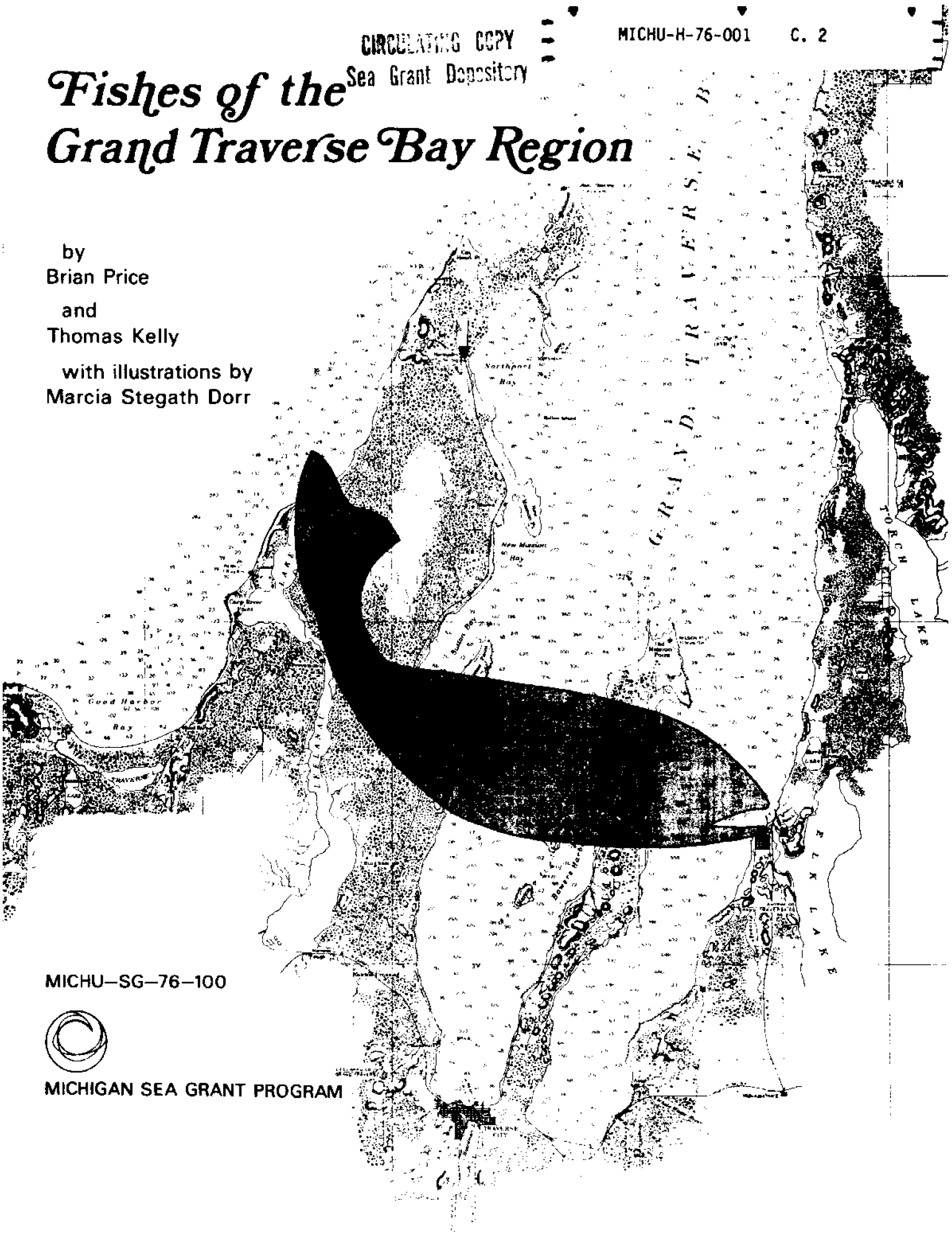
Fishes of the Grand Traverse Bay Region

by
Brian Price

and
Thomas Kelly

with illustrations by
Marcia Stegath Dorr



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MICHIGAN SEA GRANT PROGRAM

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MICHU-SG-76-100
March 1976

Michigan Sea Grant Program
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PREFACE

During the years 1970 to 1975, the Michigan Sea Grant Program was involved in a study of the circulation, chemistry and biology of Grand Traverse Bay, Lake Michigan. The purpose of the study was to determine the complex relationships among various components of the aquatic ecosystem and the effect of man's activities on the system. During the course of these investigations, scientists in the field became aware of the public's interest in their work, and in all aspects of the bay. It became apparent that there was a great need for information of a non-technical nature about Grand Traverse Bay designed to serve the public. This is an attempt to satisfy one aspect of this need.

In describing the fishes of this area, we have attempted to include material of interest to fishermen, amateur biologists, students, and teachers. Each species of fish is discussed according to its mode of reproduction, habitat preferences, present distribution, feeding habits, and role in the aquatic ecosystem. The volume of information about a particular species as presented in the text reflects the amount of previous scientific study on the species, its relative importance in the local fish fauna, public interest, and the biases of the authors. It is for these reasons that more material is presented, for example, on salmon and trout than on mudminnows and the anded killifish. A guide for identification is presented with each family group.

The geographical area covered by this book includes the waters of Grand Traverse Bay and its tributaries, including the Chain-O-Lakes system.

In researching material for the text we were dismayed to find very little information, published or otherwise, on past and present fish distribution in our area. Past collecting by universities and state agencies has been insufficient at best. Temporal and financial constraints prevented the authors from doing the extensive collecting necessary for detailed distribution maps of each species. For these reasons distribution and occurrence information as presented is a compilation of published accounts, notes on dile at local and regional Michigan Department of Natural Resources offices, collection notes at the University of Michigan Museum of Zoology, and personal interviews with other fishery biologists and commericial fishermen. We have attempted to be conservative in reporting the occurrence of species in our area, and have relied on credible sources of data (i.e. trained professional fishery workers) in our discussions of fish distribution.

ACKNOWLEDGMENTS

In preparation of this book, many individuals and organizations have offered their assistance and encouragement. We gratefully acknowledge: Dr. Gerald Smith, University of Michigan Museum of Zoology, Fish Division; Dr. Erwin Seibel, Cheryl Bozorgmanesh, and Steve Schneider, Michigan Sea Grant Program; Pat Garvin and Jackie Bannon, Regional Coastal Zone Laboratory; and Mel Bonham of the Michigan D.N.R. office in Traverse City.

We are particularly grateful to Myrl Keller of the Michigan D.N.R. Charlevoix Great Lakes Fisheries Station for sharing with us his extensive knowledge of fish distribution and the history of the fisheries in Grand Traverse Bay.

We would also like to thank Dr. Stanford Smith, National Marine Fisheries Service, and Dr. David Jude, University of Michigan Great Lakes Research Division, who reviewed the manuscript and offered many helpful suggestions.

GLACIAL GEOLOGY AND A HISTORY OF THE REGION'S FISH FAUNA

The lakes and streams that are enjoyed by so many people in the Grand Traverse Bay region have come to us as a legacy of the great continental glaciers that covered the land as recently as 11,000 years ago. Four times the massive ice sheets rode down over the land, carving the earth and leaving deposits that resulted in the hills, plains, and lake basins which we see today.

Enormous masses of ice move in a way that is almost fluid; they can be dammed up between walls of mountains or hills, can spill over sills, and race through valleys. Each time the ice sheet advanced, it was preceded by massive tongues or lobes of ice which spread through the ancient river valleys and lowlands. These tongues of ice acted as inverted conveyor belts picking up soil and rocks, carrying them to the place where ice was melting, and depositing them there. In these lowlands situated in the basins of the present day Great Lakes the ice came first, stayed longest, and did its greatest work carving out the basins of our deepest lakes. West Bay, East Bay, Elk Lake, and Torch Lake were carved by four fingerlike extensions from the main body of glacial ice which was seated in the Lake Michigan basin.

The retreat of the glacier was marked by many halts and readvances as the climate warmed slightly. Each time the glacier halted it deposited its accumulated load of debris. The gravelly debris formed moraines, long ridges along the glacier's front. Water from the melting glacier flowed away south of the moraines, forming the valleys of the present day Manistee and Boardman Rivers.

Other common features of our landscape date back to the time of the last retreating ice sheet. In some places large slabs of ice broke off from the glacier and were imbedded in or covered over by glacial debris. When these chunks of ice melted underground centuries later, large pits were left in the moraine, which filled with water to become "kettle lakes." These ovoid, relatively shallow lakes often occur in clusters such as the Arbutus-Spider-Rennie Lakes complex, and the Sand Lakes of Grand Traverse County.

In many places melt water was dammed up between the moraine and the glacial front, creating "ice-border lakes," whose levels were considerably higher than their contemporary equivalents. For several centuries glacial ice remained in the northern two-thirds of the Lake Michigan and Lake Huron basins. At this time a powerful river, draining the glacial precursors of Lakes Huron and Erie, flowed across northern Michigan. It skirted between the high moraine and the ice sheet which marked the boundaries of its flood plain, to a final discharge into the Mississippi River valley. This ancient river can be traced on present-day topographic maps. It passed through the south arm of Lake Charlevoix; up the Jordan River valley; across what is now a swampy watershed between the Jordan and Intermediate Rivers; through the valley of the Chain-O-Lakes; into the basins of Bellaire, Torch, and Elk Lakes; and finally into the south end of Grand Traverse Bay. When the glaciers retreated further north a new route of discharge through the Straits of Mackinac was uncovered. The glacial river which had previously transported tremendous amounts of meltwater across northern lower Michigan was diverted, leaving some water in the low areas along its former route, the present-day Chain-O-Lakes.

By painstaking examination of surface features, such as the beach ridges and river channels left by the moving waters, geologists have been able to trace the subsequent history of the upper Great Lakes. Since the retreat of the last glacier about 10,000 years ago, a succession of lakes occupied the basins of the Great Lakes. The levels of these post-glacial lakes were controlled by the location and level of their outlet rivers, which in turn were controlled by erosion and post-glacial rebound (the uplift of the earth's surface after the weight of the glacier was removed). At various times the Lake Michigan basin drained to the south into the Mississippi River by way of the Des Plaines River, or to the east through the Straits of Mackinac, depending on the position of ice blocks and the relative levels of the outlet rivers.

In the Grand Traverse Bay area two of the post-glacial lakes have left evidence in the form of wave-cut terraces and beach lines. The beach of the Algonquin lake stage lies at 619 feet above sea level and the Nipissing lake beach lies at 605 feet (Dorr and Eschman 1970). The average level of present day Lake Michigan is 579 feet above sea level (Lake Survey Center 1974).

During the glacial period all living organisms formerly occupying the Great Lakes region were pushed southward in front of the advancing ice sheet. When the glacial ice retreated northward, these plants and animals moved north to occupy the barren land. Sedges, grasses, and tundra-like vegetation grew up near the receding ice, soon followed by spruces, willows, birches, alders, and finally by the mix of conifer and deciduous species we find today. Land mammals such as the mastodon, moose, musk-ox, and caribou came to browse on the revegetated land.

Even as terrestrial plants and animals reinvaded the land, fish and other aquatic organisms used the river connections to regain access to the vast expanses of fresh water left in the wake of the glaciers. From un-

glaciated refuge areas to the northwest came lake trout, whitefish, ciscoes, trout-perch, and sculpins. The southern Mississippi River basin supplied gars, bowfins, suckers, shiners, and minnows. From both the east and west came pike, perch, darters, dace, and members of the sunfish family. These fish were accompanied by the smaller organisms and plants which produce the food and habitat conditions in which fish thrive. Algae and rooted aquatic plants spread into the area, and where they found conditions suitable became established. Small crustaceans, aquatic insects, and molluscs also reinvaded. In this way aquatic communities developed in response to the physical conditions of the water bodies left by the glaciers.

The relatively shallow kettle lakes and the lakes of the upper Chain-O-Lakes developed a characteristic warmwater assemblage of aquatic organisms. These lakes are shallow enough for sunlight to penetrate to the bottom over much of their area. Under such conditions rooted aquatic plants thrive, incorporating the minerals present in the water and the energy of the sun to form their tissues. When they die and decay, plants produce a rich muck, as well as a thriving community of organisms which live off the decaying plant fibers. In such shallow lakes and sluggish rivers, animal species able to survive the warm summer water tempperatures and utilize the abundant food resources thrive in great numbers. This environment produces a characteristic community of warmwater algae, invertebrate animals, and the common kinds of warmwater fish, especially members of the perch, pike, and sunfish families.

The deeper bodies of water such as Grand Traverse Bay, Torch Lake, and Elk Lake produce physical conditions very different from those found in the shallow lakes, and harbor a very different community of aquatic organisms. Deep lakes contain a volume of water too large to be thoroughly heated during the summer months. While near-surface water may be heated to 70°F (21.1°C) or more, the deeper parts of these lakes seldom exceed a temperature of 40°F (4.44°C). Light penetrates to the bottom only near the shore, so most parts are devoid of rooted vegetation.

The deep recesses of these lakes contain organisms that are intolerant of warm water. This group is composed of sculpins, whitefish, lake herring, chubs, and the bottom-dwelling crustaceans on which they most often feed, the oppossum shrimp *Mysis relicta* and the scud *Pontoporeia affinis*. Also present are suckers and sturgeon. Characteristic deepwater predators include the lake trout and burbot. In former times they preyed largely on the small species of ciscoes and sculpins. Shallow inshore areas of such deep lakes may harbor the characteristic warmwater assemblage of fish and plants.

Spring-fed streams and rivers in the Grand Traverse Bay area were formerly dominated by the indigenous stream salmonids, the brook trout and grayling. They fed largely on stream-dwelling aquatic insects. Both of these fish were found only in cold, clean, rushing waters. Such streams also held sizable populations of sculpins, dace, and creek chubs, as well as seasonal spawning migrations of suckers and sturgeon.

