the adult insects supply food, for they remain nearby and are captured when they fall into the water or rest upon its surface to lay their eggs.

Young aquatic insects feed largely upon both algae and small water animals, even their own kinds. A few, such as dragonfly nymphs, are quite voracious and may even destroy small fish.

Many fish eat other fish, and are not too selective in doing so. The kinds of fish which are most important as food are those such as minnows and sculpins. These are called forage fish. A good forage fish not only remains small, but is also capable of reproducing rapidly enough to be present in large numbers.

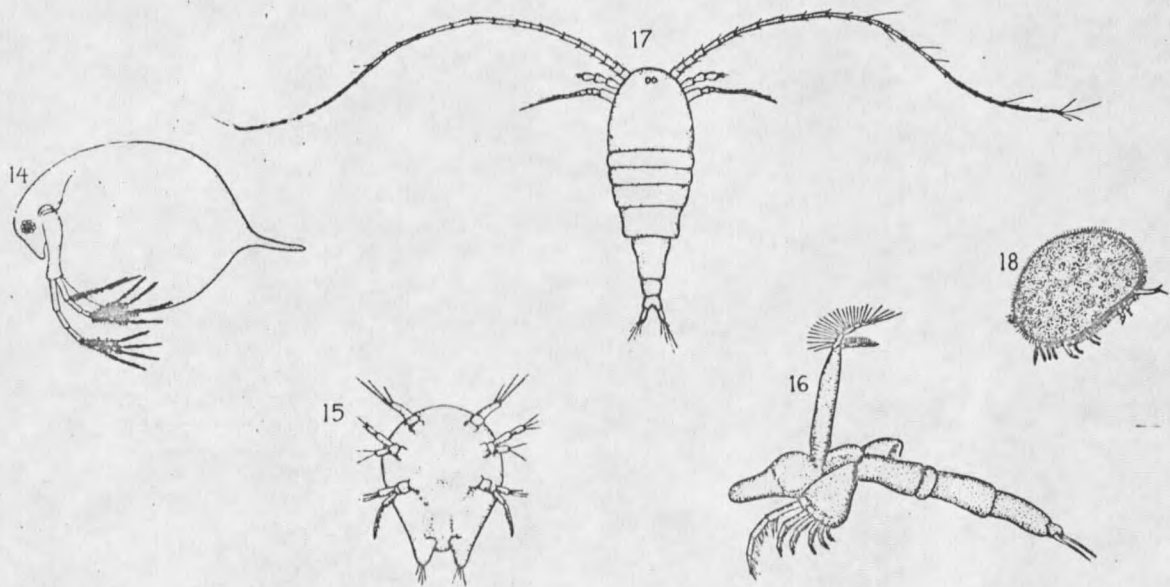
Many other water animals like snails, shrimps, and even crayfish may serve as an important part of a fish's diet. The kind and quantity of food taken usually depends upon its abundance and availability.

Animals and plants are all associated with each other according to their food habits. A trout, for instance, eats insects that feed upon plants, and in turn the trout may be eaten by some other animal, or may die and supply nutrient



SINGLE-CELLED ANIMALS

ROTIFERS



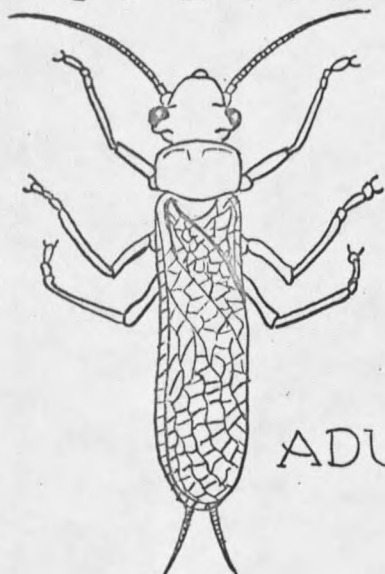
WATER FLEAS

- 1 DIFFLUGIA
- 2 PARAMOECIUM
- 3 VORTICELLA
- 4 VOLVOX
- 5 CHALMYDOMONAS
- 6 EUGLENA

- 7 CERATIUM
- 8 ROTIFER
- 9 TRIARTHRA
- 10 DIURELLA
- 11 NOTEUS
- 12 NOTHOLCA

- 13 ANURAEA
- 14 DAPHNIA
- 15 NAUPLIUS
- 16 LEPTODORA
- 17 DIAPTOMUS
- 18 CYPRIDOPSIS

STONE FLY

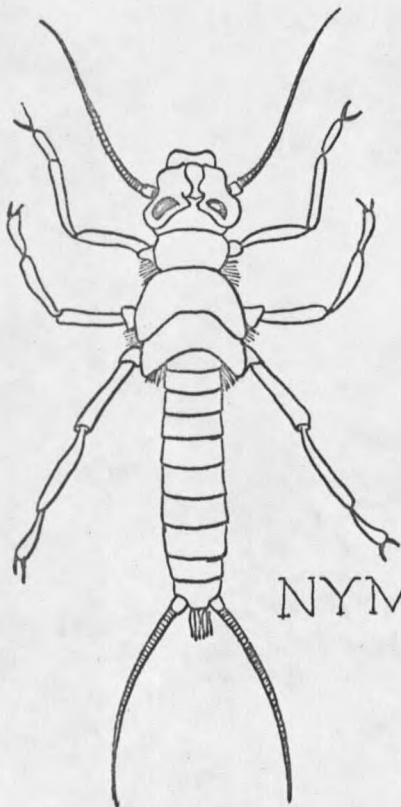


ADULT

Nymphs, or young stone flies

1. Bodies flat
2. Two claws on each foot
3. Usually thread-like gills on underparts
4. Two tails

These nymphs hatch from eggs laid in cool, swift water and live in the riffles clinging to the undersides of stones and sticks.



NYMPH

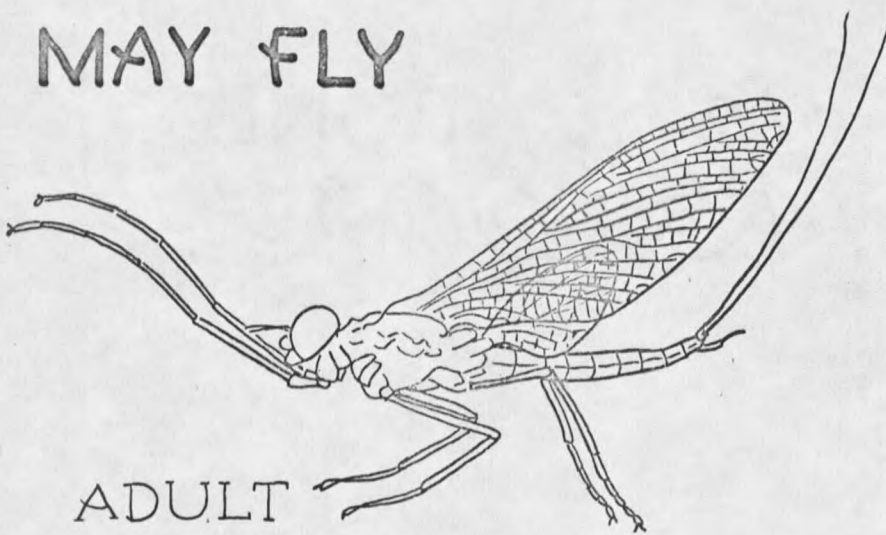
Adults

1. Flight ungainly with bodies in nearly vertical position
2. Front pairs of wings folded over rear pairs and held flat against backs when at rest

Adults seldom travel far from streams, and may be found on the undersides of leaves or stems, or under rocks along the shore.

Example: Acroneuria

MAY FLY

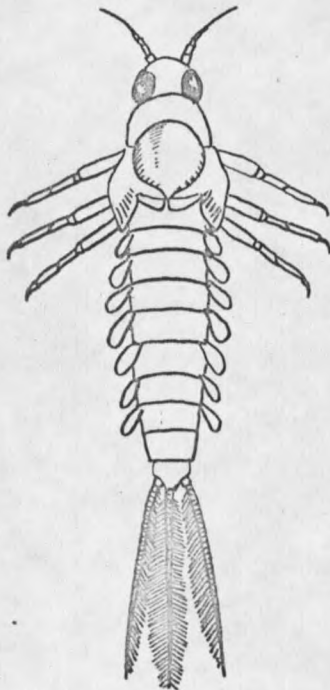


ADULT

Nymphs, or young may flies

1. Either round or flat-bodied
2. One claw on each foot
3. Leaf or plate-like gills on sides
4. Usually three tails

Many different kinds are found among the rocks, weeds, and in the mud of both standing and flowing water.



NYMPH

Adults

1. Abdomens slender and curved upward
2. Two or three long tails
3. Front wings much larger than rear ones; when at rest, wings are held close together in a vertical position

During the evenings, misty gray swarms congregate over patches of water. They are strongly attracted to light at night.

Example: Ameletus

DRAGONFLY

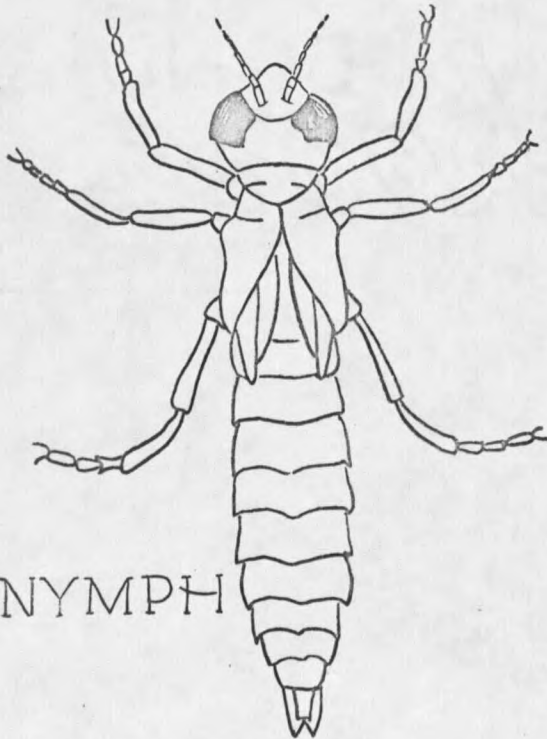
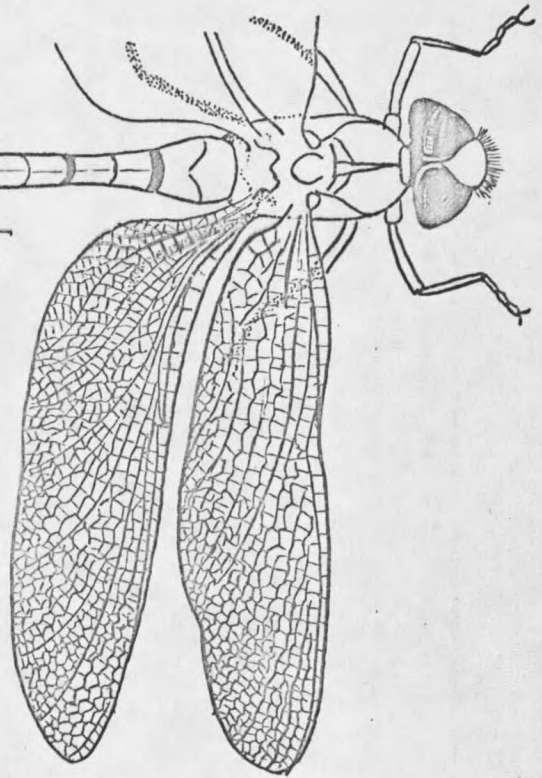
ADULT

Adults

1. Bodies long and stout;
- legs heavy and strong
2. Eyes extremely large
3. Swift and agile in flight; wings are held out horizontally away from bodies when at rest

The adults are found darting about water areas, especially ponds, or resting upon the stems of plants.

Example: Aeshna



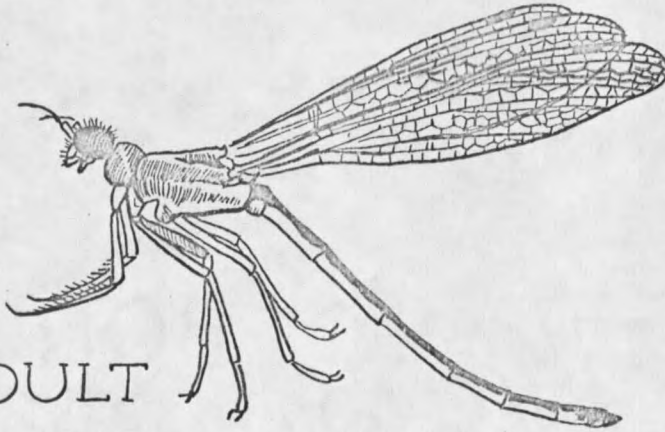
NYMPH

Nymphs, or young dragonflies

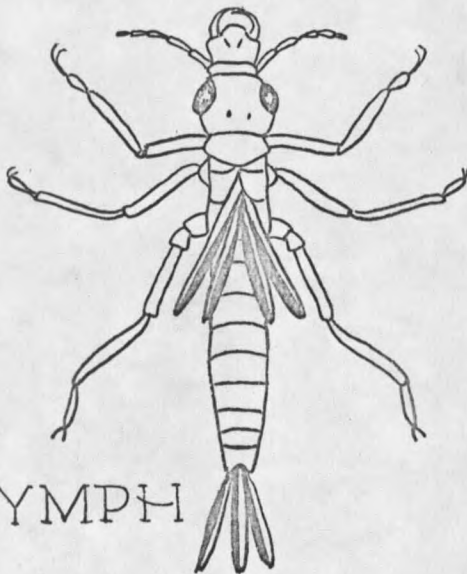
1. Strong, thick bodies
2. No external gills
3. Lower lips modified into arm and hand-like food catchers, usually kept folded under heads when not in use

Dragonfly nymphs are generally found in weedy, mud-bottomed ponds, but may be found in streams. Some kinds spend the winter in mud or submerged debris.

DAMSEL FLY



ADULT



NYMPH

Nymphs, or young damsel flies

1. Generally slender-bodied
2. Three, leaf-like gills at posterior ends of bodies

Damsel fly nymphs are usually found in quiet, weed-filled water.

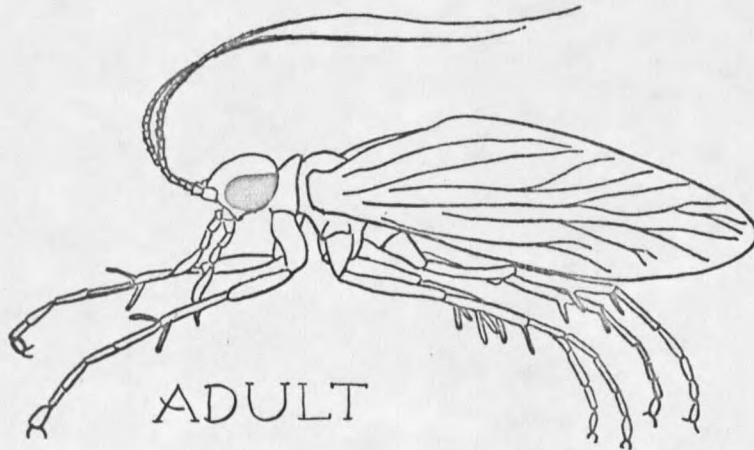
Adults

1. Bodies long and slender
2. Usually metallic green or blue in color
3. Slow, weak flyers; at rest, wings are folded and held at an angle over backs

Damsel flies are found near water, leisurely flying about or resting upon plant stems.

Example: Argia

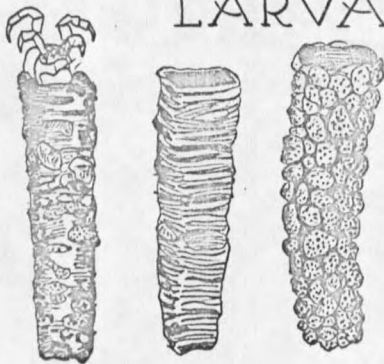
CADDIS FLY



ADULT



LARVA



Larvae, or young caddis flies

Most larvae build houses and many can be identified by the types of homes they build. Some are of small pebbles, and others are of wood, strips of bark, etc. Some live in nets they spin and attach to rocks.

The larvae are widely distributed in both standing and flowing water.

Pupae, intermediate between larvae and adults

In the spring, the larvae cease feeding, plug up their houses, and slowly change into adults.

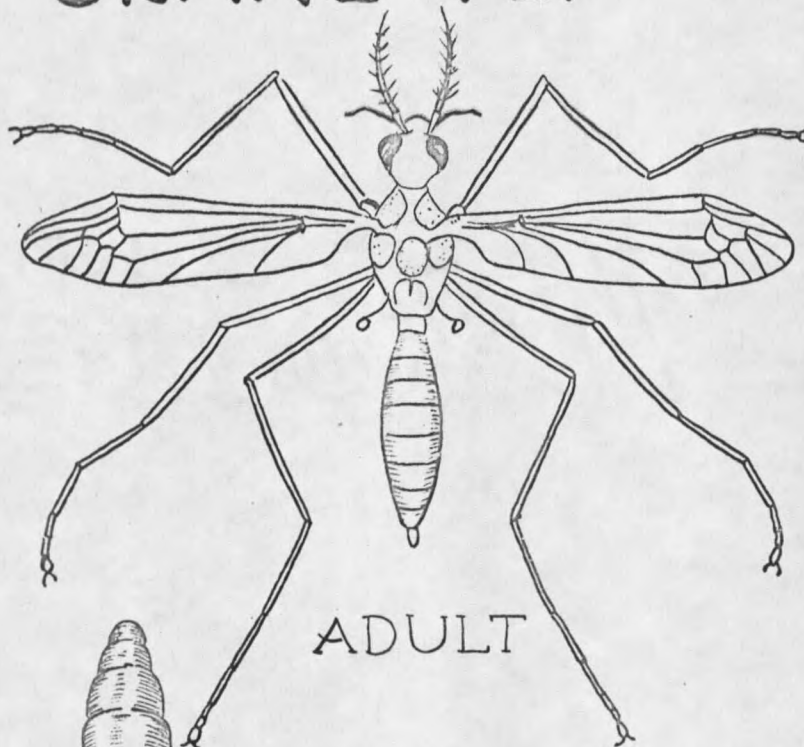
Adults

1. Delicate, slender bodies, often mistaken for moths
2. Usually gray or dully colored
3. Hair on wings gives them a fuzzy appearance
4. At rest, wings folded over their backs like slanting roofs.

They are seldom seen during the day, but are strongly attracted to light at night.

Example: Arctopsyche

CRANE FLY



ADULT



LARVA

Larvae, or young crane flies

1. Worm-like with soft, rubbery bodies
2. Some have finger-like projections on the posterior ends of their bodies

The larvae live within debris and mud in quiet water of stream edges, and go through a pupal stage before emerging as adults.

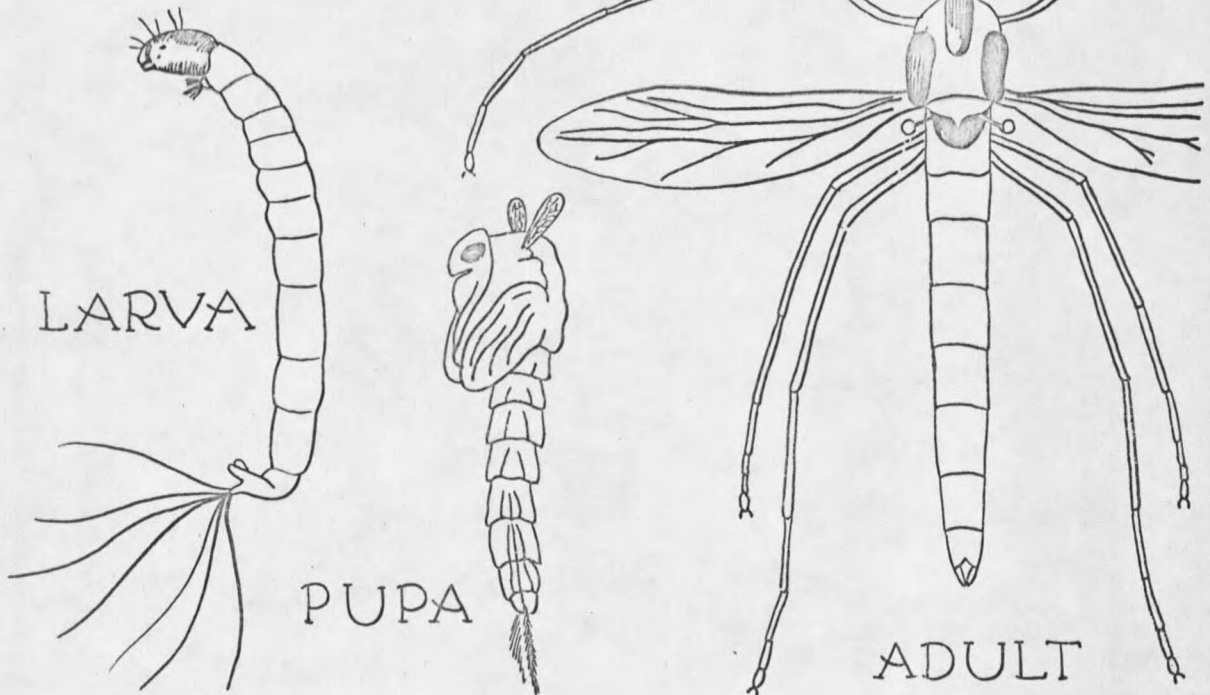
Adults

1. Long, slender bodies; look like overgrown mosquitos
2. Long, spidery legs which are easily broken
3. One pair of wings

The adults are usually found near water, flying clumsily about, or in swarms that dance and sway over water areas.

Example: Tipula

MIDGE



Larvae, or young midges

1. Small, worm-like; legs not noticeable
 2. Often enclosed in delicate earthen tubes
- They are widely distributed in fresh water.

Pupae, intermediate between larvae and adults

1. Active, not quiescent like many pupae
2. Large front ends (thoraces); slender posteriors

Midges are closely related to mosquitos, and many look like them. Bodies of midge pupae are less curved than those of mosquito pupae.

They hang at the surface in fresh water.

Adults

1. Usually very small, never longer than one-half inch
2. At rest, they hold their front legs in space; (mosquitos hold their rear legs in space).
3. Feather-like antennae often on heads of males

Midges congregate over fresh water in summer, spring, and fall. In winter, they are found on the snow near streams, and are called snow flies. Light attracts them strongly.

OTHER WATER INSECTS

WATER BOATMEN

Nymphs, or young water boatmen and adults look much the same.

1. No gills
2. Air on the bodies of submerged individuals often gives them a silvery appearance.
3. Two, long, oar-shaped legs used for swimming; other four legs short

Water boatmen are found in still water and in quiet backwaters of streams, especially in weedy areas.

Example: Corixa

WHIRLIGIG BEETLES

Adults

1. Dark, oval-shaped bodies
2. Two, short, pudgy antennae
3. Each eye divided into an upper and lower part
4. When scooped from the water, they often give off an unpleasant odor not unlike rotten apples.

They are often seen in quiet water, whirling and scuttering over the surface in peculiar gyrations.

Example: Gyrinus

DIVING BEETLES

Larvae, or young diving beetles

1. May attain a length of three inches
2. Curved bodies; flat heads, two, scythe-shaped jaws

The larvae are found in shallow areas of quiet or gently flowing water. Some hang head down with the ends of their abdomens sticking into the air. They are very carnivorous, even to the point of attacking small fish.

Adults

1. May attain a length of over one inch
2. Dark brown or black in color
3. Antennae fairly long and thread-like

Adults forage in shallow, vegetated areas in search of food. Many tadpoles fall prey to the large mauraunders.

Example: Dytiscus

OTHERS

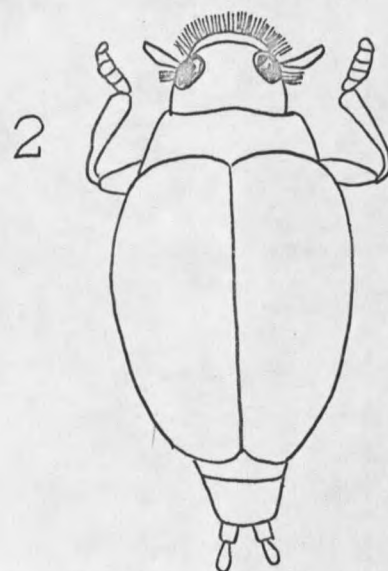
57



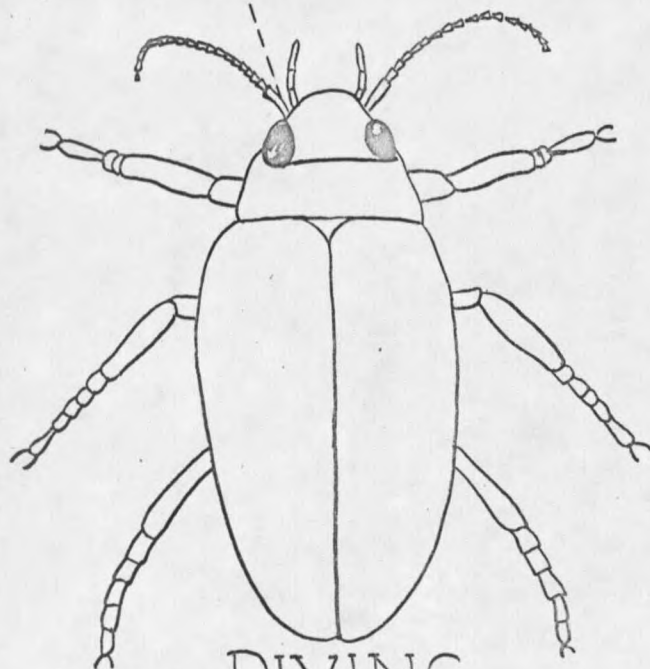
DIVING
BEETLE
(LARVA)



WATER
BOAT-
MAN

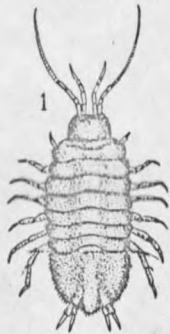


WHIRLIGIG
BEETLE

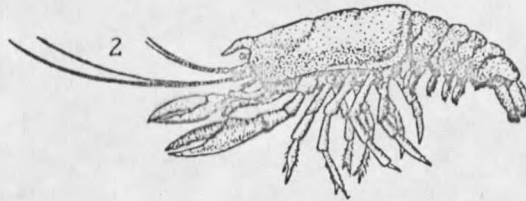


DIVING
BEETLE (ADULT)