The present drainage system was established with the closing of the last permanent outlet to the Mississippi River valley some 2,500 years ago (Dorr and Eschman 1970). This effectively isolated the Great Lakes watershed from other river drainage systems and also from the ocean, as any aquatic organisms migrating upstream would find Niagara Falls to be an insurmountable barrier. Thus all of the native species were on hand some 2,000 years ago, and any new aspirants were denied entry.

Native people had also followed very closely behind the final retreat of glacial ice. Indian artifacts found near Skegemog Point have been dated at around 9,000 B.C. (Cleland 1966). These people occupied the area during periods of warm weather, retreating southward when climatic fluctuations caused extended periods of cold weather. Many Indian villages were located near major bodies of water, as access to fish resources was an important criterion in early settlements. Fish bones and scales are often found at such sites. These early inhabitants of the region speared sturgeon and muskellunge when the fish made annual spawning migrations in the springtime. In the fall they took the whitefish that moved into shallower water to spawn.

With the coming of white settlers in the 1840's, major changes began to take place in lakes and streams of the area. The early lumber industry was responsible for a great deal of destruction to fish habitat. Logging operations destroyed the massive white pine forests which caused greater runoff from the land, siltation of streams, and warming of stream water. The huge rafts of logs floating down the rivers gouged the gravel beds used as spawning sites by fish. A combination of stream habitat destruction and overfishing caused the eventual extinction in Michigan of the beautiful but frail grayling.

Sawmills were constructed, and dams at these sites also had a major impact on the fish fauna. Kid's Creek in Traverse City was dammed by Horace Boardman in 1847. By 1851 the first sawmill and dam was established at Elk Rapids. These dams blocked the upstream migration of fish, especially spawning runs of sturgeon, whitefish, suckers, and lake trout, resulting in a great reduction of some fish stocks.

Dams sometimes caused major changes in the upstream watershed also. For instance, the dam at Elk Rapids raised the level of Elk Lake about 8 feet, connecting what had formerly been two separate lakes, Elk Lake and Round Lake (now called Skegemog Lake).

Early white men who fished the lakes also contributed to changes in fish stocks of the area. Most of these early fishermen used seines or fished from small boats with gill nets, selling their catch to local settlers for their winter provisions, as poor transportation facilities denied access to large city markets. By the 1880's, improvements in transportation and in fishing techniques brought about an upsurge in local fishing activity. Pound nets, which were not used in the early fishery, came into general use. They were a very efficient method of catching whitefish, and an early historian of the Grand Traverse region, Dr. D. M. Leach (1883), wrote "After they came into general use there was a sensible and rapid diminution in the quantity of fish."

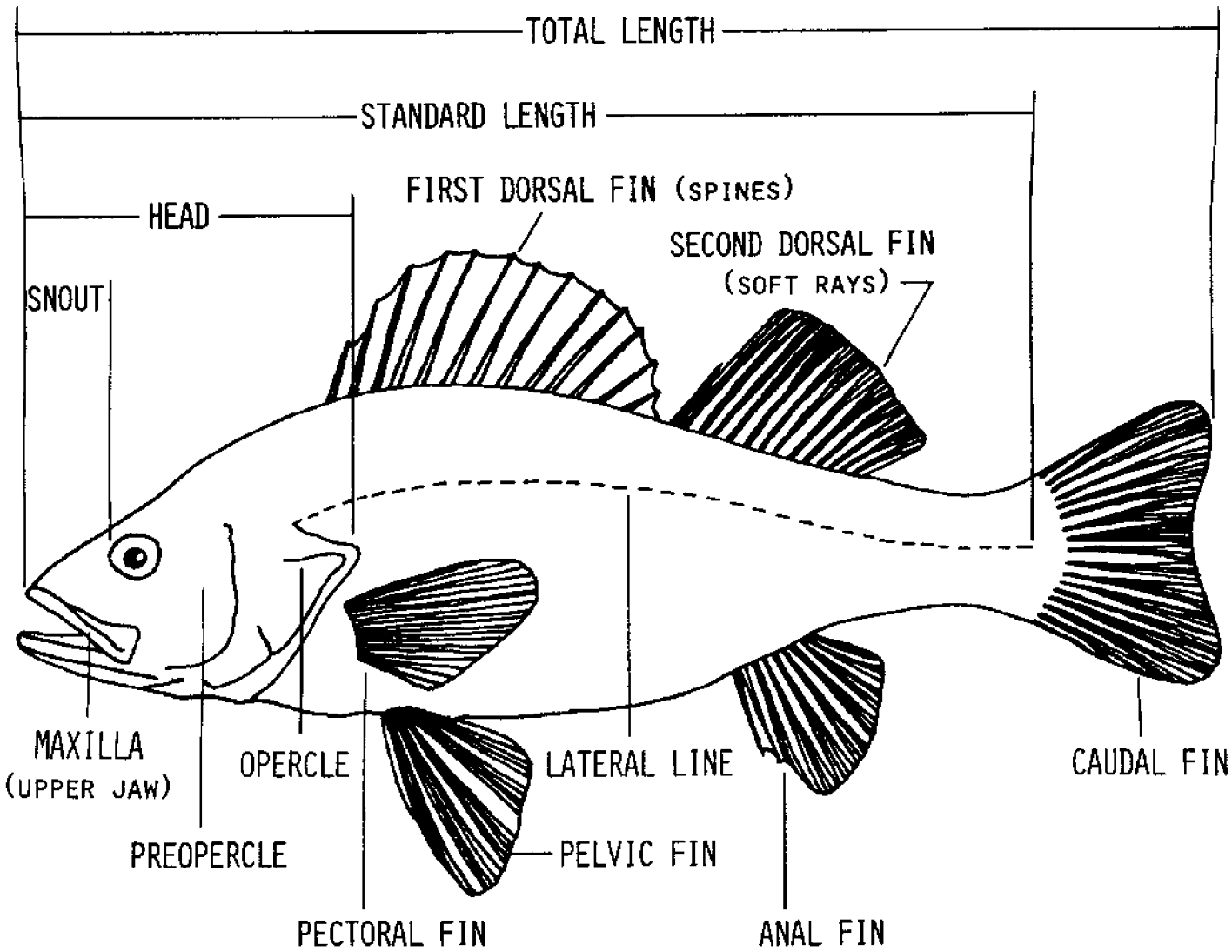
The 1870's saw the rise of early fish cultural work. This was a period of bounding optimism among early proponents of hatcheries. It was felt that almost any fish could be planted and thrive nearly anywhere. Already State Fish Commission workers were experimenting with the introduction of non-native salmonids, particularly the "California salmon" (primarily chinook salmon), steelhead and brown trout. Hatchery men were certain they could not only save but actually extend the range of the highly esteemed but already failing grayling (Michigan State Board of Fish Commissioners 1879). Carp were introduced during the latter part of the 19th century and smelt were introduced in 1912.

Despite the decline of some fish stocks and the introduction of others, the early part of the 20th century was a relatively stable period in Lake Michigan fisheries. Lake trout, whitefish, lake herring, chubs, and sucker yields remained fairly steady in Grand Traverse Bay until the advent of a completely unanticipated new threat in the late 1930's. The opening of the Welland Canal around Niagara Falls in 1829 gave access to the upper Great Lakes not only to ocean-going freighters, but also to a pair of destructive new marine invaders. The sea lamprey caused a collapse of the ailing lake trout fishery, and the alewife in the absence of large predators to keep them in check underwent an explosive population growth in the 1960's that raised their population to unbelievable numbers. The dams along the Boardman and at Elk Rapids were now a blessing, as they blocked the invasion of these pests into the upstream waters. Another change in the fish fauna occurred in the late 1960's with the second introduction of the Pacific salmon to the Great Lakes. The introductions of salmon in the late 1800's to establish self-sustaining populations failed. The recent hatchery-supported introduction of coho and chinook salmon now provide a major sport fishery in our area.

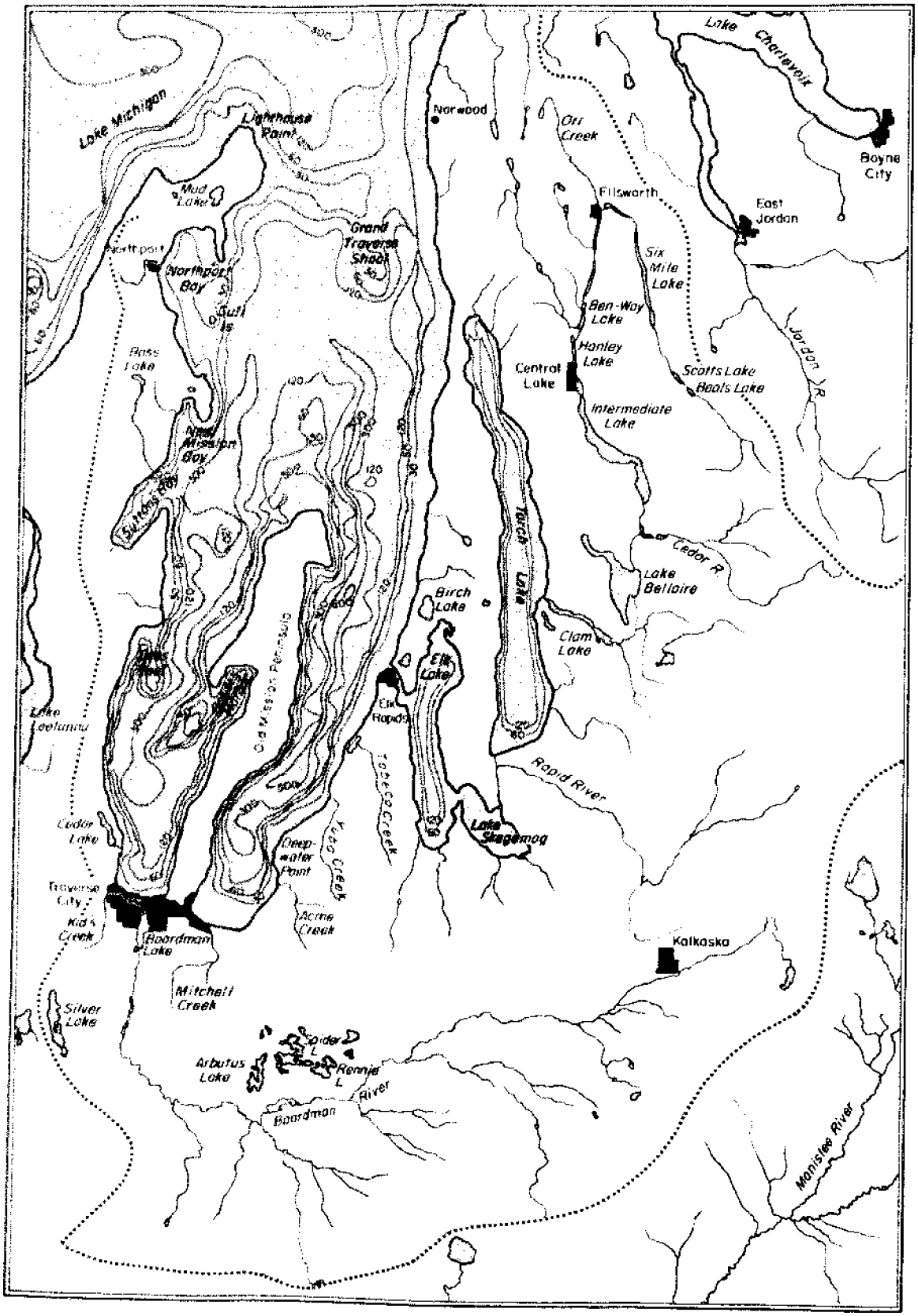
The 1960's also saw the culmination of the protracted struggle between commercial and sports fishing interests for the right to harvest the fishery resources of the bay. Commercial fishing, formerly restricted to areas north of the 45th parallel, was altogether banned in Grand Traverse Bay in 1968.

The future of our fisheries is somewhat uncertain. Ecologists feel that Lake Michigan's fish community is still undergoing great changes and we can expect to see some species decline in abundance while others may increase. The possibility of unseen pollution due to organic chemicals, especially pesticides, also remains a threat. Our future use and enjoyment of the fishery depends on our understanding and careful stewardship of this resource.

EXTERNAL FEATURES OF A SPINY-RAYED FISH



MAP OF THE GRAND TRAVERSE BAY WATERSHED



The Fishes of the Region

Sea Lamprey

Lamprey Family (Petromyzontidae)

Lampreys are among the most primitive of all known vertebrates, and after following their own evolutionary path for 400-500 million years, are now only distantly related to the "true fishes."

Unlike all other vertebrates, lampreys possess a circular sucking mouth rather than jaws. All lampreys are eel-shaped, lacking both scales and paired fins. The skeleton is composed of cartilage, and has no bones. Lampreys also possess a unique breathing mechanism comprised of 7 gill chambers with 7 separate openings on each side. Water entering through the mouth can be passed over the gills (as with most fish) or it can be pumped in and out through the gill openings, a convenient feature when the lamprey is using its mouth for feeding on a host fish.

Michigan has 5 different species of lampreys, and 3 of these have been found in the Grand Traverse Bay watershed. The American brook lamprey *(Lampetra lamottei)* is a nonparasitic animal which never leaves its natal stream. The chestnut lamprey *(Icthyomyzon castaneus)* is a parasitic stream-dwelling form. The non-native sea lamprey *(Petromyzon marinus)* is parasitic, and spends its adult life in the open waters of the Great Lakes where it has done great damage to the fisheries.

Spawning of all 3 common lampreys usually occurs in June or July with the eggs hatching several weeks later. Nests are built in areas with moderate current and a bottom composed of sand, gravel, or rubble. Small stones are carried away in the sucking mouth, while lighter material is cleared from the nest site by thrashing movements of the body. Sea lampreys sometimes move 25 pounds of material in the excavation of a nest (Scott and Crossman 1973).

The young lampreys are a larval form known as ammocetes, which drift downstream after hatching to backwater areas of silty sand or mud. They burrow down, tail first, and spend the rest of their ammocete lives filter-feeding on small organisms from the stream water.

Brook lampreys have a 5 or 6 year life span, nearly all of which is spent in the filter-feeding larval form. Upon reaching the adult stage, the digestive tract atrophies, and the brook lamprey lives without feeding until the following spring, when it spawns and dies. Brook lampreys are the most common lamprey species in our area.

The parasitic lampreys have a very different life history. Sea lamprey ammocetes grow steadily in their U-shaped burrows, reaching about 6 inches in length by late summer, after a larval life that ranges from 3 to more than 15 years. Chestnut lampreys grow to a length of 4 inches in 5 to 7 years. Both lampreys then complete the transformation into parasitic adults with the oral hood becoming a circular sucking disc replete with rows of sharp rasping teeth.

Chestnut lampreys spend their 18 month adult life as parasitic stream-dwellers. They do not migrate to lakes, but attack a wide range of stream fishes. Chestnut lampreys do relatively little damage because they seldom kill the fish they parasitize, and because they are never abundant. They have only recently been discovered in the Elk and Boardman Rivers, and in Cedar Creek.

Sea lampreys, however, have done tremendous damage to economically important fish species. Most sea lampreys migrate to the open lake during the spring following their transformation to the adult stage. They spend 12-20 months in the lake as parasitic adults before ascending streams to spawn and die. It is estimated that the average sea lamprey destroys about 20 pounds of fish during the parasitic period (Parker and Lennon 1956). Attaching itself to a fish of suitable size by mouth suction, the lamprey uses the circular rows of teeth along its tongue to rasp a hole in the side of the host. A solution from the lamprey's mouth called lamphredin is injected into the wound and acts to break down the muscle tissue and prevent coagulation of the host's blood. Attachment by sea lamprey often results in the death of the host fish, due to weakening from loss of blood and body fluids, or by infection of the open wound.

Sea lampreys gained access to the upper Great Lakes by way of the Welland Canal around Niagara Falls. With no natural enemies in the lakes, many suitable spawning streams, and an abundance of large fish to parasitize, the sea lamprey spread rapidly throughout the lakes. First recorded in Lake Erie in 1921, they had reached Lake Michigan by 1936. The destructive effect of this invader has since become legend. Largely due to sea lamprey predation, the commercial catch of lake trout in Lake Michigan fell from 6.5 million pounds in 1944 to less than 1,000 pounds in 1953 (Parker and Lennon 1956).

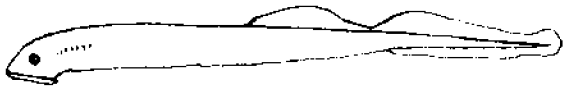
Efforts to control Great Lakes lamprey parasitism

led first to the production of mechanical weirs and electric barriers to block the upstream migration of spawning lampreys, and eventually to the development of chemical lampricides which poison lamprey ammocetes in their burrows. Under contract with the Great Lakes Fishery Commission, the U.S. Fish and Wildlife Service checks streams for lamprey ammocetes, poisoning the stream if significant numbers are found. These control measures have cut Great Lakes lamprey numbers by over 90 percent (Baldwin and Saalfeld 1962), yet lamprey-scarred lake trout are still found in Lake Michigan. Elk River, Mitchell Creek, and Kid's Creek have held considerable sea lamprey populations in the past.

Identification of Lampreys

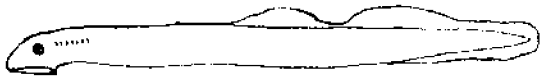
Sea Lamprey *(Petromyzon marinus)*

Dorsal fin composed of two separate lobes joined by a low connection; round mouth with teeth radiating outward in circular rows. Larvae have rounded tail fins with pigmentation extending to the edge of the rays.



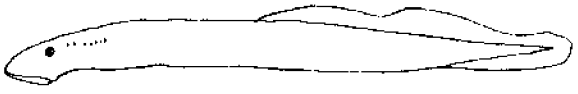
Brook Lamprey *(Lampetra lamottei)*

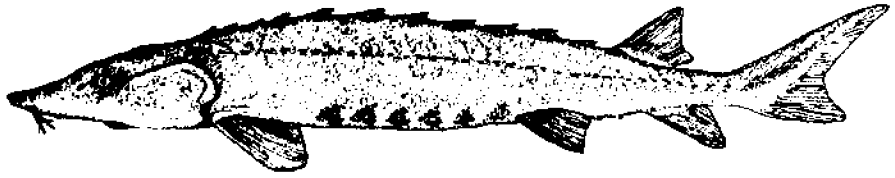
Dorsal fin composed of two separate lobes joined by a low connection; round mouth with teeth not radiating in series, but in several groups. Larvae have bluntly pointed tail fins with pigmentation only near base of fin.



Chestnut Lamprey *(Icthyomyzon castaneus)*

Dorsal fin single but notched.





Sturgeon Family (Acipenseridae)

Lake Sturgeon *(Acipenser fulvescens)*

Lake sturgeon are hold-overs from an earlier age in fish evolution, living virtually unchanged in fresh waters for 100 million years. Often referred to as "living fossils," these fish have a cartilaginous skeleton, shark-like (heterocercal) tail, cellular swim bladder, bony "armor plates" instead of scales, and a ventral sucking mouth.

Lake sturgeon browse over the highly productive shoal areas of larger lakes employing the ventral mouth to suck up such edible morsels as aquatic insect larvae, crayfish, molluscs, and small fish. Inedible materials pass out under the gill covers or are cast out of the mouth. Although they consume huge quantities of these small organisms, lake sturgeon are an extremely slow-growing species. They may weigh only 2 pounds by the fifth year, and do not mature sexually until 20 years of age. Under favorable conditions a sturgeon may live for 50-80 years.

Adult sturgeon spawn every 3 to 6 years. Large spawning runs were common in the Great Lakes tributary streams before settlement of European immigrants, and sturgeon was a major source of food for some Indian settlements. These spawning runs were eliminated by the construction of dams and loss of spawning habitat due to logging.

Sturgeon can also spawn on the wave swept shoals of large lakes. Each female sturgeon carries between 100,000 and 1,000,000 eggs, which hatch in 5 to 10 days. By 2 weeks of age the young sturgeon are miniatures of the adult, having reached 1 inch in length.

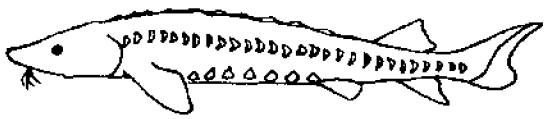
Before 1870 sturgeon were so abundant in Great Lakes waters that they did considerable damage to commercial fishing gear designed to catch other fish. Viewed primarily as a nuisance, they were fed to hogs, or stacked on the beach and burned. By the late 1800's white men began to realize the value of these giant fish. The flesh was good to eat, fresh or smoked. Eggs were sold for caviar, a gelatin extracted from the swim bladder was used to make isinglass (from the Dutch word huysenblasse, or sturgeon-bladder), and the skins were tanned for leather (Scott and Crossman 1973). Commercial fishing for sturgeon became quite lucrative, although the catch could not be sustained on such a slow-growing species with much of its former spawning areas destroyed. Initial large catches dropped to virtually nothing in just a few years over the entire Great Lakes.

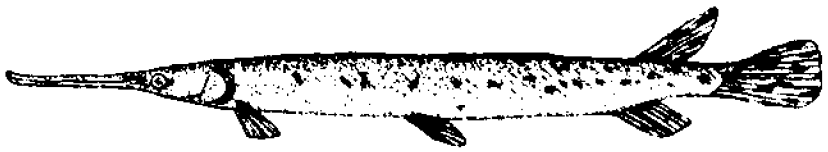
Today sturgeon are seldom seen in the Grand Traverse Bay watershed although they were formerly common in Torch and Elk Lakes, as well as in the bay. Ice fishermen and spearers are occasionally startled by a shadowy form that looks like a slow-moving torpedo against the bottom of one of the larger lakes, but the experience is becoming increasingly rare.

Identification of Sturgeon

Lake Sturgeon *(Acipenser fulvescens)*

Upper lobe of tail fin much larger than lower lobe; mouth directed downward and well behind snout; 5 rows of bony plates running the length of body; 4 barbels under snout.





Gar Family (Lepisosteidae)

Longnose Gar *(Lepisosteus osseus)*

The gars are another group of primitive freshwater fish represented in our area by only 1 species. Like the sturgeon they possess unique anatomical features which immediately set them apart from our other native fishes. Gars have long cylindrical bodies and very long jaws studded with sharp teeth. An armor plating of large bony (ganoid) scales covers the body and the tail is asymmetrical as in several orders of primitive fishes (sharks, sturgeons). The gas bladder of gars is connected by an open passage to the throat, allowing them to breath air at the surface. Gars obtain oxygen both through the gills and by gulping surface air. Gars have been known to drown when trapped in underwater nets and unable to reach the surface.

Gars spawn in late spring over the weedy margins of lakes or streams. The young grow very rapidly throughout the summer months, putting on nearly an inch a week in body length. Even small gars are piscivorous. They wait quietly in the cover of vegetation, impaling prey fish with a sideways swing of their long tooth-studded beak.

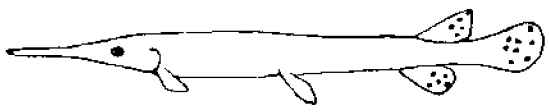
Gars are generally considered to be a noxious fish because they feed heavily on desirable game and forage fish, and because they are rarely eaten by man. Even their eggs are poisonous to mammals and birds. In waters where they occur together, gars may be serious competitors with the more valuable northern pike. Despite the fact that gars and pikes are not closely related, they have an uncanny resemblance in body shape, spawning requirements and feeding habits, both having evolved to occupy a similar ecological niche. Gars are a particular nuisance to anglers, because they will take a bait minnow as would a northern pike, but their long bony snout makes them nearly impossible to hook. To catch these bait thieves the offended anglers often rig minnows inside a wire loop, snaring the gar when he strikes the bait.

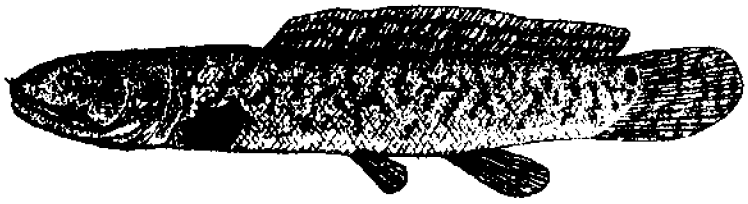
Gars are not found in the deep cold waters of the Great Lakes, but prefer the warm, quiet back waters of inland lakes and rivers. There a gar will rest among the submerged vegetation, waiting for his minnow meal to swim into reach.

Identification of Gar

Longnose Gar *(Lepisosteus osseus)*

Long narrow beak; dorsal fin small and set far back; large bony scales.





Bowfin Family (Amiidae)

Bowfin *(Amia calva)*

Bowfins, commonly called dogfish, are large predators of warm lakes and rivers. They represent the only living species of a group of fish which lived in Europe and North America millions of years ago. Like the gars, bowfins possess the ability to respirate through the swim bladder by gulping air at the surface. This ability gives the bowfin a distinct advantage over other fish in stagnant, swampy, deoxygenated water, and under such conditions they may be the only large predator present.

Highly predacious, bowfins consume large amounts of perch, sunfish, bass, minnows, crayfish, and frogs. Because of this fondness for game fish, bowfins are considered a nuisance if they are found in great numbers.

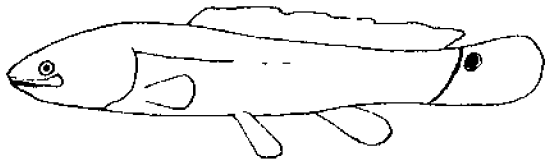
Spawning takes place in the spring, when the water reaches 61-66°F (16.1-18.9°C). The male bowfin builds a circular nest by clearing away aquatic vegetation in shallow water. Eggs are deposited on the bared roots of plants and the nest is then guarded by the male. After hatching the fry remain in the nest, attended by the male until they have grown large enough to fend for themselves.

The Grand Traverse Bay area lies near the northern edge of the bowfin's natural range, as the colder waters of the north are an unfavorable habitat for this fish. They are occasionally taken by a surprised angler in nearby inland lakes, but are apparently not present anywhere in the Chain-O-Lakes or Boardman River valley, and are probably very scarce in Grand Traverse Bay.

Identification of Bowfin

Bowfin *(Amia calva)*

Single long dorsal fin; rounded caudal fin; mouth lined with sharp teeth; males have eye spot on caudal fin.



Salmon family (Salmonidae), subfamily Salmoninae

The salmonid fishes are widely distributed over the northern hemisphere and can be distinguished from other families of fish by their fine scales and rayless adipose fin. Included in the family are migratory forms which spawn in fresh water streams but spend the greatest part of their lives in a larger body of water (anadromous fishes), as well as nonmigratory forms which generally stay in their natal stream or lake. Several species, including the brown trout, rainbow trout, and brook trout, contain both migratory and nonmigratory populations in our area.

The subfamily Salmoninae contains fish of three genera, the Pacific salmon, the true trout, and the chars. Pacific salmon (genus *Onchorynchus*) are strictly anadromous fish except for the land-locked Kokanee. Young salmon invariably head for the ocean or lake soon after smolting and return 2 to 7 years later to spawn. Before reentering the spawning streams these fish undergo tremendous physiological changes associated with the ripening of sexual organs and, in their native marine environment, adjustment to the freshwater of spawning streams. Male Pacific salmon grow much darker than females and develop a hooked jaw or kype. Pacific salmon die soon after spawning.

The true trout (genus *Salmo*) is represented in our area by the brown trout, rainbow trout, and Atlantic salmon. The steelhead is the migratory or anadromous form of the rainbow trout. These fish include both migratory and nonmigratory races and species, and they may show a tremendous variability in appearance dependent upon environment. In general all the lake-run (anadromous) fish of the true trout group appear to be strikingly similar, and they can be difficult to tell apart. Atlantic salmon and migratory brown and rainbow trout are large silvery fish with dark spots on their sides. They also exhibit darker colors when they reenter streams to spawn, and male fish, especially the Atlantic salmon, show changes in body shape. Unlike Pacific salmon, members of the trout group do not necessarily die after spawning. Streams in the Grand Traverse Bay region also contain resident brown trout and smaller numbers of rainbows which never migrate to the lake. These fish remain smaller and darker than the lake-run trout.