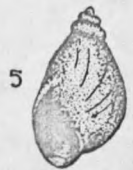
- 1 CORIXA
- 2 GYRINUS
- 3 DYTISCUS



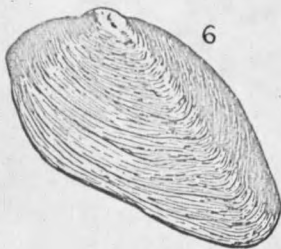
SOW-BUG



CRAYFISH



SNAILS



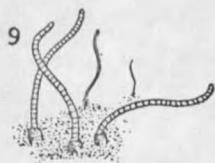
MUSSEL



WATER
MITE



MOSS
ANIMALS



SEWAGE
WORMS



LEECH



FLAT-WORM

- 1 ASELLUS
- 2 CAMBARUS
- 3 LYMNEA
- 4 PLANORBIS

- 5 PHYSA
- 6 MARGARITANA
- 7 HYDRACHNA
- 8 PLUMATELLA

- 9 TUBIFEX
- 10 HAEMOPIS
- 11 PLANARIA

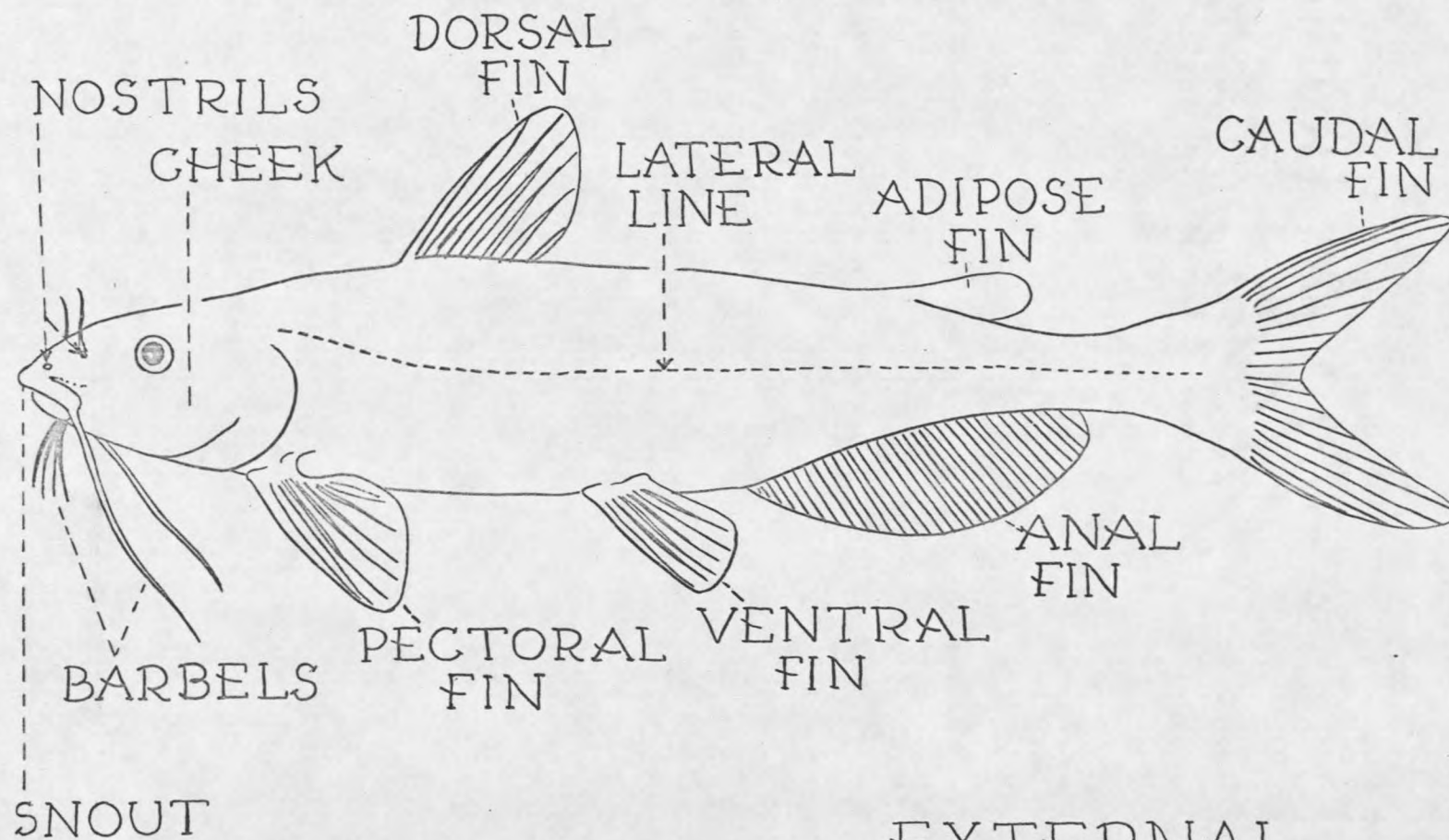
FISH COMBINATIONS



Most kinds of native fish can live together without evidence of ill effects, but when two or more kinds of fish not native to the same waters are put together, one or the other often suffers. The introduction of brown, rainbow, and brook trout into many of our waters has been a major factor in the restriction of grayling and cutthroat trout to a fraction of their original ranges, and may possibly result in their eventual extinction. A few fish seem able to hold their own regardless of the introduction of other kinds. The mountain whitefish is an example of such a fish.

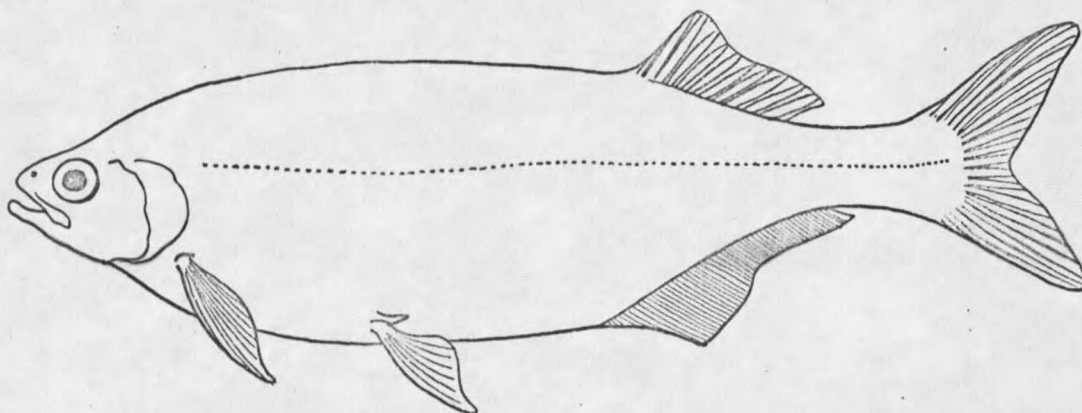
Some natural combinations which are known to do well together are: cutthroat trout, grayling, mountain whitefish, sculpins, and suckers; yellow perch and sauger; largemouth bass and bluegills; lake trout and lake whitefish. Some which are known to be unsuitable are: yellow perch and trout; walleye pike and bass; and carp and bluegills.

Care should be taken to determine the possible effects of introducing new kinds of fish before they are planted, for once they become established in a drainage it is almost impossible to get rid of them should they prove undesirable. For this reason, a state law makes it illegal to move or transport fish from one water to another.



61

EXTERNAL CHARACTERISTICS



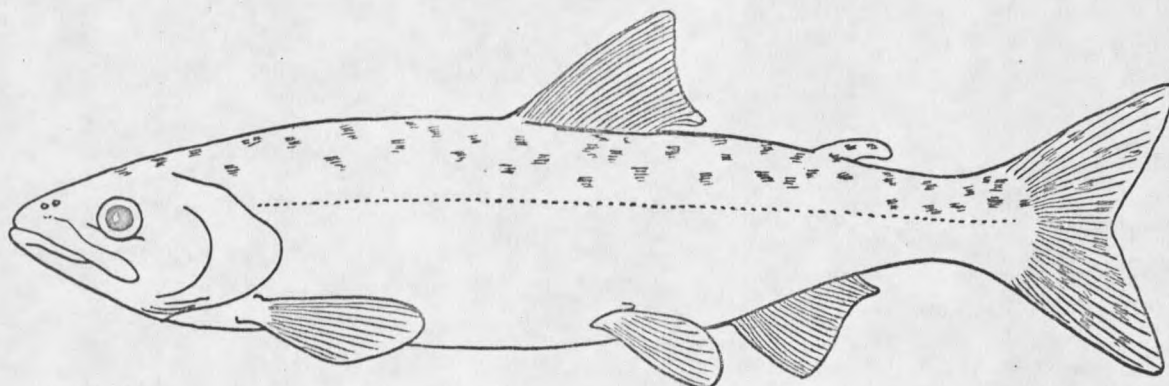
Goldeye: Amphiodon alosoides (native, food fish)

1. Body color olive above; silvery with gold lustre on sides

2. Body flattened from side to side; sharp ridge on belly

It is very abundant in the lower Missouri, Milk, and Yellowstone Rivers and their tributaries.

In Canada, goldeye is much valued as a food fish, but is not utilized in Montana.



Kokanee: Oncorhynchus nerka (introduced, game fish)

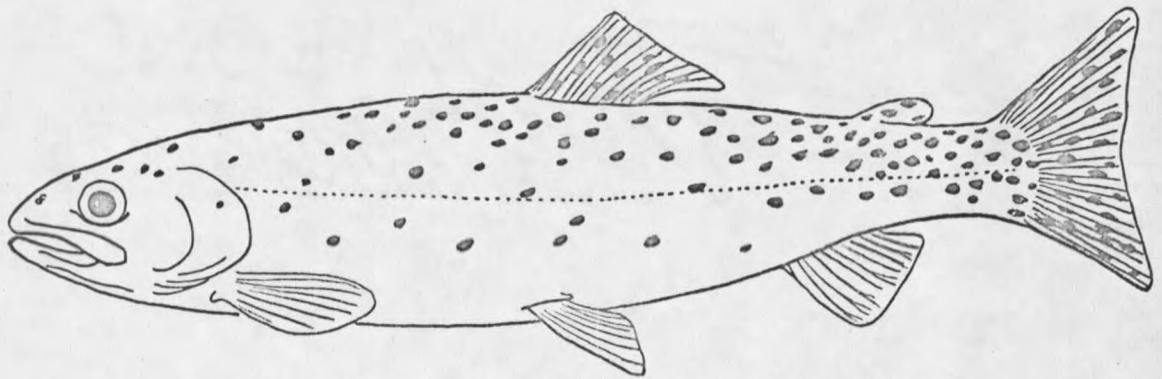
1. Color dull blue above; silvery sides

2. A few black spots scattered on back and tail

During spawning, the bodies of males change form and their lower jaws become hooked, the tops of their heads become green, and their sides become bright red. All die soon after they spawn.

The kokanee requires cold water and is found in Flathead, Placid, and other lakes and reservoirs.

It is hard to catch, but is an excellent food fish.



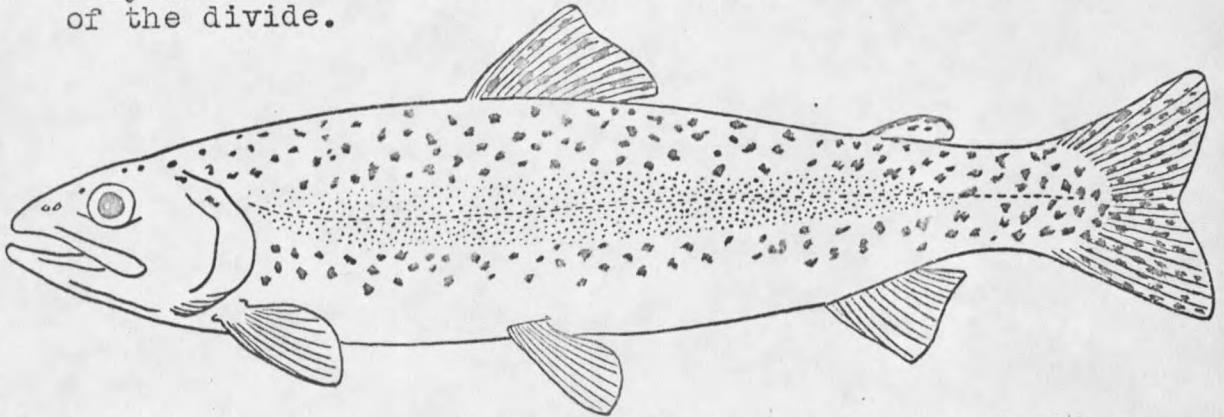
Cutthroat Trout: Salmo clarkii (native, game fish)

1. Color yellowish-green above; silvery, often rosy tinted sides; red on opercles and front of body

2. Red streaks along creases on undersides of lower jaws; sprinkled with round spots on back and sides, becoming more numerous toward the tail; few spots below lateral line. The red gash beneath the jaws is a distinguishing mark.

It will cross with rainbow, and the offsprings are difficult to distinguish from either rainbow or cutthroat.

Once abundant in all our cold-water streams, it is now generally limited to headwater streams and lakes on both sides of the divide.



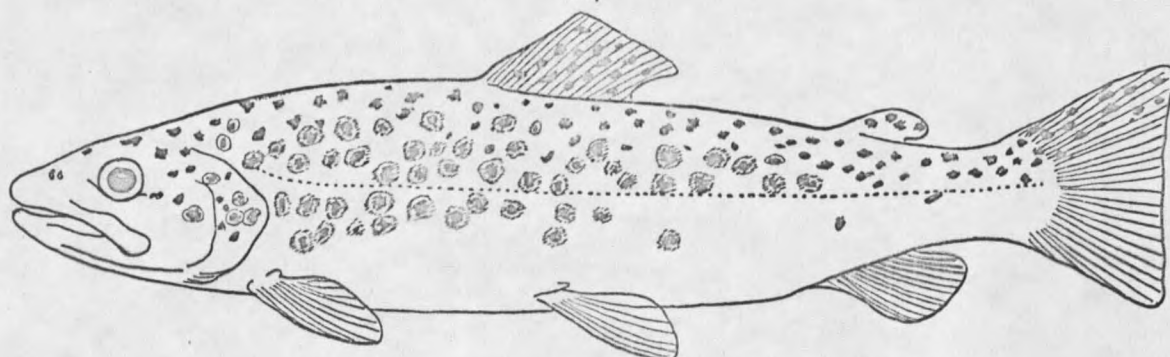
Rainbow Trout: Salmo gairdnerii (introduced, game fish)

1. Body color olive to blue-green above; sides silvery with pink or reddish stripes running lengthwise

2. Small, usually irregular black spots on upper head, body, and fins; many spots below lateral line

The rainbow trout is generally distributed throughout Montana in cool streams and lakes.

It is probably the most favored of game fish.

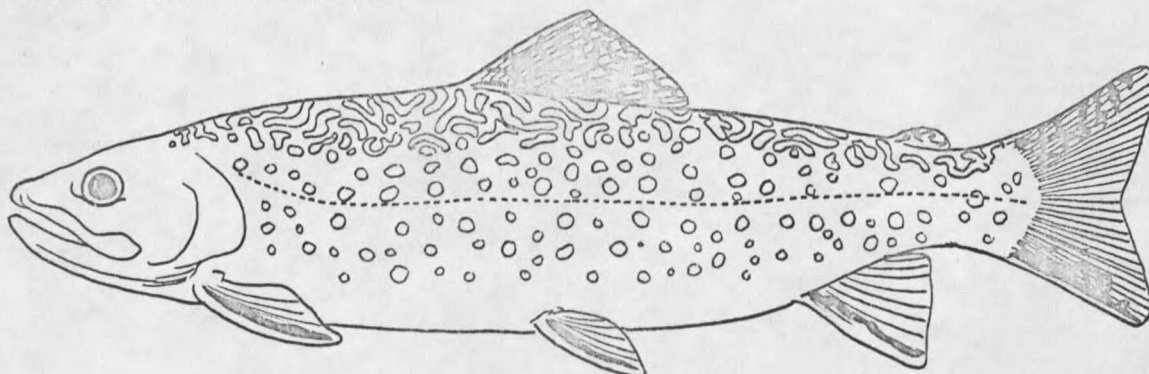


Brown Trout: Salmo trutta (introduced, game fish)

1. Body color brown to yellow-brown above, lighter on sides
2. Jaws very strong; teeth pronounced
3. Head, cheeks, and body spotted with black and red; dull blue circles surround red spots on younger fish; on old fish, circles become white or pink and enclosed spots become brown blotches

The brown trout inhabits streams, lakes, and reservoirs on both sides of the divide. It prefers the lower reaches of the larger rivers.

This trout grows to a large size and is one of the most difficult to catch.

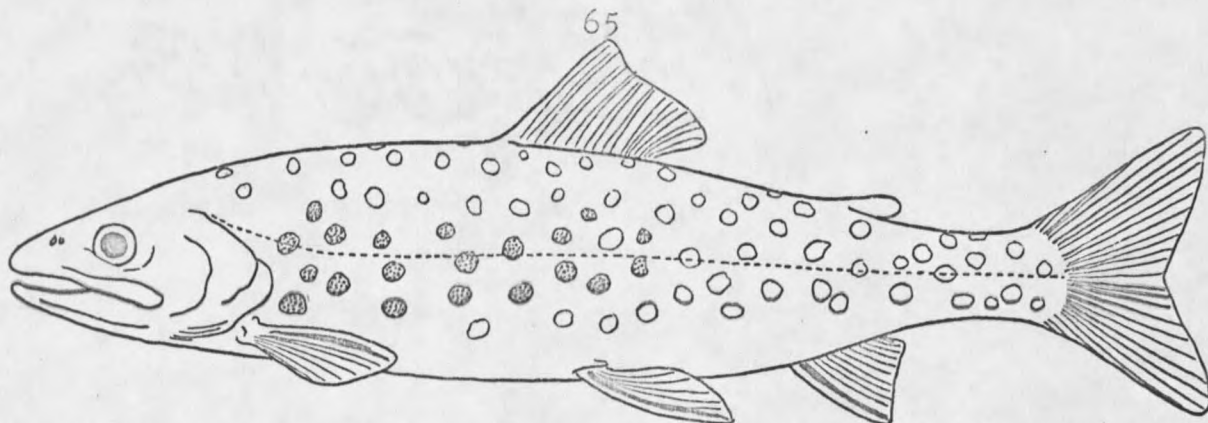


Eastern Brook Trout: Salvelinus fontinalis (introduced, game fish)

1. Body color olive above; sides greenish-blue; underparts often orange
2. Back distinctly mottled; sides spattered with several encircled red and yellow spots; lower fins and tail bear white forward margins followed by black stripes.

The brook trout is found in many cold streams and lakes throughout Montana, especially in valley spring runs and brooks.

It is an excellent food and game fish, and is recommended for cold-water ranch ponds.

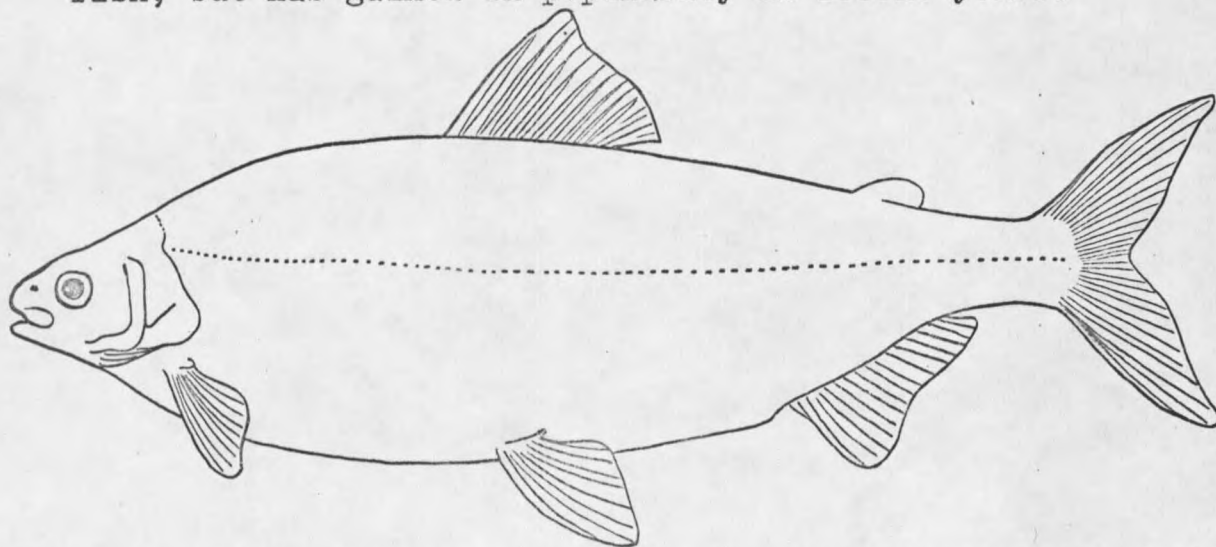


Dolly Varden: Salvelinus malma (native, game fish)

1. Body color olive on back and sides
2. Head large and broad; teeth strong
3. Spotted with red and light orange on back and sides; lower fins light margined followed by dark stripes

It inhabits both streams and lakes west of the divide.

The dolly varden was formerly looked upon as an undesirable fish, but has gained in popularity in recent years.

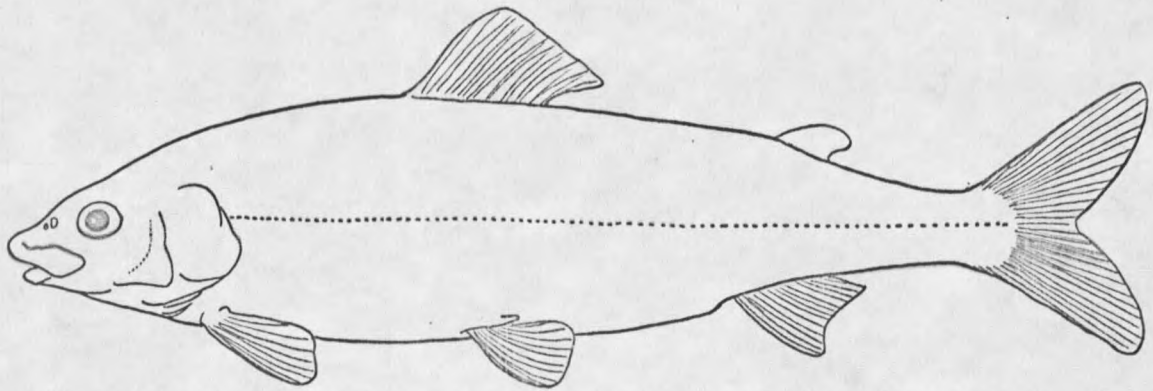


Lake Whitefish: Coregonus clupeaformis (introduced, game fish)

1. Body color silvery to greenish-brown above; silvery sides
2. Body deep and flattened from side to side
3. Small mouth; two flaps on each nostril

It is confined to Flathead Lake, Whitefish Lake, and a few other waters in Montana.

The lake whitefish is an important commercial fish in some places, but is not utilized much in Montana.

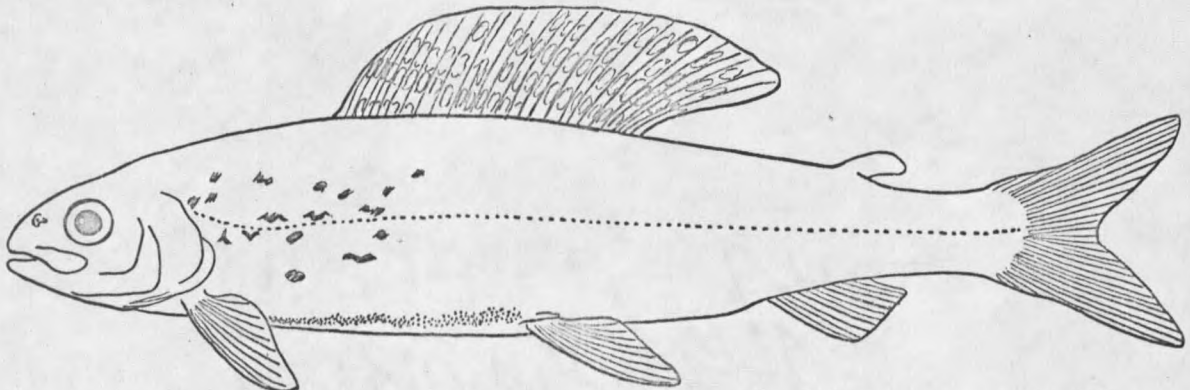


Mountain Whitefish: Prosopium williamsoni (native, game fish)

1. Body color light above with bluish cast; silvery sides; almost white belly
2. Body cylindrical
3. Small mouth; snout more or less pointed; one flap on each nostril

This whitefish is found in the larger streams and in lakes on both sides of the divide.

The true value of the whitefish is not yet recognized. Most often it is caught in the winter and used as a smoked fish.

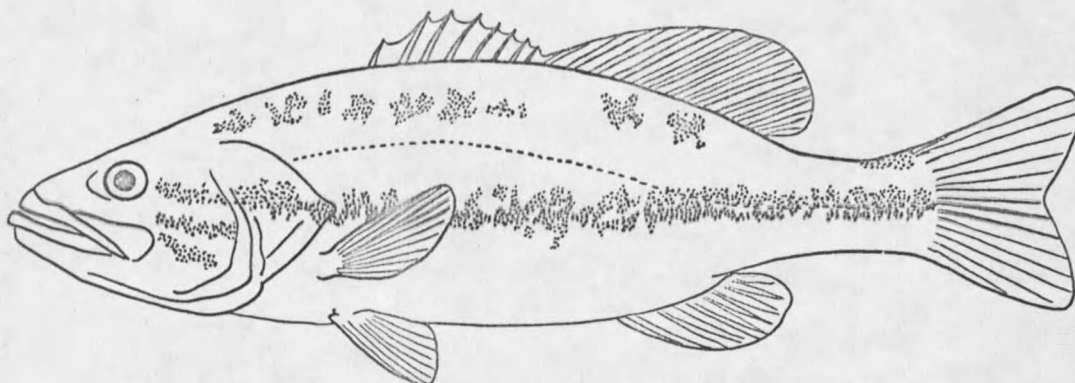


American Grayling: Thymallus signifer (native, game fish)

1. Body color purplish above; purplish-silver sides
2. A few characteristically U or W-shaped spots on sides; brown stripe lengthwise on each side of belly of spawning fish

It is found in the headwaters of the Jefferson and Madison Rivers, and in some cool mountain lakes where it has been planted.