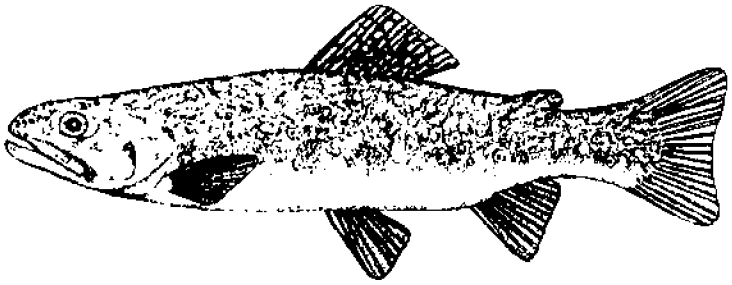
The char group (genus *Salvelinus*) contains our only native salmonids, the brook trout and lake trout. These "chars" have white borders along the fore-edges of their pectoral, pelvic, and anal fins, as well as dark blotches which look like worm tracings on their backs. Chars do not show the massive physiological changes usually associated with spawning run salmon. They commonly spawn in lakes and may spawn many times before dying. Chars are more restricted to colder water than the salmon or trout.

The salmon, trout and char are very similar in their spawning habits. In our region most salmonids (except rainbow-steelhead) spawn in the fall or early winter. Ripe fish may travel some distance upstream to find a suitable spawning place. The chosen spot must satisfy a number of conditions. The bottom must be of gravel with a steady current of clean, cold water to circulate over the eggs. Upon selection of a proper site the female fish will excavate a narrow depression in the gravel, called a redd, by lying on her side and vigorously beating her tail. During spawning the male lies alongside the female while eggs and milt are released into the redd. The eggs are usually deposited in several spawning acts punctuated by rest intervals. After her eggs are spent, the female will generally sweep clean gravel downstream to cover the exposed eggs in the redd. This keeps the eggs from washing away and discourages predators from raiding the nest.

Minor variations in spawning behavior occur with each species. Chinook and coho salmon generally spawn over coarse gravel in large streams, whereas the brown trout, rainbow trout, and brook trout are more likely to spawn on gravelly riffles of small tributaries. A single female may be accompanied by two males (coho, steelhead, chinook) or a female may build several redds (Atlantic salmon, brown trout, steelhead). Lake trout seldom enter streams to spawn, preferring to spawn over the rocky shoals of lakes where eggs fall between crevices in the rocks. Many lakers apparently spawned in streams before logging operations and other human obstructions ruined the better spawning streams. Similarly, there is evidence that brown trout and brook trout may also spawn in lakes.

Eggs deposited in the redd will hatch in 30-150 days depending on the species and the temperature of the water. The newly hatched larval fish lie under the gravelly canopy until their yolk sac is absorbed and they must wriggle out into the stream to forage for food. The young salmonids are 1 to 5 inches long and have 6-14 vertical bars, or parr marks, on their sides. They may stay in the streams feeding on aquatic insect larvae, or they may soon develop on insatiable urge to migrate downstream. All salmon, most rainbows, some browns, and a few brook trout will migrate to the larger bodies of water.

Stocks of both lake-resident and stream-dwelling salmonids are largely dependent on the quality of water maintained in the streams which the fish utilize for spawning. Dams and weirs often deny access to upstream spawning areas, and clean gravel spawning sites may be hopelessly fouled by siltation from construction or agricultural runoff. Floating debris and even canoes can disrupt the constructed redds. Hatchery plantings alone cannot maintain current salmonid populations without protection of stream and lake habitat.

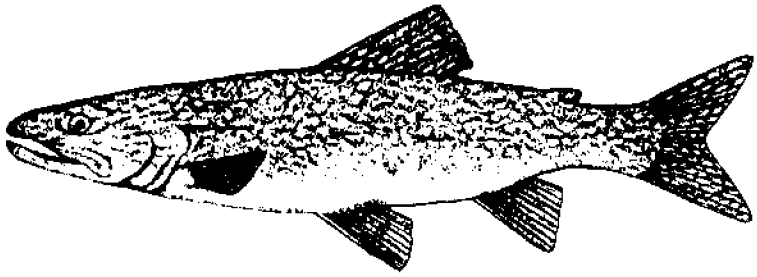


Brook Trout *(Salvelinus fontinalis)*

Brook trout are the only stream-dwelling salmonids native to Michigan. Close relatives of the arctic char, brook trout are confined to cold, clear, well-oxygenated waters. For this reason, brookies are a good indicator of high quality streams, and in our area they are most abundant in spring-fed brooks where summer water temperatures stay below 65°F (18.3°C). In larger rivers brook trout are not as abundant as brown trout, and they may virtually disappear from the main channel of many river systems, residing only in the cooler, small tributaries. Spawning occurs in autumn over fine gravel. Brookies may also migrate to lakes, in which case they approximate the habits and appearance of other lake-run salmonids. Brook trout found in Great Lakes waters are known as "coasters."

There has been some debate over whether brook trout occurred naturally in the grayling rivers of northern Michigan. Brook trout were widely planted in northern lower Michigan in the 1880's, and they apparently were not present in the Manistee and Au Sable Rivers before that time (Vincent 1962). However, fishermen caught brook trout in the Boyne and Boardman Rivers in the 1850's, while grayling were still the dominant fish. It is known that brook trout were abundant in the Upper Peninsula streams, and because of the migratory habit of some brook trout, it seems unlikely that populations of these fish would be confined entirely to Upper Peninsula streams. Spawning-run coasters probably frequented streams in the Grand Traverse Bay watershed, while small creeks most likely held resident brook trout much as they do today. Larger rivers, which are now dominated by brown and rainbow trout, were undoubtedly ruled by the native grayling.

Recent brook trout plantings in the bay near Northport and Acme were largely unsuccessful as the introduced fish failed to disperse and establish breeding populations. Many of the adults were caught several years later very close to the planting areas. However, many of the small streams in the area will yield fine, although small, native brook trout to the patient angler.



Lake Trout *(Salvelinus namaycush)*

The lake trout is the largest of our native salmonids, and several individuals have been caught in Grand Traverse Bay which weighed in excess of 50 lbs. Giants also in the economy of the region, these fish were for many years the most valuable commercial species of the bay.

In former times, lake trout were extremely abundant in the four deepwater Great Lakes and throughout most coldwater lakes of Canada. Since the white man's arrival in this area, lakers have come under enormous pressures, and were for a time almost entirely dispossessed of their native Great Lakes haunts. When wastes from logging, sawmills, and other industries fouled spawning streams, lake trout were restricted to spawning on lake shoal areas. Heavy commercial fishing pressure caused changes in the age

structure and size of lake trout populations. However, the annual yield of lakers remained steady into the 1940's, when sea lamprey predation brought about a total collapse of the lake trout population.

With effective lamprey control now a reality, extensive stocking programs have brought the lake trout back to Grand Traverse Bay providing the base for a highly productive sport-trolling industry. For the past 10 years an average of 200,000 lake trout yearlings have been planted annually in Grand Traverse Bay (Great Lakes Fishery Commission 1975). Lake trout eggs for the hatchery program are obtained from hatchery brood stock or from mature lake trout of inland lakes and Great Lakes waters. The young trout are raised to the yearling stage in federal fish hatcheries, and prior to release are marked with fin clips to identify them as hatchery raised fish. It became apparent several years after the planting program began that there was little or no natural reproduction of lake trout. All mature lake trout taken from Lake Michigan had clipped fins.

It is hoped that lake trout will once again reproduce naturally in Grand Traverse Bay. Although early returns have been discouraging, fishery biologists feel certain that with time and continued improvement in technique a viable breeding population can be established. Researchers recently learned that sexually mature adult lake trout were homing to their release sites to spawn, rather than seeking out the rocky shoals where lakers have successfully spawned in the past. For this reason, many fingerling lake trout are now planted on offshore reefs instead of inshore sites.

Lake trout feed on fish at or near the bottom of large lakes, moving throughout the year in response to both water temperatures and available food. Recent examinations of lake trout taken near Ludington show that only three groups of fish enter significantly into the diet of adult lakers. In this study alewives and smelt each comprised about $\frac{1}{3}$ of the food intake, while sculpins made up about $\frac{1}{4}$ of the adult diet (Chiotti 1973). In the spring, lake trout move into shoal waters, feeding heavily on the spawning smelt. From June through October alewives are by far the most important food fish. By November and presumably throughout the winter, lake trout feed more heavily on several species of sculpins. In former times chubs were a preferred food of lake trout, but these fish are now scarce in comparison with the alewife and smelt.

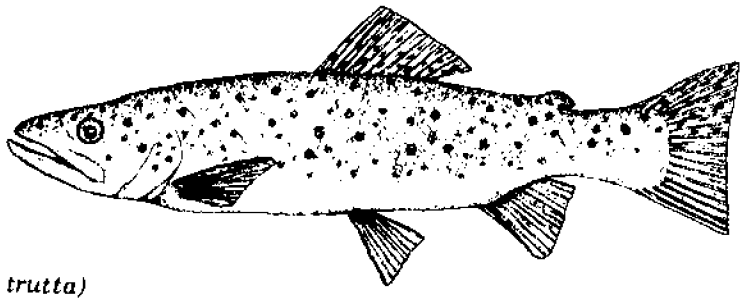
As a result of massive plantings, lake trout are found virtually everywhere in Grand Traverse Bay. They are particularly plentiful off Deepwater Point, Elk Rapids, Northport Point, and along the eastern shore from Norwood to Fisherman Island. Lakers are also present in Torch, Elk, and Bellaire Lakes, but are common only in Torch Lake.

Splake *(Salvelinus fontinalis* X *S. namaycush)*

The splake is a hybrid fish produced by fertilizing lake trout eggs with milt from male brook trout. Although this hybrid cross is known to occur occasionally in nature, nearly all splake found in our region are hatchery reared. Unlike many hybrid fish, splake are fertile, and it is hoped that they will reproduce naturally. This fish thrives in cold lakes, and is said to grow faster than either parent species.

Splake are fairly common in Elk Lake as a consequence of plantings carried on until 1974. Some splake are taken in the east arm of Grand Traverse Bay, these fish having passed over the dam from Elk Lake.

Identification of splake is somewhat difficult, as their appearance is intermediate between that of the lake trout and brook trout.



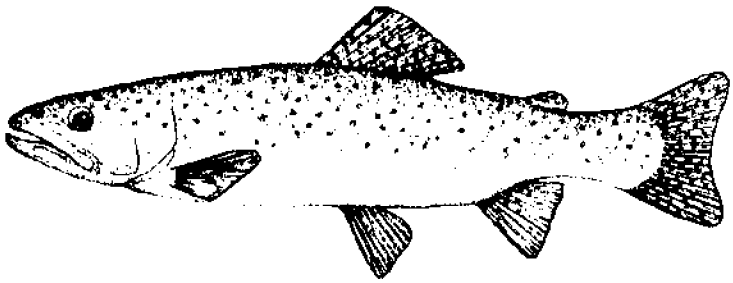
Brown Trout *(Salmo trutta)*

Brown trout are a species native to Europe. When first brought to Michigan in the late 1800's, they incurred the violent opposition of some trout fishermen and biologists. Fishermen claimed that the fish were ugly, and that they were poorer tasting and harder to catch than native fish. Biologists and management officers were afraid that browns might displace native brook trout and grayling. But 75 years have passed, and brown trout are firmly entrenched and highly esteemed members of the local fish fauna. In fact, they are endowed with certain characteristics that make them particularly valuable in modern fish management. Browns are able to withstand a greater range of temperature and water conditions than other trout. They are also cagier, and are not as easily overfished as brook trout. Highly adaptable, browns thrive in waters from the smallest feeder streams to the largest lakes.

In streams brown trout usually reach maturity in 2 to 3 years and seldom grow over 15 inches long. They are rather sedentary, the individual fish often having a preferred station in a hole or behind stones or roots. They feed on a wide range of aquatic insects, as well as some crustaceans and small fish.

Lake-run brown trout are a migratory form living in large, cool lakes and spawning in September and October in tributary streams. Several streams also have spawning runs in the fall. They mature somewhat later than the stream-dwellers and can grow to enormous sizes, sometimes in excess of 30 pounds. Lake-run browns are largely pisrivorous, rounding out their diet with insect larvae and crustaceans. Their optimum temperature range is 60-70°F (15.6-21.1°C).

Brown trout are scattered throughout Grand Traverse Bay, but seem to reach greatest concentrations in the lower west arm where they are taken by anglers in Bowers Harbor and near Traverse City. Brown trout are also present in a number of lakes and ponds, usually as a result of plantings. Included in this group are Bellaire and Belanger's ponds, and also Intermediate, Torch, and Elk Lakes. Most sizable streams harbor good populations of resident brown trout.

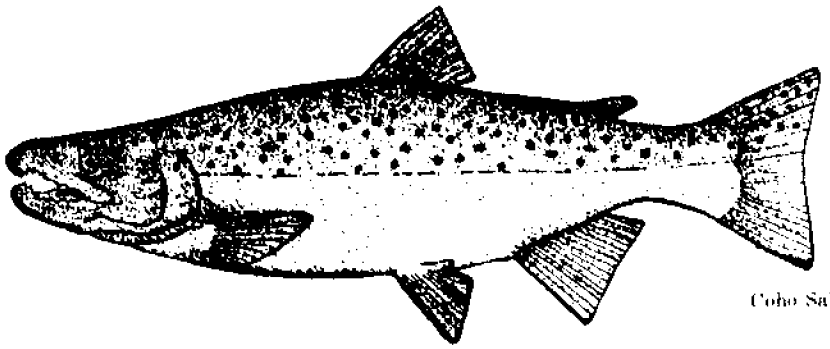


Rainbow or Steelhead Trout *(Salmo gairdneri)*

In the West Coast haunts of this big trout there are two distinct races which vary greatly in appearance and habit. The rainbow or kamloops trout is a largely nonmigratory race. These colorful, non-silver rainbows have been introduced to a number of commercial trout ponds and some inland lakes. The steelhead is a silver anadronomous race of the same species with a very different life history. Fish planted in Michigan in the late 1870's were apparently taken from the migrating steelhead strains of Oregon and Washington, because biologists soon learned that the stocked fish were moving downstream to feed in the Great Lakes before returning to spawn a year or two later.