The grayling was once very abundant in Montana, but today is greatly reduced in numbers and has become more or less a novelty.

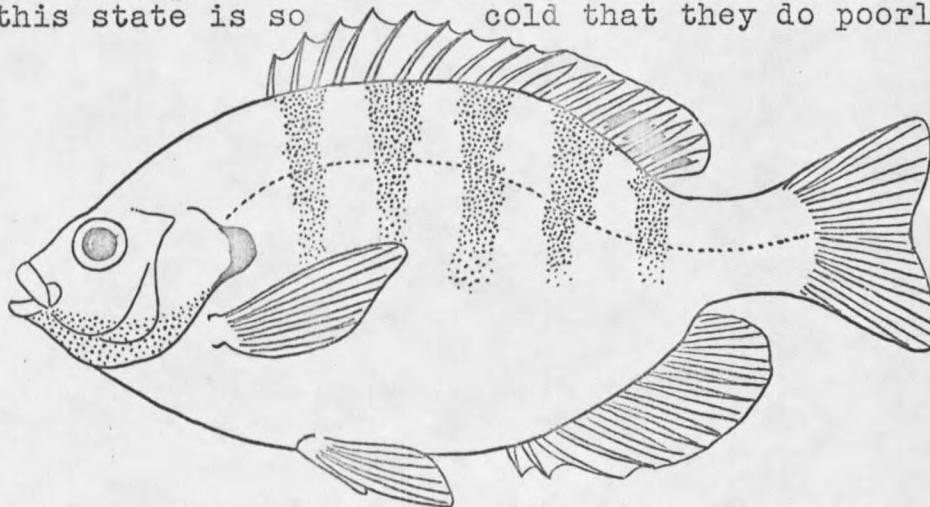


Largemouth Bass: Micropterus salmoides (introduced, game fish)

1. Body color green on back, lighter green on sides
2. Blotched on sides; three dark stripes on cheeks; As the fish grow older, the blotches grow faint or disappear.
3. Dorsal fin almost divided

The largemouth bass is found in warm-water ponds and reservoirs on both sides of the divide.

Many have been planted in Montana ponds; however, the water in this state is so cold that they do poorly.

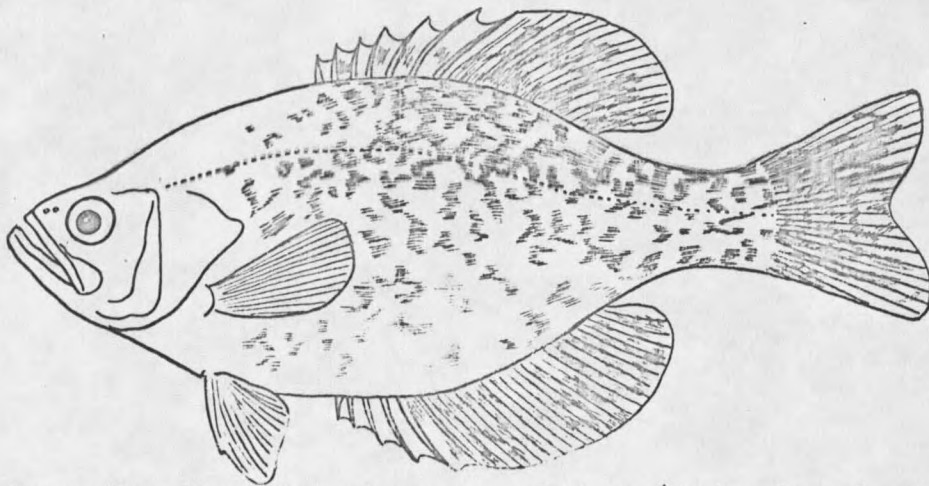


Bluegill: Lepomis macrochirus (introduced, food and forage fish)

1. Body compressed; color greenish-yellow above and on sides; light or red-orange on underparts
2. Black spots on rear of dorsal fin; lower head and gill covers blue; black or purplish ear-lobes; five to seven vertical bars on body

The bluegill is found in reservoirs and ranch ponds throughout the state.

It is an excellent food fish, and may serve as forage for bass. Rarely does it attain seven or eight inches here.

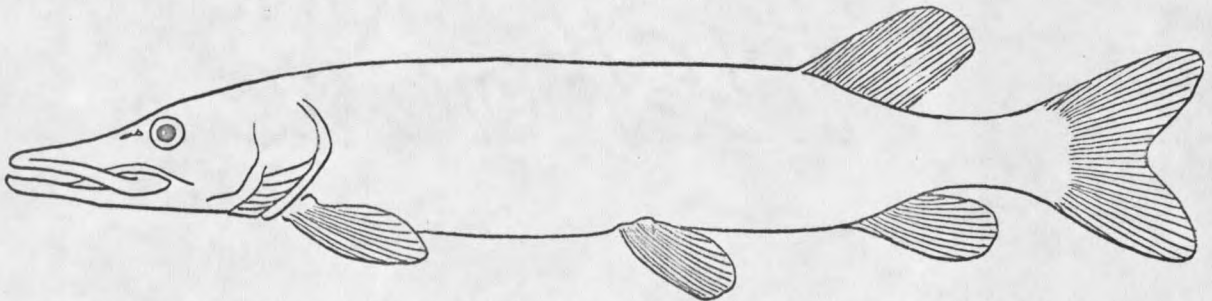


Black Crappie: Pomoxis nigro-maculatus (introduced, food fish)

1. Body much flattened; color green above, sides lighter green than back; belly light green to white
2. Sides of body, and dorsal, caudal, and anal fins faintly blotched with green
3. Anal fin as large as dorsal fin

It is found in reservoirs and ponds east of the divide.

The black crappie is a good food fish, but cold water limits its size in Montana.

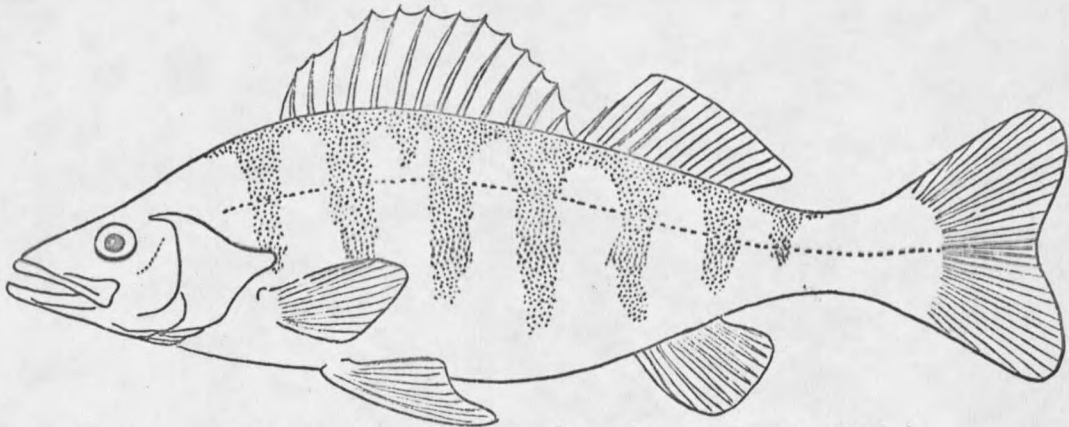


Northern Pike: Esox lucius (probably native, game fish)

1. Body rounded and elongated
2. Head flat; jaws shaped like duck's bill and edged with strong teeth
3. Dorsal fin set far back near caudal fin

This species has been introduced into reservoirs and ponds in northern and eastern Montana.

The pike is a good sports fish and an excellent food fish. It is one of the most voracious of all fresh-water fish.

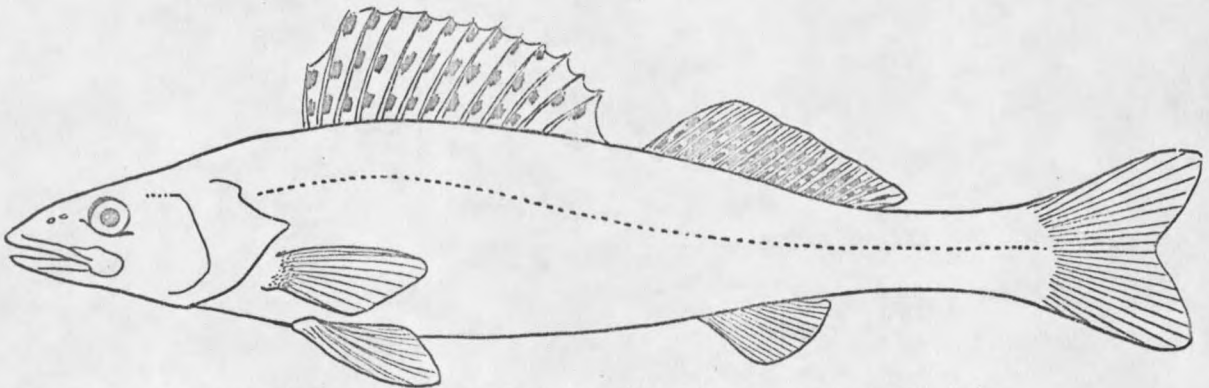


Yellow Perch: Perca flavescens (native, food fish)

1. Body color yellowish-green above; sides yellowish
2. Six to eight dark, vertical bars on sides
3. High, spiny dorsal fin

The perch is abundant in the Missouri River, its larger tributaries, and in streams and lakes throughout the state where it has been planted.

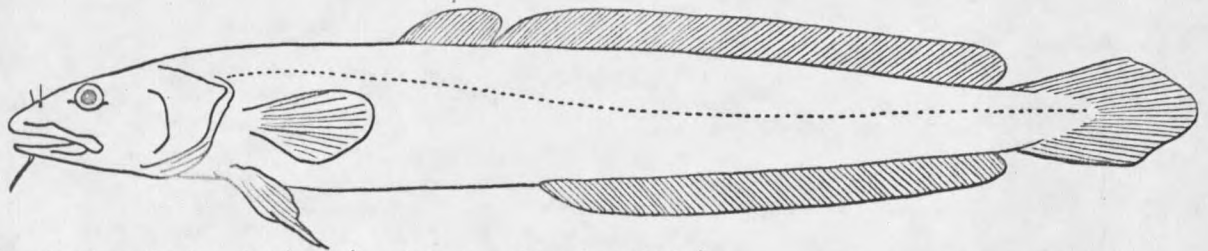
It is a good food fish, but does not reach a usable size in many waters.



Sauger: Stizostedion canadense (native, game fish)

1. Body color olive-gray above; sides with orange or brassy sheen
2. First dorsal with two or three rows of black spots; second dorsal with three rows of spots; black patch at base of pectoral fins

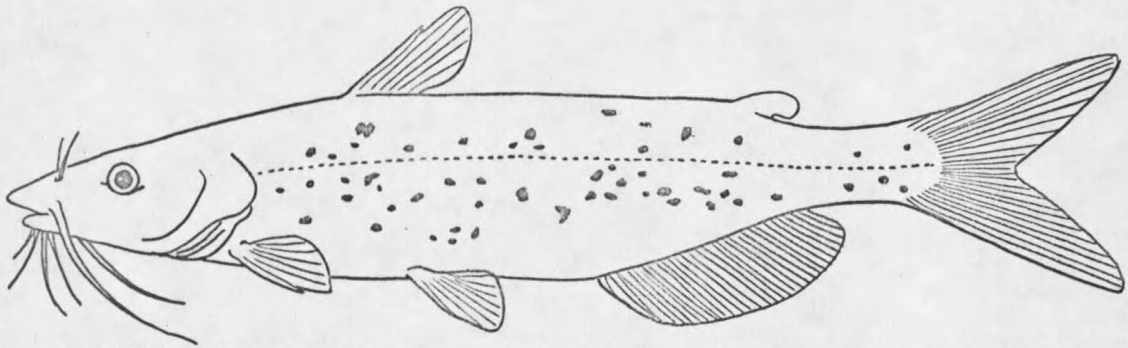
The Missouri River and its larger tributaries contain sauger. It is very abundant in Montana, but is not used much at the present time.



Burbot: Lota lota (native, food fish)

1. Body long, eel-like; scales not visible
 2. One short barbel on each nostril; one barbel on chin
 3. Anal and second dorsal fins very long; caudal fin rounded
- The burbot lives in streams, especially rivers, on both sides of the divide.

This is a good food fish, but is not sought a great deal.

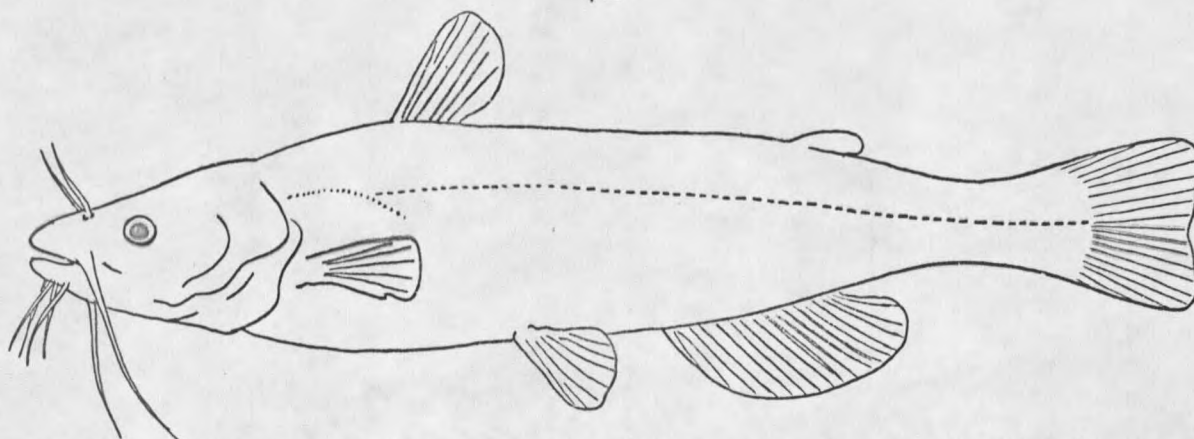


Channel Catfish: Ictalurus lacustris (native, food fish)

1. Body color bluish to silvery-gray on back and sides; belly silvery
2. Sides sprinkled with a few dark spots
3. Head small; snout protrudes beyond lower jaw
4. Caudal fin deeply notched

This catfish is found in the lower Missouri River and its tributaries.

It is credited as being a good food fish, but is not extensively utilized in Montana.



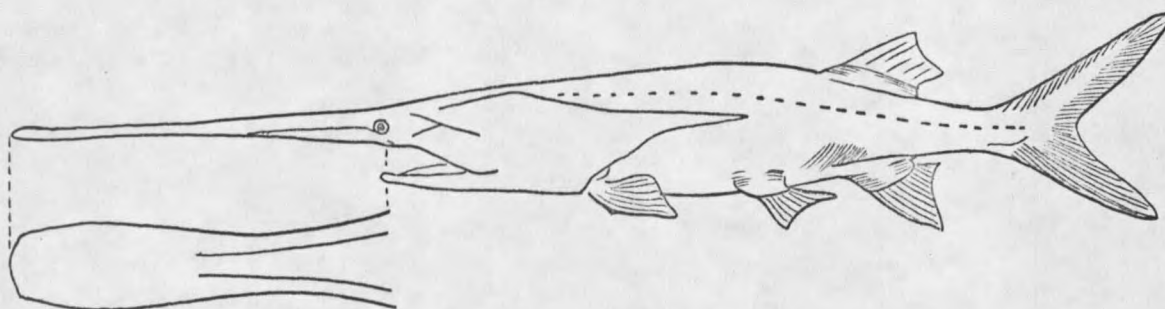
Black Bullhead: Ameiurus melas (introduced, scrap fish)

1. Body color dark brown, green, or black above; sides greenish or brassy

2. Tail rounded or very slightly forked

Many warm ponds and streams in eastern Montana contain bullheads.

The bullhead is valued little in Montana, but is a good fish in that it can survive in waters that are unsuitable for more desired kinds.



TOP VIEW

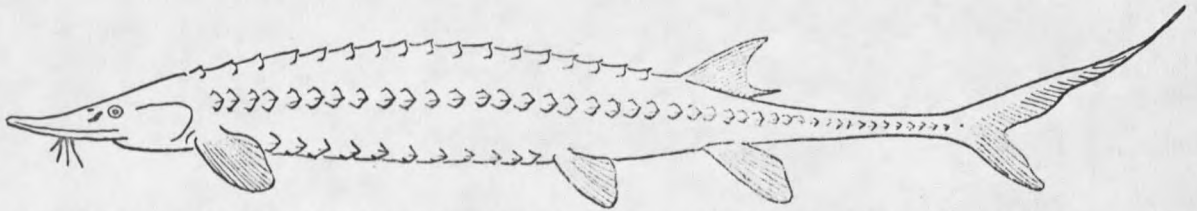
Paddlefish: Polyodon spathula (native, scrap fish)

1. Long, paddle-like snout

2. Skin smooth

This strange looking fish is found in the lower Missouri and Milk Rivers.

Flesh of the paddlefish is coarse but edible. It is valued more for its eggs which are made into caviar, but is not utilized in our state.

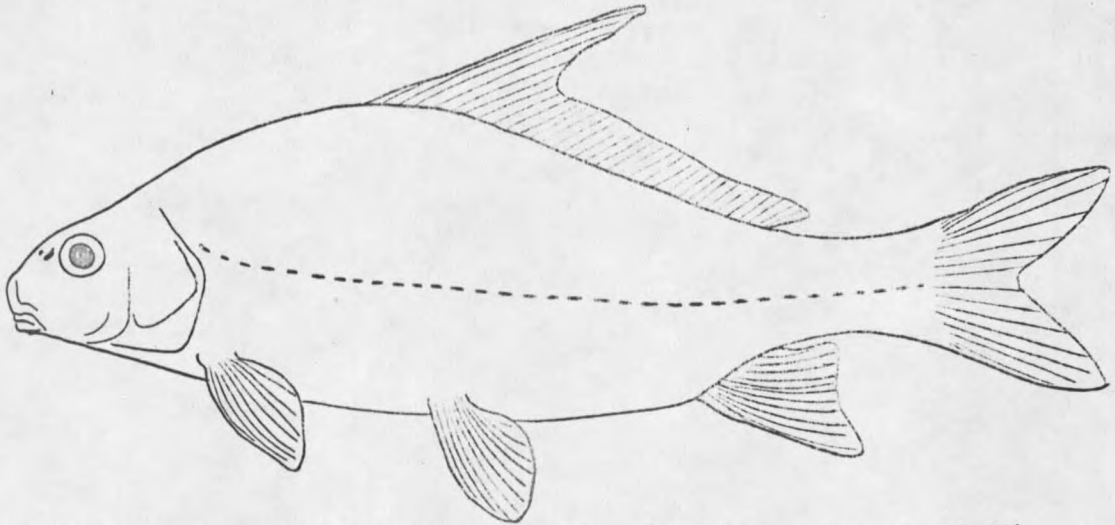


Shovelnose Sturgeon: Scaphirhynchus platyrhynchus (native, scrap fish)

1. Four rows of bony plates on sides of body and one row on back
2. Snout flat and shovel-shaped; barbels on bottom of snout
3. Upper fork of caudal fin much longer than lower fork

The shovelnose sturgeon is found in the Missouri River as far up as Great Falls.

Flesh of sturgeon is edible and the eggs are made into caviar; however, this fish is little utilized in Montana.

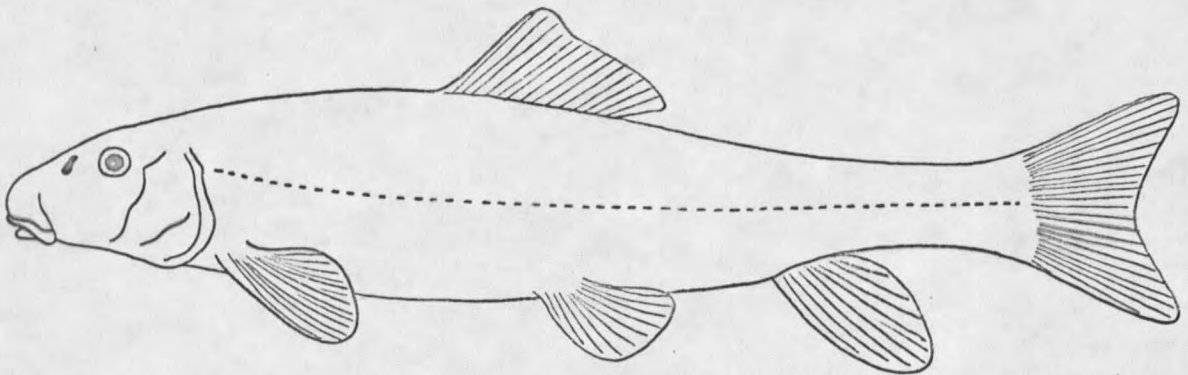


River Carpsucker: Carpiodes carpio (native, scrap fish)

1. Body color silvery or brassy
2. Head blunt; lips small and thin; front of dorsal fin elongated

The river carpsucker is found in the lower Missouri River and its tributaries.

This fish is of little value for either game or food.



White Sucker: Catostomus commersonnii (native, scrap fish)

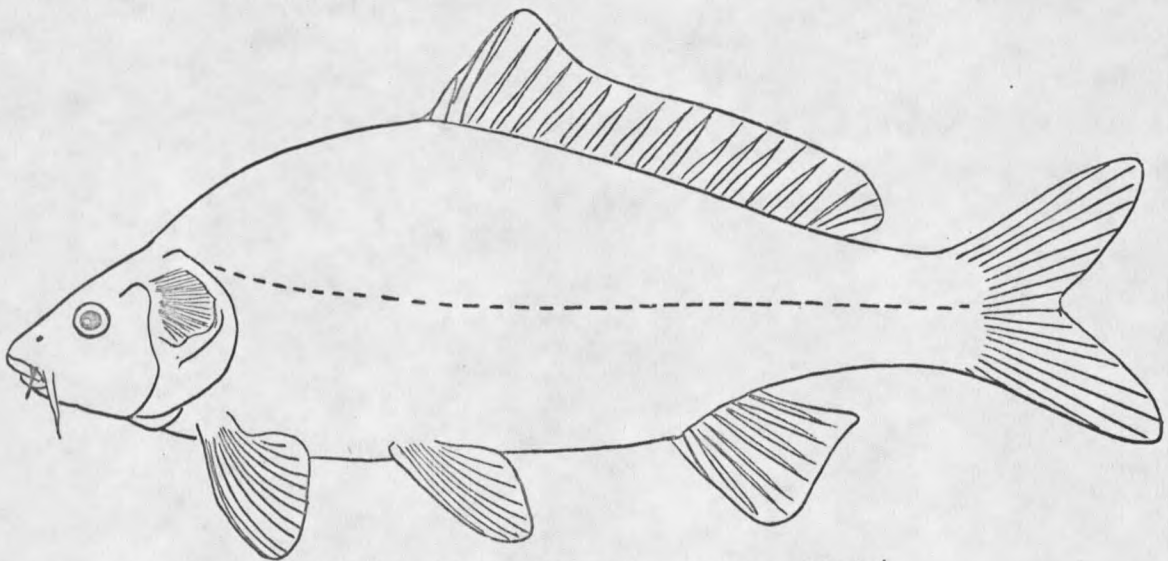
1. Body color greenish or blackish above; light below; males sometimes rosy on sides

2. Body rounded

3. Lips on bottom of snout fleshy and bumpy (papillate)

We have several kinds of suckers distributed throughout the state.

They are important as food in some parts of the country, but are considered a nuisance in Montana.



Carp: Cyprinus carpio (introduced, scrap fish)

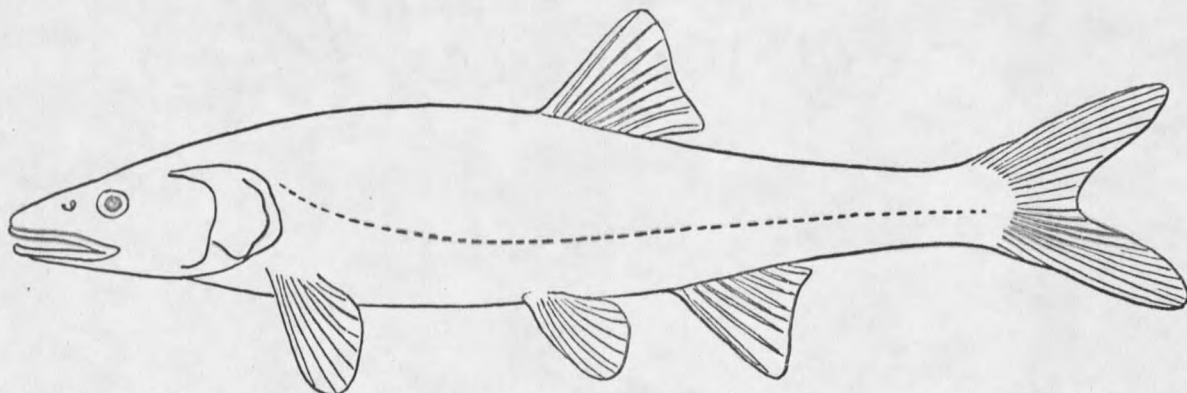
1. Body color greenish or bluish above; yellow below; scales large when present

2. Four barbels on upper jaw

3. Long dorsal fin; spine on front of dorsal fin

Many waters throughout Montana contain carp.

In some parts of the world, the carp is an important food and a source of protein and fertilizer. It is used as food for hatchery fish in our state, but is generally considered a nuisance. Sometimes, it grows quite large.