Unlike the other salmonids, rainbows and steelhead spawn in the spring when water temperatures exceed 50°F (10°C). Many steelhead enter spawning streams during the fall salmon runs, apparently lured in by the prospect of a meal of salmon eggs. Steelhead that have been in the rivers for several months are darker than those fresh from the lake.

Steelhead are scattered throughout the midwaters of Grand Traverse Bay during most of the year, usually at a depth of 20-40 feet. They provide a good sport fishery from late fall through early spring when they congregate in inshore waters and spawning streams.



Coho Salmon

Coho Salmon *(Onchorynchus kisutch)*
and Chinook Salmon *(O. tshawytscha)*

Coho and chinook salmon are natives of the Pacific Northwest. They spawn in river systems from northern California to Alaska but spend the greatest part of their lives in the open ocean. These Pacific salmon were introduced into Lake Michigan to help control the exploding alewife population and also to provide an exciting inshore sport fishery. Beginning with initial plantings of coho (silver) salmon in the Platte River in 1966, the recent Michigan salmon program has been expanded to include both coho and chinook (king) salmon in many streams throughout Michigan. Another Pacific salmon which may become a part of the Grand Traverse Bay fish community in the future is the pink salmon *(Oncorhynchus gorbuscha)*. This salmon has recently increased to major abundance in Lake Superior after a Canadian introduction of fingerlings in 1956. It has spread into Lakes Michigan and Huron in the past decade where indications are that it is increasing rapidly. The pink salmon spawns every two years and, since there has been but one introduction in the Great Lakes, spawning runs occur only in odd years. The Atlantic salmon (genus *Salmo*) which is actually a trout and a native of the East Coast, has also been introduced.

Most Lake Michigan tributaries are notably deficient in proper spawning areas for Pacific salmon, making local salmon populations largely dependent on hatchery rearing and stocking. Fertile eggs are purchased from the West Coast or collected from mature Great Lakes salmon. Salmon fry hatch after 30-50 days and are nurtured in the hatchery until they smolt, which is a physiological adaptation allowing the young salmon in its natural habitat to migrate from spawning streams to the open ocean. Chinook smolt in 90-120 days, whereas coho must spend 16 months in the hatchery before they can be planted.

Salmon smolts are imprinted with the chemical environment of the hatchery stream or release site, and through a memory system of direction and smell, they are generally able to return to the same stream upon reaching sexual maturity. Great Lakes populations, however, seem to contain a large number of strays, probably due to differences between the water of the hatchery and that of the release site.

Young salmon feed on insects and small crustaceans. As they grow larger, salmon begin feeding on small fish, and as adults, feed almost entirely on smelt and alewives found in the midwaters of the Great Lakes. Because they feed in the midwaters, Pacific salmon are not serious competitors for food with native lake trout, which feed on or near the lake bottom.

By early summer of their final year in the lake, the nearly 3-year-old coho and nearly 4-year-old chinook go on a feeding binge. In a few short months the salmon, now rapidly approaching sexual maturity, will double or even triple in body weight. By late summer the fattened salmon have "homed" back to their release sites, congregating in huge schools. Changes take place which, in their native environments, would allow mature salmon to make the transition from saltwater back to the freshwater spawning streams. Scales become tightly set and a heavy slime coating develops over them. Sides of the fish turn dark red or olive, and the males grow hooked jaws. The flesh becomes softer, milk-colored, and watery as the fish ascend spawning streams. In their weakened condition a break in the mucous coating from a scrape on a log or rock is all that is necessary for the common fungus *Saprolegnia* to gain a foothold. At this time salmon resolutely refuse all the normal blandishments that fishermen offer as bait, preferring the search for a spawning site. Apparently few Great Lakes salmon build redds, and spawning success among those that do is low, due to factors such as egg retention and poor water quality in the streams. These fish die after spawning in the late fall or winter.

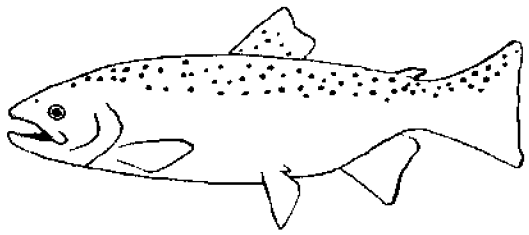
Pacific salmon are common in Grand Traverse Bay, particularly in the west arm. Plantings of 100-150,000 salmon smolts per year of each species have insured a large population in the bay (Great Lakes Fishery Commission 1975).

Identification of Salmons, Trouts, and Chars

Pacific Salmon (genus *Onchorynchus*) are large silvery fish with black mouths. Spawning fish are dark and males develop a hooked jaw or kype.

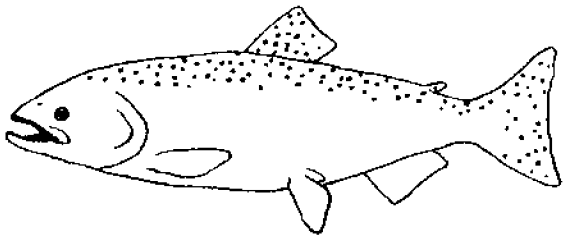
Coho Salmon *(Onchorynchus Kisutch)*

13-15 anal fin rays; spots on dorsal and upper caudal fin and on back; mouth black with grayish gums.



Chinook Salmon *(Onchorynchus tshawytscha)*

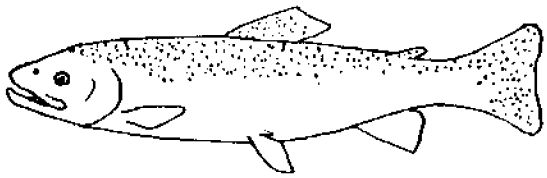
15-17 anal fin rays; spots on dorsal fin, adipose fin, entire caudal fin, and on back; mouth and gums black.



True trout *(genus Salmo)* have light-colored mouths and varying numbers of spots on the body and fins. There are 9-12 anal fin rays. Body shape and color may vary greatly depending on habitat, size, and sexual condition. Spawning males have a hooked jaw.

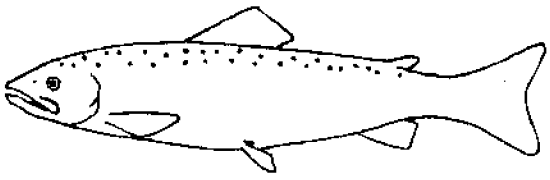
Rainbow or Steelhead Trout *(Salmo gairdneri)*

Small black spots on dorsal, caudal, and adipose fins, and usually on back; rosy or pink stripe sometimes apparent; upper jaw extends back to rear edge of eye; two rows of small teeth on tongue.



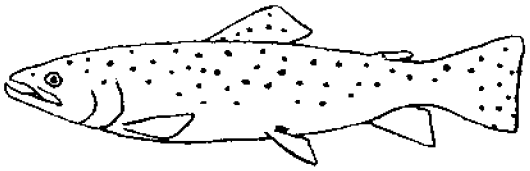
Atlantic Salmon *(Salmo salar)*

Large spots on body but very few or absent on fins; upper jaw extends to rear of eye; narrow tongue with 4-6 small teeth. Fish can be held by grasping at the base of the tail.



Brown Trout *(Salmo trutta)*

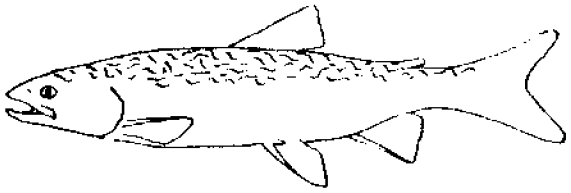
Large and distinct spots on dorsal fin, adipose fin, usually on caudal fin, and on back and sides; upper jaw extends past rear margin of eye; tongue broad, square, with 10-12 strong teeth.



Chars (genus *Salvelinus*) have light colored spots and worm-like markings on their backs and white leading edges on pectoral, pelvic, anal, and caudal fins.

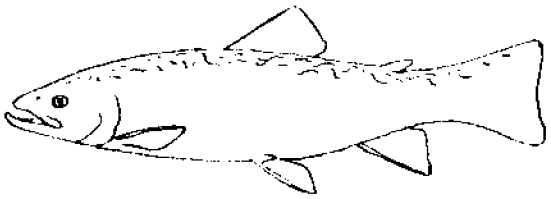
Lake Trout *(Salvelinus namaycush)*

11 anal fin rays; deeply forked caudal fin.



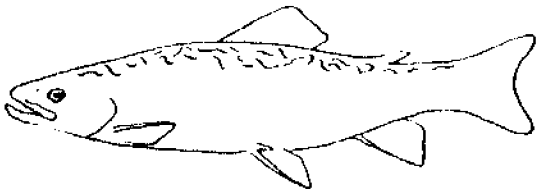
Brook Trout *(Salvelinus fontinalis)*

9 anal fin rays; nearly square tail. White leading edges of lower fins, lined in black.



Splake *(S. namaycush* X *S. fontinalis)*

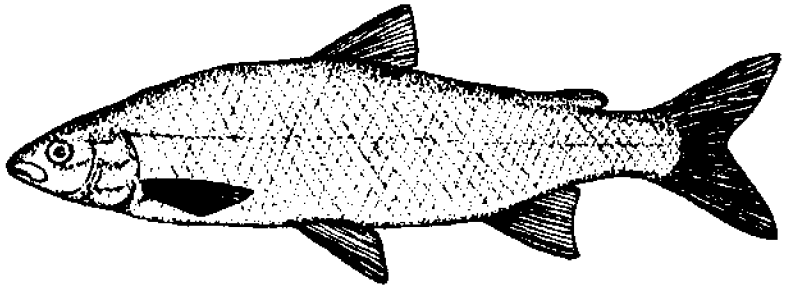
9-11 anal fin rays (usually 10); tail slightly forked; intermediate between brook and lake trouts.



Salmon Family (Salmonidae), Subfamily Coregoninae

This group of freshwater fish is widely distributed throughout the colder reaches of the northern hemisphere. Very closely related to the trout, salmon, and chars (subfamily Salmoninae), the whitefish are characterized by their deeply forked tail fins, small toothless mouths, and larger scales.

All members of the chubs in the whitefish subfamily exhibit a tremendous variability in physical characteristics, making them very hard to identify. This plasticity of form has led to a great deal of confusion in the taxonomy of the whitefish subfamily, especially the lake herring and chubs. Size, shape, growth rate, and the number of scales and gill rakers, all features used by early investigators to identify the various species and subspecies of this family, have been shown to be greatly influenced by the environment. The same species taken from two different lakes may vary greatly in physical appearance. Lake whitefish, round whitefish (menominee), and the ciscoes comprise the three major groups present in the Grand Traverse Bay region. Included in the ciscoes are the lake herring, inhabitants of inshore regions, and the chubs which are bottom feeding residents of the deeper Great Lakes waters.



Lake Whitefish *(Coregonus clupeaformis)*

> "This fish is to Michigan the fish of fishes. Its consumption by our people is larger than that of any other species, and commercially, it is to Michigan of more value than any other variety found in our lakes . . . the size to which it grows,—the range of its habitat,—its fecund habit,—its plump form, and flanks of silver sheen, with its sweet and savory flesh, all combine to render it the most valuable freshwater fish on the continent."

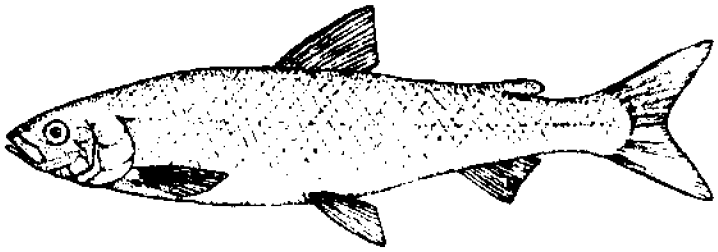
This passage, excerpted from the Third Report of the Superintendent of the Michiran State Fisheries Commission for 1877-78, is but a sample of the verbal excesses inspired in admirers of the lake whitefish. Because they were held in such high esteem by fishermen, consumers, and fishery managers, whitefish fry were produced by the millions in early state fish hatcheries. For instance, over the winter of 1876-77 the state produced over 7,000,000 whitefish fry for distribution to inland lakes and the Great Lakes, with Grand Traverse Bay receiving 500,000 fish in one planting (Michigan State Board of Fish Commissioners 1879). Although hatchery planting of whitefish has been discontinued, lake whitefish have remained a mainstay of the commercial fishery. Grand Traverse Bay alone produced an average of 27,000 pounds per year of this delectable fish until commercial fishing on the bay was banned in 1968 (Colby 1971). More recently a thriving winter sport fishery for whitefish has developed on Torch and Elk Lakes, and on the lower east arm of Grand Traverse Bay.

Requiring very cold water for the incubation of their eggs, whitefish spawn in early winter when water temperatures drop below 46°F (7.78°C). Eggs are cast over rocks or sand in fairly shallow water usually less than 25 feet deep. In Grand Traverse Bay whitefish spawn on the rocky reefs off Raft's Camp, Lee's Reef, Grand Traverse Shoal, and along the rocky eastern shoreline from Deepwater Point north. Developing very slowly in the icy water, whitefish eggs require 130-150 days to hatch under natural conditions. Larval whitefish remain inshore until mid-summer of their first year, before moving slowly into deeper, cooler water.