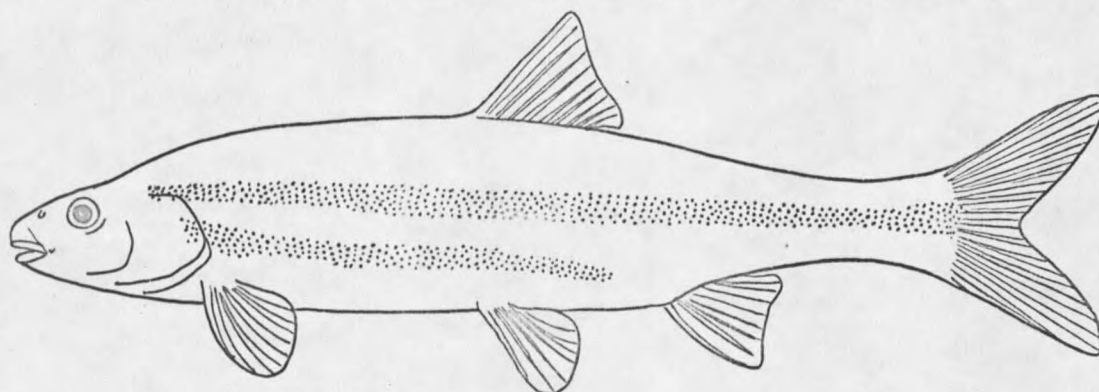


Squawfish: Ptychocheilus oregonensis (native, scrap fish)

1. Body color dull greenish above; sides silvery or dull yellow; underparts light or yellowish
2. Head long; mouth large
3. Lateral line curves far down in front

The squawfish is found west of the divide in cold streams, reservoirs, and lakes.

There are so many bones in this fish that it is seldom used as food. It is one of the largest minnows in the state.

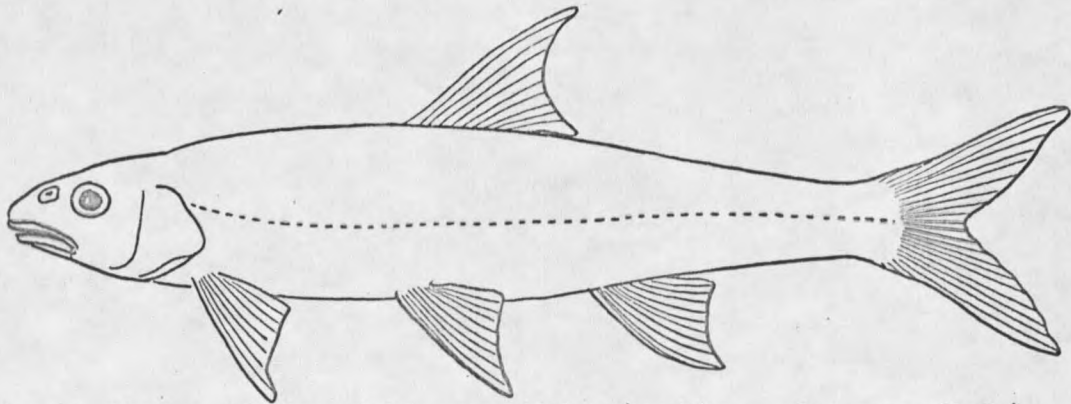


Columbia River Chub: Mylocheilus caurinus (native, scrap fish)

1. Body color dark olive above; silvery or yellowish-silver on sides; light underparts; males in breeding color quite red on sides and belly
2. Small barbel at each end of mouth
3. Dark band along lateral line, shorter dark band below lateral line

It is found in the Columbia River drainage.

This chub is occasionally used as food, but is of little importance except for its possible use as a forage fish.

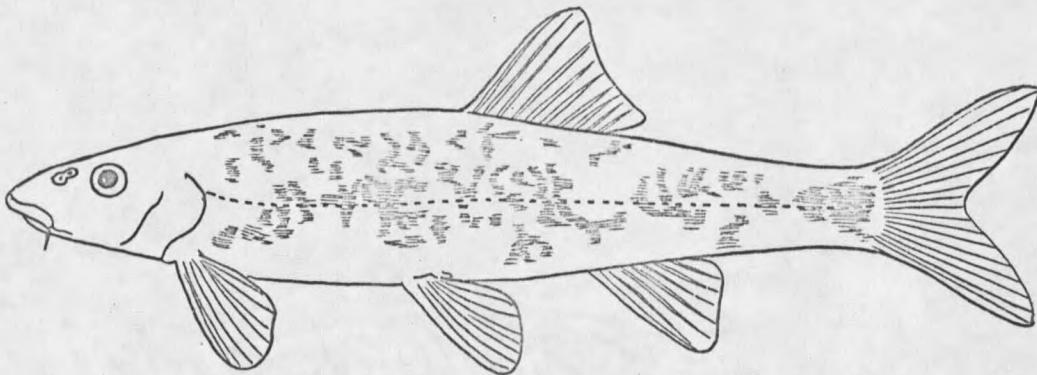


Flathead Chub: Platygobio gracilis (native, forage fish)

1. Body color light olive above; silvery on sides
2. Barbel at each corner of mouth
3. All fins pointed on outer edges

It lives in the muddier waters of eastern Montana and as far up as Three Forks in the Missouri River.

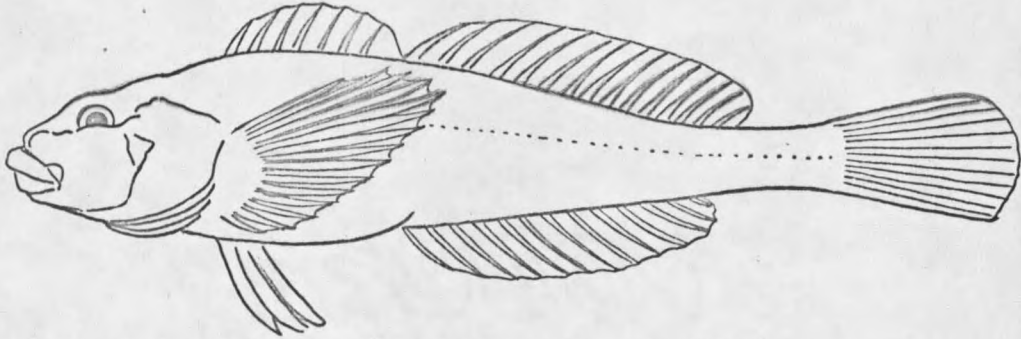
The flathead chub is an important forage fish for sauger, perch, etc.



Longnose Dace: Rhinichthys cataractae (native, forage fish)

1. Body color olive or brownish above, light underparts; blotched on sides
2. Snout pointed and overhangs mouth; small barbels on upper jaw

The longnose dace is distributed on both sides of the divide. It is a good bait minnow and provides forage for trout.



Sculpin: Cottus bairdii (native, forage fish)

1. Body tapering from head to tail; no scales
2. Head broad and flat; mouth broad; eyes placed wide apart and high in head
3. Caudal fin not forked

There are several kinds of sculpins distributed throughout Montana in cool streams.

These fish remain small and inhabit trout waters; therefore, they are good forage fish. They are often erroneously called bullheads.



The problem of predation is not as simple as it may appear, and there is a great deal of controversy about it. One view is that predators unnecessarily deplete fish populations and should be wiped out as completely as possible. Another view is that only the surplus, weak, and diseased fish are captured, and the presence of predators is desirable.

The most effective fish predators are other fish. Hatchery fish must be constantly sorted as to size and kept apart, otherwise, the smaller ones would soon be eaten by the larger ones. Of course, some fish are more predaceous than others. The dolly varden is possibly the most predaceous trout species in Montana. The important predators like pike, perch, crappie, and bass actually depend on other fish for their livelihood.

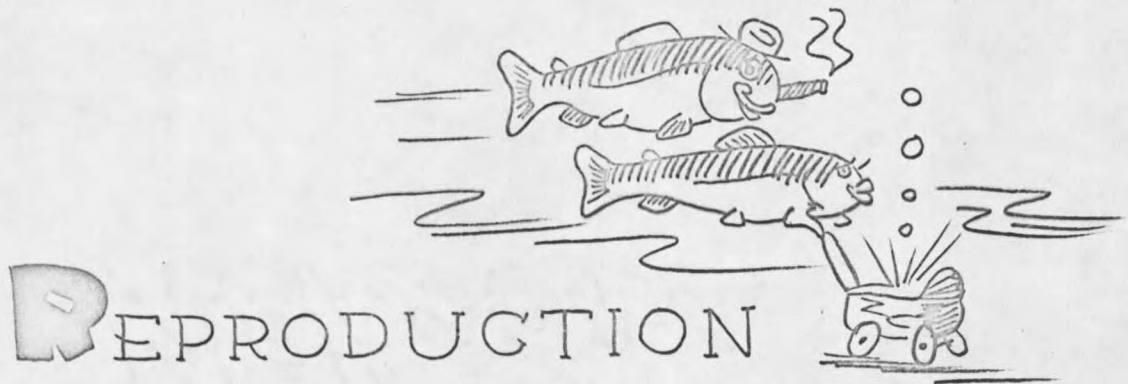
Certain birds are important predators of fish, but there

are few instances where such predation is a serious menace to fish. The most notable loss occurs when hatchery ponds are raided. White pelicans, mergansers, blue herons, and kingfishers are some of our more common fish-eating birds.

Among the mammals, mink and otter are probably the notable fish-eaters. These animals take whichever fish are most available and most easily caught; consequently, a large percentage of the fish they take are suckers, minnows, etc. Mink and otter are so few that the damage they do to game fish is probably not important.

Fish taken by snakes and turtles under natural conditions represent a very small loss. When small fish are concentrated the loss of fish to such animals may be considerable.

Just how serious is predation then? There is little question that predators may do a lot of damage to fish in hatchery ponds and such places where they are concentrated and accessible. However, predation has not been shown to cause appreciable damage under natural conditions. In fact, predators improve fishing in some cases. For example, large-mouth bass do well when feeding heavily on bluegills, and at the same time, the bluegills are kept down in numbers so that competition for food and space is not so great that they become stunted.

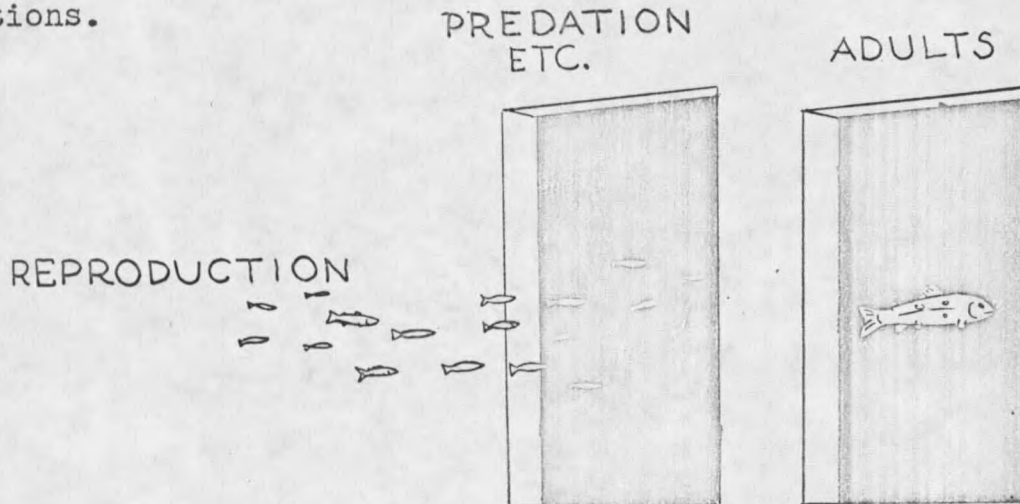


The spawning habits of fish and the development of the eggs and young are quite variable. Trout, excepting lake trout, construct crude nests by fanning out small pockets in the clean gravel of stream beds with their tails. After spawning, they show no further concern for the eggs. Water carries oxygen to the eggs, and yolk supplies the materials for body building. After a time, two black eyes appear in the fertile eggs. Upon hatching, the young fish seek shelter in shallow water, near rocks, in weed beds, etc. to keep from being swept away, and to escape being eaten by larger fish or other predators. The large-mouth bass protects its nest, and may even herd the young bass around for a while. When they



reach a certain size, the young are left to shift for themselves. In hatcheries, it is necessary to remove the parent bass when the young reach a certain size; otherwise, all the young are eaten.

If all the trout eggs that are produced each year were to hatch, and the young grow into adults, streams, lakes, reservoirs, and ponds would soon be completely filled with fish. It is estimated that a single four-pound rainbow trout produces about 3,000 eggs each year, a mountain whitefish 3,000 to 24,000, and a large burbot over one million. Many of the eggs never hatch, for some of them are infertile, others are washed from the gravel and eaten by fish, some may be smothered under silt, or may meet death through other natural causes. Under favorable conditions, the percentage of eggs hatching is high. Ninety-seven percent of brown trout eggs have been found to hatch under natural spawning conditions.



The fish that are hatched are subjected to predation, winterkill, and other hazards that may whittle their numbers down until those that reach maturity represent only a small fraction of the eggs deposited. The number of fish that do

survive is determined by conditions within the water itself. Young fish have a better chance for survival in underpopulated streams where there is unused fish food, space, and cover than they do in streams already filled to capacity. Each water does have a maximum capacity to produce fish. We do not expect to produce an unlimited number of cattle on a pasture, or thousands of bushels of grain on an acre field.