Planktonic creatures probably form a large part of the diet of very young whitefish, but older fish assume the bottom feeding habit displayed by the other adult coregonids (chubs, menominee), feeding heavily on the common benthic organisms such as *Pontoporeia*, midge larvae, and fingernail clams. Whitefish must eat prodigious numbers of these organisms for they grow rapidly and can reach weights in excess of 20 pounds, although most whitefish are found in the 2 to

5 pound range. After several years there are few predators that can attack such a large fish, and unless at runs afoul of fisherman's nets or sportmen's cleverness, a whitefish may live for 15 or more years. Lamprey predation was once a serious threat to the whitefish population, but lamprey control efforts appear to have reduced this problem in recent years.

The Michigan DNR has for years been interested in the whitefish population of Grand Traverse Bay because it provides a comparison between the age structure and morality of "natural" unfished populations and the commercial fishing stocks in the rest of Lake Michigan. Such information is used to set quotas for whitefish production that will allow maximum use of this valuable resource while insuring stability of the commercial whitefish stocks.



Lake Herring or Shallow Water Cisco
(Coregonus artedii)

The lake herring is so variable in its characteristics, particularly in smaller inland lakes, that biologists thought they had found a new species or subspecies from nearly every lake in which it occurred. As recently as 1964, 22 subspecies were described from the Great Lakes region alone (Hubbs and Lagler 1958). Biologists now tend to lump all such disparate populations together, recognizing that differences in this fish were largely due to the environmental conditions in which they lived.

Lake herring spawn in late fall about the time of first ice. Huge schools can be seen as they move into shallow spawning grounds in 3 to 20 feet of water. Eggs are broadcast over stone, sand, or vegetation and take over 100 days to hatch at cold winter temperatures.

Lake herring move into deeper water in the summer, staying below the thermocline, as they are intolerant of higher temperatures. Unlike their close relatives, the chubs, lake herring stay largely in the midwaters and near shore. In the Great Lakes they feed heavily on zooplankton including *Mysis*, *Pontoporeia*, copepods, and aquatic insect larvae, which are strained from the water with their fine gill rakers.

Until the mid 1950's lake herring were a principle target of the commercial fishery, but nearly all were taken across the lake in Green Bay. They were also a favorite food of the lake trout and steelhead. Overfishing, environmental degradation, and increased competition from exotic species, particularly smelt, have in various combinations decimated the once strong lake herring stocks in the Great Lakes. Lake herring still have viable populations in Torch Lake, Elk Lake, Suttons Bay, and the lower east arm of Grand Traverse Bay, although they are not as abundant as they were before the smelt and alewife were present.

Chubs or Deep Water Ciscoes *(Coregonus sp.)*

Chubs are endemic to the Great Lakes and a few other deep bodies of water. Close relatives of the shallow-water cisco or lake herring *(C. artedii)*, the chubs are commonly found at depths to 600 feet, and some live in the deepest waters of the Great Lakes. As unspecialized bottom feeders, they are among the very few native fish able to take advantage of the wealth of invertebrate food in very deep lakes. Throughout the year the bulk of the chubs' diet is composed of opossum shrimps *(Mysis)* and the scud *(Pontoporeia)*.

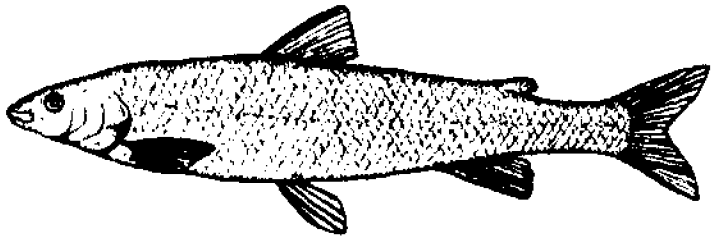
Over the years 7 species of chubs have been identified from Lake Michigan, and all of the 7 have been recorded in Grand Traverse Bay. In descending order of size they were the blackfin *(C. nigripinnis)*, deepwater *(C. johannae)*, shortjaw *(C. zenithicus)*, longjaw *(C. alpenae)*, shortnose *(C. reighardi)*, kiyi *(C. kiyi)*, and bloater *(C. hoyi)*. These chub species were identified by size, the water depth they frequented,

the time of year they spawned, and by scale and gill raker counts. Since most species of chubs probably evolved after the last glacial advance these characteristics often overlapped greatly among species, and they are sometimes referred to as sibling species, or incompletely evolved species.

The larger, more highly valued populations of chubs were generally found in the deepest water and were subject to the greatest commercial fishing effort and sea lamprey predation. In repetitive fashion, each of the larger chub varieties declined or disappeared until only the bloater remained to supply the market for smoked chubs. Concurrently with the species succession among Lake Michigan chubs, changes within the dominant bloater population became apparent. Bloaters which had been the smallest and slowest growing of Lake Michigan chubs grew faster and to greater sizes than before. This in part led to record catches of bloaters in the early 1960's and also made them vulnerable to lamprey predation. By the late 1960's, although chub production remained high, the fish being caught were larger and older, indicating failing reproduction of the bloater. At the same time an extreme imbalance in the sex ratio of chubs occurred. In northern Lake Michigan female chubs comprised 69 percent of the catch in 1954-55, 97 percent in 1969, and 79 percent in 1972 (Michigan Department of Natural Resources 1974a). Female dominance is apparently characteristic for the chubs, but reasons for this gross imbalance are unknown. It has been observed before in other populations of coregonid fishes, and is taken as a sign of stress in the chub population.

No doubt commercial fishing has played a large part in the massive changes that have occurred in populations of Great Lakes chubs. In many areas of Lake Michigan this fish has been the only commercially fished species in recent years. The competition afforded by alewives and smelt is also a significant cause of the chubs' recent decline since chubs declined in areas of other Great Lakes where fishing was minimal or absent. Both species occupy the same waters as the chubs for at least part of the year. They feed on the same kinds of zooplankton as chubs, and they occasionally eat young chubs. In their 1973 report to the Great Lakes Fishery Commission, Brown and Wells stated "there is no real evidence anywhere that bloaters and other deep water ciscoes can sustain themselves in the presence of large populations of alewives (and possibly smelt). Drastic changes in the fish stocks in Lakes Huron and Ontario suggest that ciscoes are incompatible with, and are eventually replaced by the non-native competitive species" (Michigan Department of Natural Resources 1974a).

In Grand Traverse Bay and other parts of the U.S. waters of the Great Lakes commercial fishing for chubs has been stopped or drastically reduced in recent years, with their future yet unknown. It is uncertain if chubs will be able to make a comeback as an important commercial species in the face of continuing changes to their habitat and competition from introduced species.



Round Whitefish or Menominee
(Prosopium cylindraceum)

Menominees are native to all the Great Lakes except Lake Erie. They have never been as abundant as other coregonids and have not been able to colonize inland lakes in the Grand Traverse Bay region, as have the lake whitefish and lake herring. In fact few people ever see them except in October and November when schools move into relatively shallow water to spawn. At this time of year menominees are often caught on wigglers or spawn, particularly in Bower's Harbor and near Raft's Camp, Northport Point.

Menominee are strictly bottom feeders, and rely heavily on insect larvae (especially midges), fingernail clams, snails, and the eggs of other fishes for food. Lake trout are known to feed on the smaller menominee, while the latter fish will occasionally reciprocate with a meal of trout eggs. White suckers, perch, and burbot have also been found to consume menominee eggs.

Studies in Canadian waters have shown a depressed growth rate for menominee when lake whitefish are present. Apparently lake whitefish are more efficient at procuring food, and are more successful in a compe-

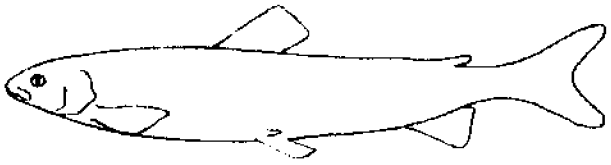
titive situation. This may help to explain why the round whitefish has never been as abundant as other coregonids.

Due to smaller size, and poor shipping characteristics, the menominee has not been as important to the commercial catch as the lake whitefish, although the flesh of the menominee is excellent.

Identification of Coregonids

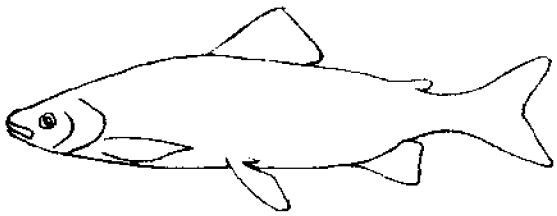
Round Whitefish *(Prosopium cylindraceum)*

Gill rakers stout, short, fewer than 20; single flap between the nostrils; long cylindrical body, overhanging mouth.



Lake Whitefish *(Coregonus clupeaformis)*

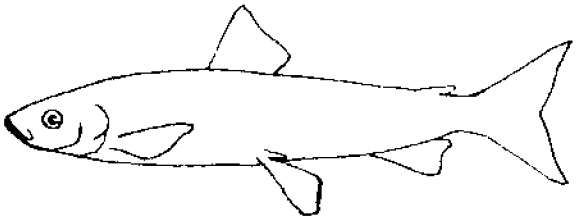
22-33 long gill rakers; double flap between nostrils; snout blunt, overhanging mouth; larger fish often with pronounced humpback.



Lake Herring, Chubs *(Coregonus sp.)*

Gill rakers more than 32 (often 40 or more); double flap between nostrils; snout pointed, upper and lower jaws nearly equal in length.

Note: No attempt is made here to distinguish among the chubs and herring due to the extreme variability of these fishes.



Salmon Family (Salmonidae), Subfamily Thymallinae

Artic Grayling *(Thymallus arcticus)*

When early explorers first penetrated northern Michigan's deep pine forest they discovered a fish of incomparable quality, the "flag fish" or grayling. Two distinct relict populations of grayling remained well south of this species' normal range, one in western Montana and one in the clear rushing rivers of Michigan. Fishermen soon took note of this "beautiful and queenly" fish and such rivers as the Au Sable and Manistee became famous throughout the East as the natural haunts of "our unrivaled grayling." But early naturalists and fishermen noted also that the grayling was a delicate and peculiar fish, and that it suffered more from the encroachments of civilization than other native fish. In particular, grayling populations were greatly reduced when logging operations denuded the land causing siltation and warming of the cold northern rivers.

Annual spring log drives on the Boardman and other northern Michigan rivers sent thousands of huge white pine logs gouging the stream bed at the time when Michigan grayling were spawning. The grayling also suffered from competition with the more versatile and tolerant brook trout, which by natural range extension had invaded northern Michigan streams as far south as the Boardman in the first half of the 19th century. Observers at the time noticed that, in streams which grayling and brook trout cohabited, grayling were declining in numbers even before logging.

In addition the grayling, an inhabitant of watercourses in the deep pine forests, suffered from what was taken to be a backwoods innocence, as it rose steadily to the fisherman's hook and could be taken in almost unbelievable numbers. One observer on the Au Sable River decried those fishermen who "creel all that come to their hook, big and little indiscriminately, and then after selecting the largest, cast the dead fingerlings back into the river, or on the banks to rot." Some fishermen would cart away "eight or ten large boxes filled with the odorous proofs of their prowess" leading the observer to wonder how long the famous grayling rivers could "stand such ignominious drafts on their abundance?" (Michigan State Board of Fish Commissioners 1879).

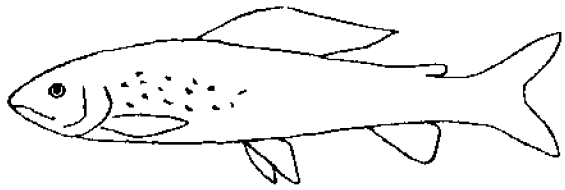
The Michigan grayling succumbed to a combination of three major factors: habitat destruction due to logging, competition with the brook trout, and overfishing. Any one of these factors would probably have been sufficient to cause a decline in grayling populations over a number of years but, faced with all 3 at once, the ecologically sensitive grayling underwent a rapid and irreversible collapse. In the Boardman River, said to be a good mix of both trout and grayling in 1855 and again in 1867, Charles Hallock caught 30 trout and only 1 grayling in 1875. By 1887, Herschel Whitaker in a scientific paper on the demise of the Michigan grayling, reported only an occasional straggler (Vincent 1962).

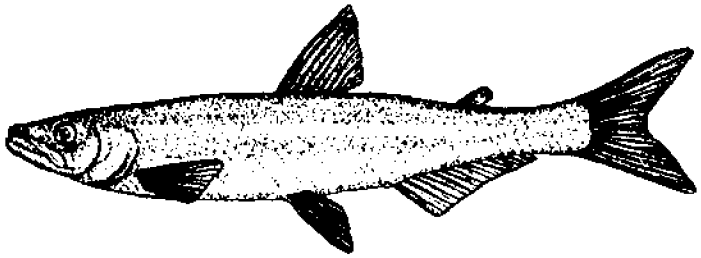
No one can say with certainty when this fish became extinct in the Boardman River, but it appears that the grayling had completely disappeared from the lower peninsula by about 1905, and from the upper peninsula's Otter River by 1935.

Identification of Grayling

Artic Grayling *(Thymallus arcticus)*

Troutlike fish with adipose fin and forked tail; long dorsal fin. Now extinct in Michigan.





Smelt Family (Osmeridae)

Rainbow Smelt *(Osmerus mordax)*

Smelt began their career in the Great Lakes as escapees from a Michigan Conservation Department experiment in 1912. The Department was making an attempt to establish landlocked Atlantic salmon in Crystal Lake. Biologists noted that smelt were a favorite food of landlocked salmon in Eastern Canada and brought them to a Crystal Lake tributary. Despite their inauspicious beginning, smelt soon colonized the entire Great Lakes watershed in large numbers. In the late 1950's they comprised ¼ of the total commercial catch in Lake Michigan.

Like the alewife, the rainbow smelt is primarily an anadromous species, but both spawn along the shore in some locations. Spawning usually takes place in tributary streams of the Great Lakes in the sping after the stream water has warmed above 48° F (8.89° C), although this may vary due to local conditions. Spawning takes place at night, with the fish returning to the lake by dawn. It is likely that smelt also utilize offshore shoals and beach areas for spawning, although the relative importance of these areas for smelt reproduction is probably not great except in Lakes Erie and Ontario.

Young smelt hatch out in 2 to 3 weeks. Larvae are extremely skinny and nearly transparent. They grow rapidly and reach 2 inches in length by late summer. Great Lakes smelt mature quickly, with the bulk of spawning run fish being 2 and 3 years old, and the remainder being up to 6 years old and 8 or more inches long. Smelt from smaller inland lakes reach a maximum size of only about 4 inches.

Mature smelt are usually found inshore only during the time of spring spawning runs. At all other times they inhabit the offshore areas of the Great Lakes. They feed on a wide variety of small crustacean zooplankton and are probably direct food competitors with native lake herring and whitefish.

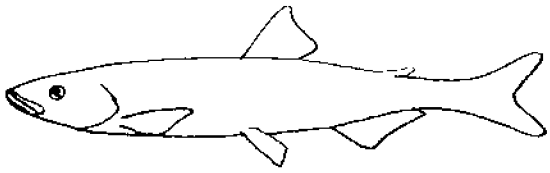
Studies by the Michigan Department of Natural Resources in 1972 indicated that smelt were more abundant in Grand Traverse Bay than in any other area of Lake Michigan (Michigan Department of Natural Resources 1974a). Many small streams tributary to Grand Traverse Bay have smelt runs in April, although the number of dams surely limits reproduction.

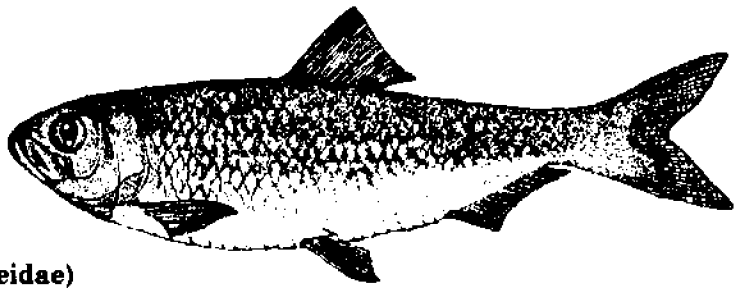
Smelt are also present in Cedar, Bellaire and Torch Lakes. Over six million smelt eggs were planted in Torch Lake by the Michigan Fish Commission in 1912 (Michigan Department of Natural Resources 1974b). The Bellaire and Torch Lake stocks probably originated from this introduction.

Identification of Smelt

Rainbow Smelt *(Osmerus mordat)*

Elongated cylindrical fish; large mouth with sharp teeth; adipose fin present.





Herring Family (Clupeidae)

Alewife *(Alosa psuedoharengus)*

The alewife is a relative newcomer to the Great Lakes. It was first detected in Lake Michigan in 1949, and the earliest records of alewives in Grand Traverse Bay date back only to 1955. These small shimmering fish soon asserted themselves. With salmonid predators nearly absent due to lamprey predation, alewives were able to utilize the abundant food resources of the lake, undergoing a population explosion in the 1960's which is now legendary. Clogging municipal water intakes and littering beaches in massive dieoffs, alewives soon became a major nuisance in Lake Michigan.

In their native East Coast environment alewives are anadromous marine fishes which move into quiet rivers to spawn in early summer. In the Great Lakes, alewives usually spawn in harbors or inshore waters, with each female broadcasting 60-100,000 eggs at random over the bottom. The eggs hatch in 3 to 6 days, and the juvenile alewives head for deeper water by July.

Alewives migrate throughout the year, apparently in response to changing water temperature. At all times they avoid the extremes of very warm or cold water. They do not move into shallow water until it has warmed considerably in the spring. By midsummer this water is too warm, and the alewives move slowly into deeper and cooler water. In winter, they avoid the cold water near the surface, seeking out the warmer water at depths often exceeding 300 feet.

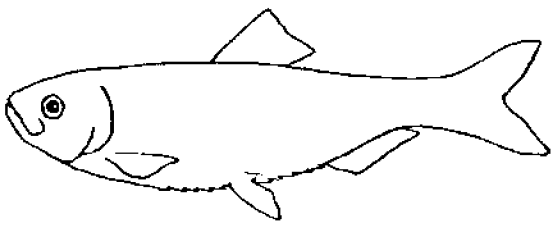
Because the alewives occupy virtually every part of the lake in very dense schools during the different seasons, they have an enormous ecologic impact on other species in the lake. Young alewives feed mostly on zooplankton, including copepods, cladocerans, *Mysis*, and ostracods in their diet. Adults eat considerable amounts of the benthic amphipod *Pontoporeia*. Many of these morsels are prime food for more valued species such as chubs, lake herring, whitefish, perch, and the young of trout and salmon. Commercial fishing catch records show that virtually every fish which occupied the same waters as the alewives and competed for the same food organisms showed a decline in the face of the alewife population explosion. Chubs and lake herring, already experiencing heavy pressure from commerical fishermen, hit new lows. Perch and smelt catches were greatly reduced but seem to have stabilized. Emerald shiners have disappeared in many places in the absence of other adverse factors. By the mid 1960's alewives had virtually saturated the lake. Despite annual dieoffs, alewives accounted for over 50 percent of the total fish biomass of Lake Michigan. In 1967 the largest dieoff to date occurred, when over half the alewives in the lake died. Annual mortality is usually attributed to the fishes' inability to acclimate rapidly to the extreme cold of the lake water in winter and the stress of spawning.

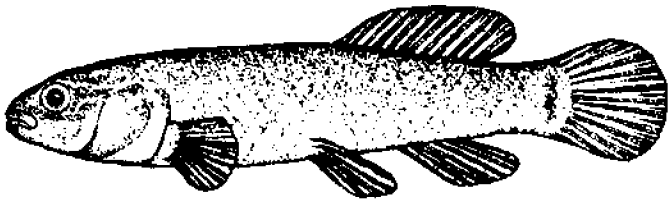
Although alewife populations in Grand Traverse Bay have never reached the nuisance proportions evident elsewhere, they nevertheless constitute a serious problem in fishery management. Large predators, including lake trout and Pacific salmon, were planted with the purpose of bringing the unstable alewife population in check. Although no true predator-prey balance has been achieved, trout and salmon seem to be feeding on alewives whenever the opportunity presents itself. It is estimated that coho salmon consume 80-100,000,000 pounds of Lake Michigan alewives annually, but this represents less than 5 percent of the alewife population (Downs 1974). There is hope that with continued predation by salmonids, and possibly a more intensive commercial fishery for alewives as fertilizer and fish meal, the alewife population may be brought under control.

Identification of Alewife

Alewife *(Alosa psuedoharengus)*

Very thin (laterally compressed) fish; scales forming a saw-toothed edge along belly; mouth directed upward.





Mudminnow Family (Umbridae)

Central Mudminnow *(Umbra limi)*

Mudminnows can be found in small lakes, ponds, and streams with mud bottoms and aquatic plants present. They feed on insect larvae, molluscs, worms, and planktonic animals. Seldom living past 4 years of age, mudminnows reach a length of about 5 inches.

These fish are very tenancious of life, possessing survival mechanisms for oxygen-poor and unstable environments. They are able to respirate through the swim bladder by gulping air at the surface, and are also known to burrow into bottom ooze to escape drought or to hibernate in winter.

Identification of Mudminnow

Central Mudminnow *(Umbra limi)*

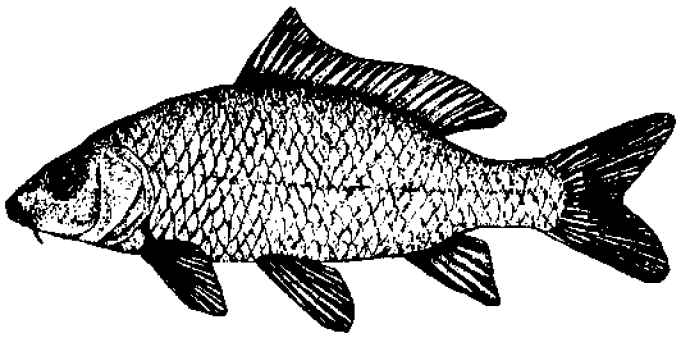
Rounded caudal fin; prominent dark vertical bar at base of caudal fin; usually 2-4 inches long.

Minnow Family (Cyprinidae)

The minnows are a large and diverse group of freshwater fishes scattered widely through North America, Eurasia, and Africa. In the Grand Traverse Bay area this family includes the shiners, bluntnose and fathead minnows, and the creek chub, daces, and carp.

Contrary to popular usage, minnows include both large and small fish grouped together by common anatomical features and ancestry, rather than by size. All members of the minnow family have a single dorsal fin. The mouth is toothless, but pharyngeal (throat area) bones are adapted for crushing food. Hearing in the minnow family is especially well developed, with sounds amplified by the swim bladder, and transmitted to the inner ear by a complex of small bones known as the Weberian ossicles. At spawning time the males of several minnow species develop small projections (nuptial tubercles), particularly on the head and forward portions of the body.

Minnows serve an important function in the aquatic ecosystem as converters of plant material and organic debris (both of plant and animal origin) into fish tissue. In turn they provide an important food source for the many piscivorous fishes including perch, walleye, trout, bass, and pike.



Carp *(Cyprinus carpio)*

Endemic only to temperate Asia, the well-known carp has spread throughout much of the northern hemisphere largely due to the efforts of man. The Romans introduced carp to Europe and they were welcomed to England during the reign of Henry VIII. Because of their suitability for pond culture and their popularity as a food fish in Europe, the U.S. Fish Commission became particularly enamored of the carp, encouraging their distribution throughout the U.S. in the late 1800's (Scott and Crossman 1973). The carp quickly established itself in North American waters, often at the expense of the native fish fauna, but unfortunately it never became a popular food fish. Today carp are generally considered a nuisance fish, although there is a limited commercial and sport fishery in some parts of the Great Lakes.

Carp are particularly fond of stagnant or slow-flowing waters with a muddy bottom and dense vegetation. They are, however, able to adapt to a great variety of conditions and they can tolerate high temperatures and low dissolved oxygen conditions. In this region they can be spotted browsing in schools of 5-20 in summer along inshore waters of Grand Traverse Bay, and they are abundant in the lower Boardman River. Introduced after the building of dams on the Elk and Boardman Rivers, carp have apparently not penetrated the Chain-O-Lakes or upper Boardman River.

Carp spawn in the spring when the water warms above 62°F (16.7°C). Moving into the shallow margins of lakes and streams, they tend to get frisky at spawning time, and have often been spotted thrashing around and jumping out of the water. A female may carry as many as 2,000,000 eggs, which may amount to $^1/_3$ of her body weight.

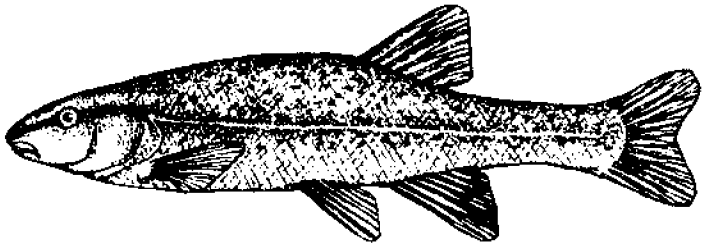
Omnivores in the truest sense of the word, carp feed on a variety of plant and animal material. They suck up bottom ooze, spitting it back into the water after selecting out food particles. Carp can grind up plant tissues with molarlike teeth in their throats, and they can sometimes be seen surface-feeding on floating algae.

Carp are taken by anglers using a wide range of bait, including doughballs, crayfish tails, potatoes, bacon, and corn.

Northern Redbelly Dace *(Phoxinus eos)*, and **Finescale Dace** *(P. neogaeus)*

These two minnows prefer the quiet tea-colored boggy waters of slow streams and ponds. They feed primarily on floating algae (phytoplankton), although zooplankton and aquatic insects are also taken. Both of these fish provide excellent forage for larger predacious fish such as perch, bass, pike and trout.

Little is known of the reproductive biology of these fish, although the redbelly dace has been observed laying its eggs in masses of filamentous algae. Both fish are spring or early summer spawners, and hybridization between the two species has been reported.



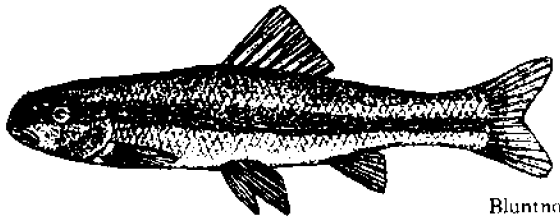
Blacknose Dace *(Rhinichthys atratulus)*

The blacknose dace is a fish of cool, clear streams in northwestern Michigan and is considered a major forage fish for brook trout. It spawns in the sand and gravel of shallow riffle areas during late spring when the water temperature reaches 70°F (21.1°C). The female dace has a projection from the genital duct which acts as an ovipositor, forcing eggs down into the substrate. Food of the blacknose dace consists primarily of aquatic insect larvae, most notably midge larvae.

Longnose Dace *(Rhinichthys cataractae)*

Longnose dace are usually found in either clean, swiftly flowing, rocky streams or in inshore waters of large lakes having boulder or gravel bottoms with turbulent water conditions similar to stream riffles. This dace is intolerant of still water and will die quickly in minnow pails. Their spawning usually occurs in early summer. These fish are bottom dwellers feeding on insect larvae, especially those of blackflies, midges, and mayflies.

Longnose dace have been found in small Boardman River tributaries, and Torch and Elk Lakes.