Hatcheries play an important part in fish management. They supply fish needed to stock newly constructed ponds and reservoirs, to replenish desired kinds where they are unable to spawn successfully, and to repopulate areas where some disaster has wiped out or seriously depleted the fish. In areas where fishing pressure is extremely heavy, legal sized

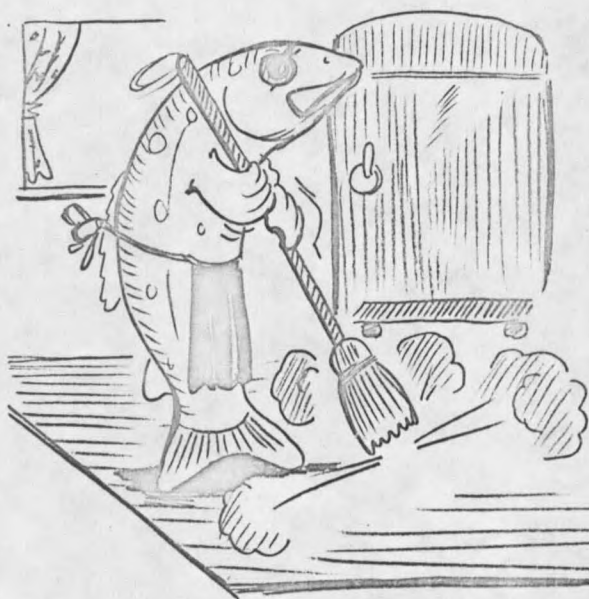


fish may be planted to advantage if the cost is not prohibitive. Such fishing pressure does not exist in most of Montana today. There may be a time, however, as the population increases, the planting of legal sized game fish will be a regular part of our fishery program.

Hatcheries can also serve for experimental purposes in developing new strains of fish, determining their nutritional requirements and resistance to disease, etc.

When fish hatcheries were first established, it was gen-

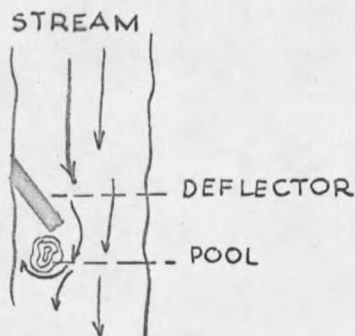
erally believed that more fish eggs would hatch under artificial conditions than could be hatched under natural conditions. But studies have shown this not to be the case. Streams and lakes once stocked with suitable fish rarely need additional plantings. Natural reproduction is adequate to supply all fish that can be supported in most instances. If waters are already stocked with all the fish they can support, what can be gained by adding more? Most of our waters are stocked to their ability to support by natural reproduction.



IMPROVING LIVING CONDITIONS

Attempts have been made to provide more favorable habitats for fish, and consequently increase fish production, by altering the physical and chemical conditions of lakes and streams. Physical improvements have been mostly concerned with increasing water depths in streams, with stopping ero-

sion of banks and shores, and with providing additional cover for fish in both streams and lakes. Chemical improvements have been largely concerned with fertilization.



Where streams are too shallow for good fish production, deflectors may be constructed to help increase the water depth in some places. These deflectors are wall-like structures, commonly made from natural materials such as boulders,

logs, etc. In order to preserve the natural appearance of streams and lakes, all physical improvements should be constructed from natural materials whenever possible. Deflectors are placed in the water at a downstream angle, thus deflecting the water and speeding up the current. This causes pools to be scoured from the stream beds. Such devices have met with some success, but wherever there is much ice and high spring runoff they must be built strongly and require maintenance.

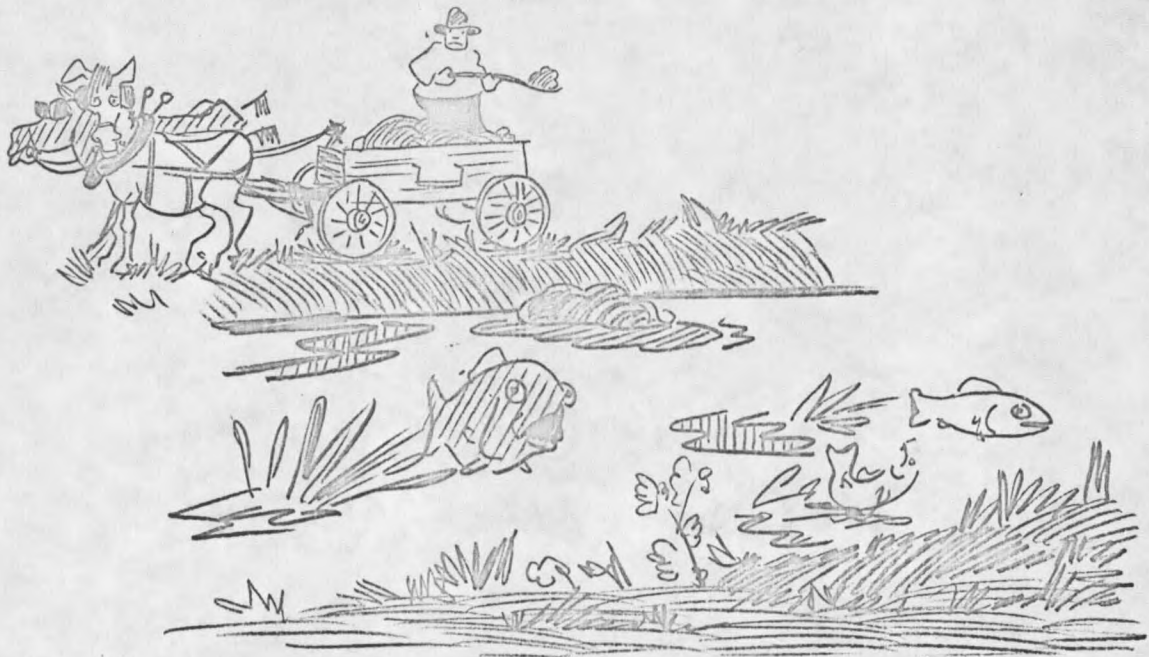
Erosion of stream banks, lake shores, and pond shores is often serious enough to keep water roily and interfere with fish production. One method for remedying erosion is to plant vegetation in the areas concerned. Where plants are unable to take root, the inclines may be terraced to slow down erosion so the vegetation may get a foothold. If there is no chance of establishing plants, rip-rapping will prevent excessive

erosion. If stock is present, fish ponds should be fenced to prevent trampling of the banks and roiling of the water.

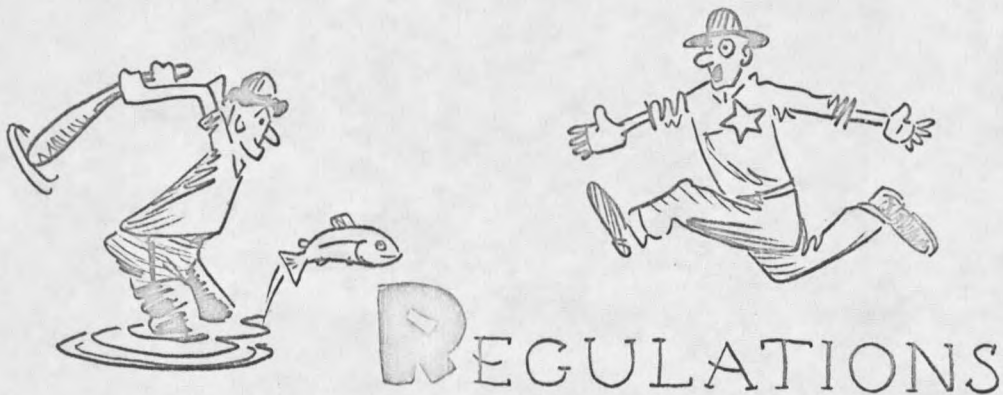


In places where sufficient fish cover is lacking, additional shelter may be provided by putting rocks, brush piles, etc. in the water. For

maximum production, the shelters should be distributed so they are near food-producing areas. If cover is already adequate, any further addition may be harmful, especially where warm-water fish are concerned. With extra hiding places, such fish may be so well protected from predation that they become overpopulated and stunted.



Fertilizing of water is one of the more widely used chemical improvements. This practice has been largely confined to ponds, for streams carry away added materials before they can take effect, and reservoirs and lakes are usually so large that the cost of fertilizers necessary to alter them can not be justified. Fertilizers, both organic and inorganic, have been added to water with the intention of speeding up the growth of minute plants, thus increasing the food supply for fish. In some cases, good results have been enjoyed from the use of fertilizers, but in other cases their use has backfired and done more harm than good. Too much fertilizer may cause excessive removal of dissolved oxygen from ponds, or may stimulate the growth of such large quantities of plants that the ponds become unsuitable for game fish.



Without regulations our game-fish resources would probably be short-lived. In pioneer days there were, of course, no fishing regulations, but as the population increased and transportation facilities improved, it became evident that

controls were necessary for the preservation of fishing. The first laws concerned seasons, size limits, and creel limits. Now, we have other laws controlling methods of taking fish, baits and fishing gear, closure of feeder streams, and fish harvest in artificial ponds and reservoirs. The transportation of fish from one water to another is also regulated. These laws are aimed to protect certain kinds of fish such as trout, chars, pike, salmon, bass, grayling, whitefish, etc. Those under such protection are called game fish. Fish like perch and bluegills are not protected, and thus not classed as game fish, even though they are good food fish. They reproduce so rapidly and are so seldom used that there is little danger of harming them by fishing.

Fishing is limited to certain seasons of the year in order to protect spawning fish. But season restrictions are not effective unless they are made to fit spawning conditions. Spawning is closely tied up with water temperature, and many fish in the higher elevations have not begun to deposit their eggs when those in the lower, warmer waters have finished. Regulations are often made to cover large areas for the convenience of enforcement rather than from the standpoint of management.

Size limits are designed to protect fish until they become large enough to spawn. But age, not size, determines when a fish will spawn, and under adverse conditions many

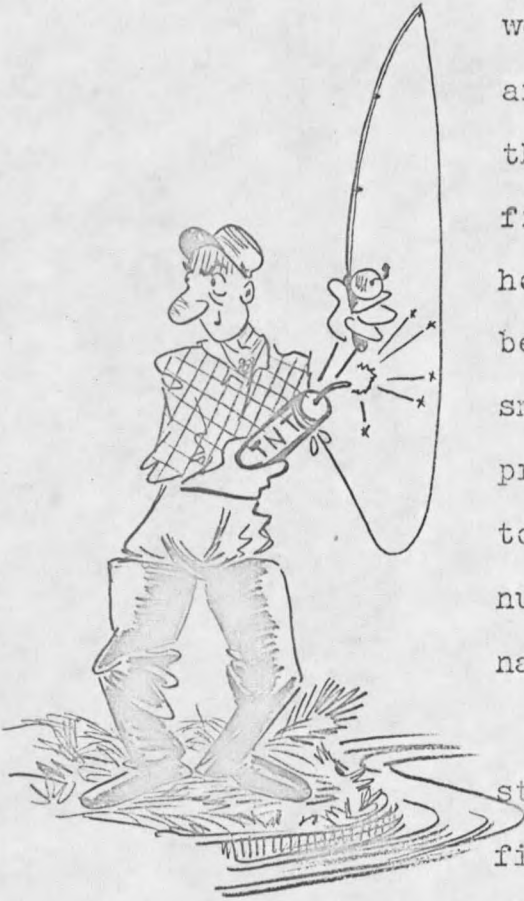
fish live their entire lives without growing more than a few inches long. In another sense, size restrictions may defeat their own purposes, for when only the larger fish are kept, fishing pressure is concentrated on the potential spawners.



Where fishing pressure is heavy, a limit on the number of fish that can be legally taken prevents depletion of fish populations and insures a more equitable distribution to the fishermen. The creel limit is so high in Montana, however, that comparatively few fishermen catch as many fish as

they are allowed, and so the limit has little effect on the fish population. Increased fishing pressure will necessitate a much reduced creel limit in order to prevent the depletion of trout species. Such regulations may never be necessary for bluegills, perch, crappie, etc.. These fish produce enough young to withstand almost any fishing pressure.

The method of taking fish has necessarily been limited, otherwise there would soon be few game fish. Not only methods, but also the materials used must be limited. For example, regulations against the use of most bait minnows prevents the distribution of undesired fish. Limitations against some baits may be unwarranted. Salmon eggs, for instance, have not been demonstrated to be more effective bait than



worms, grasshoppers, etc. It is argued that the eggs are of a size that can be swallowed by the smaller fish, thus they are injured when the hook is extracted, and they can not be returned to the water. But are small fish the ones we want most to protect? Or is it more economical to harvest the smaller fish whose numbers have not been so reduced by natural mortality?

Some streams or sections of streams have been entirely closed to fishing with the belief that more fish would be produced under protection and would move out into other areas and, thereby, improve fishing. Studies have shown that such feeder streams are of little value. One reason is that most fish do not move about as much as previously suspected, but instead remain in the protected streams where they can not be harvested.

A recently enacted state law requires that pond owners or operators apply to the State Fish and Game Warden for a pond operator's license. This license is issued free of charge. The department then designates what kinds of fish

can be planted. This is to prevent the planting of undesirable fish which may escape into drainages previously free of them. Pond operators or owners must also report to the State Fish and Game Warden the quantity of fish and spawn taken from their ponds, and must keep records of all transactions.

One law designed to prevent the sale of publicly owned fish prohibits the transportation of game fish out of the state without first obtaining a permit to do so.

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