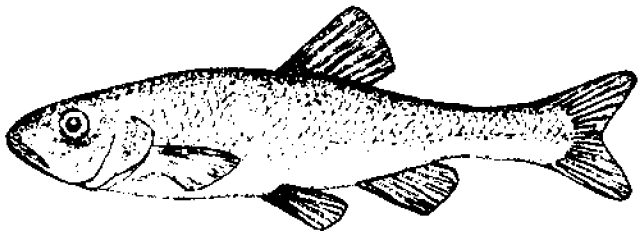


Bluntnose Minnow

Bluntnose Minnow *(Pimephales notatus)*, and **Fathead Minnow** *(P. promelas)*

Bluntnose minnows are the most common minnow in our region. They generally live in the shallows of clear lakes, ponds, and slower streams. Fathead minnows are more often found in muddy streams or ponds. Both species are bottom feeders, grazing on filamentous and unicellular algae, which are supplemented by any other small plant or animal fragments they may find. The abundance and size of these fish make them an ideal forage fish for yellow perch, sunfishes, and pike.

Many people have been privileged to observe the spawning habits of these minnows because they often build nests in shallow water near populated areas. In late spring the male minnow hollows out a nest underneath a flat stone or board (or a similar suitable object) by bulldozing pebbles out of the way with his snout and sweeping sand and silt aside with his tail. This done, the male minnow carefully cleans the roof of his nest with his back and mouth. When he is finally satisfied with the nest, the male will allow females to enter one at a time. Each female deposits 25-100 eggs which adhere to the cleared underside of the overhanging stone or board. After each visit the male goes in to fertilize the eggs. When he has collected about 2000-3000 eggs the male guards and fans them, because they will die if a constant water flow is not maintained. The young minnows hatch in 7-14 days.



Creek Chub *(Semotilus atromaculatus)*

The creek chub usually inhabits streams that are slightly warmer and slower than trout streams. They require spawning sites with coarse gravel bottoms in smooth water above or below a riffle. The spawning rituals of the creek chub are elaborate and unusual. The male excavates a depression in the gravel stream bottom by knocking stones away with his tail, and by picking up stones in his mouth and carrying them upstream. The resultant nest is usually 4 to 5 inches deep, and several feet long. The spawning act is accomplished in a series of "embraces." With each "embrace" the female releases about 50 eggs, then floats to the surface belly-up, as if dead, before swimming off. The male covers the eggs with gravel and guards the nest against intruders. This entire process may take several days (Reighard 1910).

Creek chubs locate their food by sight and are considered omnivorous, feeding on small fishes and crayfishes, as well as aquatic insect larvae.

In the Grand Traverse Bay region, creek chubs are most often reported from the Chain-O-Lakes and the upper Boardman River.

Pearl Dace *(Semotilus margarita)*

An abundant but unobtrusive member of the clear headwater stream fauna, the pearl dace is most often found in association with creek chubs, brook trout, and other dace.

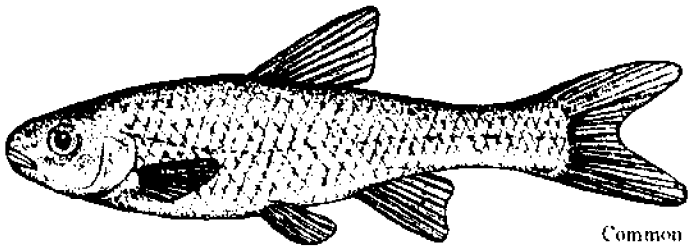
This member of the minnow family has been observed spawning in west Michigan streams in June, when the water temperature has risen to 60°F (15.6°C). Like other stream minnows, pearl dace are unspecialized sight feeders, utilizing available aquatic organisms and some algae in their diets.

Pearl dace can be found in some of the small streams tributary to the Boardman River.

Golden shiner *(Notemigonus chrysoleucas)*

The golden shiner is pond cultured in parts of Michigan not only because of its popularity as a bait minnow, but also because it is considered an ideal forage fish for bass in farm ponds. Throughout their extensive range, these shiners are found in the quiet weedy water of small lakes and ponds, and in our area they are native to the ponds and backwaters of the upper Boardman River.

Golden shiners spawn from June to August, casting their adhesive eggs over filamentous algae and other aquatic vegetation. The young grow rapidly in warm nutrient-rich waters and may reach 3 inches in length after 1 year. Growth may be retarded in cold or relatively unfertile water.



Common Shiner

Shiners (genus *Notropis*)

Shiners of the genus *Notropis* are represented by 8 species in the Grand Traverse Bay watershed. Despite outward similarities in appearance and habit, each species of shiner has a slightly different life history and habitat requirement. These differences are manifested in the distribution pattern of shiners throughout a range of habitats, and the segregation of shiners in bodies of water where several species occur together.

The common shiner *(N. cornutus)* is the largest representative of the genus *Notro-is* in our area. It prefers a stream habitat, but it also occurs along the shores of some lakes. In the late spring, when the water temperature reaches 60-65°F (15.6-18.3°C) groups of colorful common shiners can be seen spawning on the gravel riffles of shallow streams. Primarily a surface feeder, the common shiner has a diet of aquatic insects, zooplankton, and algae. It in turn is a favorite food of large fish and fish-eating birds such as mergansers and kingfishers.

The rosyface shiner *(N. rubellus)* prefers clear rivers and streams and is very intolerant of silting or turbidity. It spawns on the same areas of streams (riffles with a gravel bottom) as the common shiner, but later in the season when the water warms above 68°F (20°C). Aquatic insects, especially caddis flies, and algae have been reported as the primary food items of the rosyface shiner.

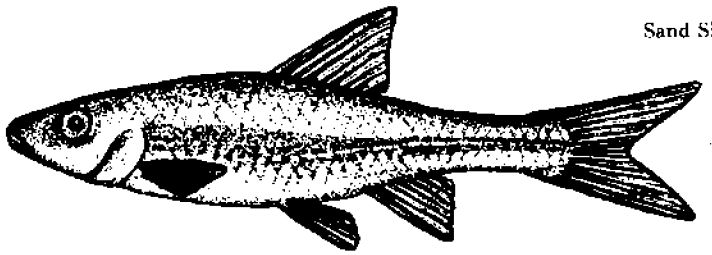
The sand shiner *(N. stramineus)* is common to the sandy shallows of lakes and rivers, usually in areas with few rooted aquatic plants. Sand shiners have a diet similar to the other shiners.

The blacknose *(N. heterolepis)* and blackchin (N. heterodon) shiners are minnows of clear, quiet embayments or pool areas of streams, where there are abundant aquatic weeds. The blacknose shiner appears to be more widely distributed in our area than the blackchin, the latter being reported only from Clam and Hanley Lakes.

The spottail shiner *(N. hudsonius)* is a fish of large lakes, and is found in our area only in Grand Traverse Bay. It spawns during the spring and summer on the sandy shoals or stream mouths of the bay. The spottail shiner is eaten by all piscivorous fish and makes a fine bait minnow.

The emerald shiner *(N. atherinoides)* is another minnow of large lakes, although it is not nearly as abundant in our area as in the past. Although large fluctuations in population size of this minnow have been reported in other areas, it is felt by many biologists that competition by alewives and smelt has considerably reduced the population of this species in Grand Traverse Bay. It has declined to near oblivion in various Great Lakes at the time the alewife became the dominant species.

The mimic shiner *(N. volucellus)* is found in ponds and the quiet backwaters of rivers. In our area, it has been found only in 2 small ponds along the Boardman River, near Kalkaska. In such habitats, it is probably an important food item for bass.

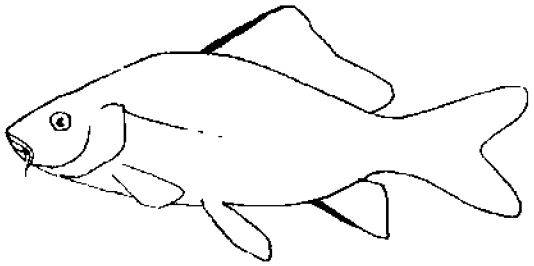


Sand Shiner

Identification of Minnows

Carp *(Cyprinus carpio)*

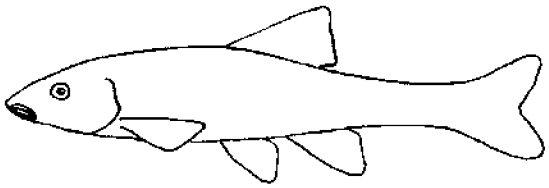
Large deep-bodied fish; dorsal and anal fins each with a strong anterior spine; two pairs of barbels on upper jaw.



Rhinichthys sp. have no groove between the snout and the upper lip.

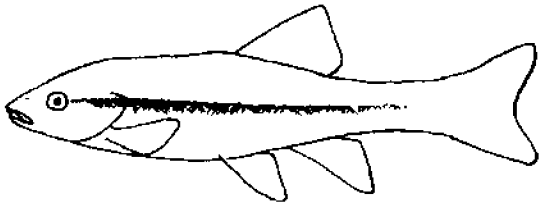
Longnose Dace *(Rhinichthys cataractae)*

Snout long, projecting far beyond mouth; lateral band absent.



Blacknose Dace *(Rhinichthys atratulus)*

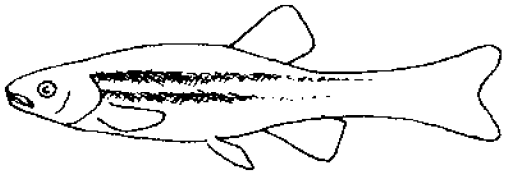
Snout short, barely projecting beyond mouth; distinct lateral band.



Phoxinus sp. have a groove between the snout and upper lip; mouth is terminal, not overhung by snout; there are more than 55 rows of scales along the lateral line; usually 8 anal rays.

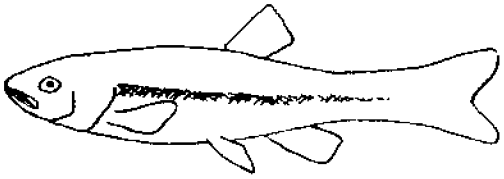
Redbelly Dace *(Phoxinus eos)*

Mouth small, jaws do not extend as far back as the eyes; Two parallel black lateral bands.



Finescale Dace *(Phoxinus neogaeus)*

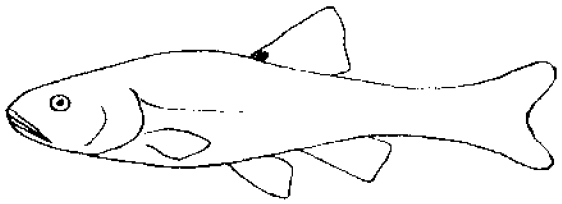
Mouth larger, jaws extending to anterior margin of the eye; minute scales; single wide black lateral band.



Semotilus sp. have a small barbel near the posterior end of the upper jaw (sometimes hidden in groove near upper lip).

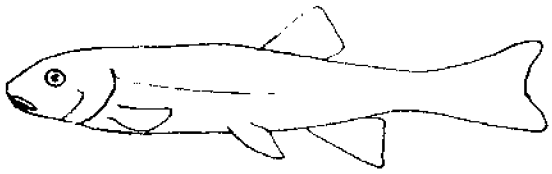
Creek Chub *(Semotilus atromaculatus)*

Small spot near anterior base of dorsal fin; upper jaw extending back as far as the eyes.



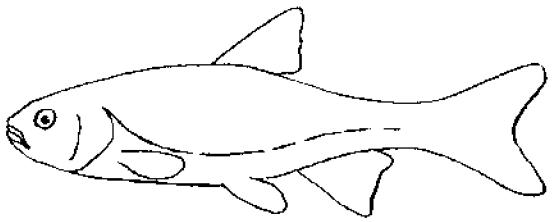
Pearl Dace *(Semotilus margarita)*

No black spot on dorsal fin; upper jaw does not reach as far back as the eyes; spawning males with red sides and belly.



Golden Shiner *(Notemigonus chrysoleucas)*

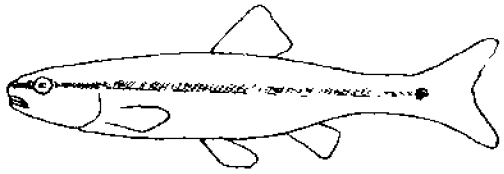
No barbel on upper jaw; abdomen behind pelvic fins with fleshy keel; 12 or 13 anal fin rays; lateral line curved downward and prominent.



Pimephales sp. have a black spot (sometimes faint) at the front of the dorsal fin. First dorsal fin half-ray is separated from first full length ray by a membrane.

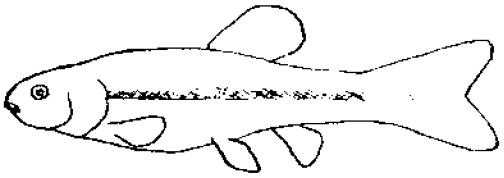
Bluntnose Minnow *(Pimephales notatus)*

Distinct dark caudal spot; lateral line complete; snout overhangs mouth.



Fathead Minnow *(Pimephales promelas)*

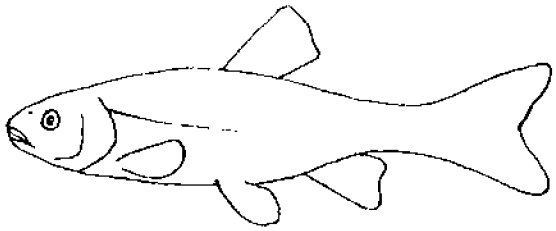
Dark spot on caudal fin faint; lateral line short or incomplete; mouth terminal and small; faint black lateral band on posterior only.



Notropis sp. usually have 8 dorsal fin rays. The first dorsal fin half-ray is closely attached to the first well-developed ray.

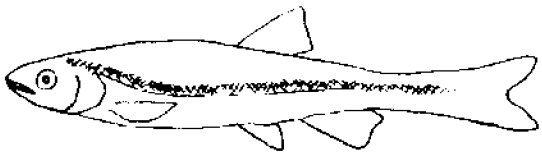
Common Shiner *(Notropis cornutus)*

9-12 anal rays; origin of dorsal fin directly above or anterior to the origin of pelvic fins; lateral line scales twice as high as wide. Scales flake off easily when handled.



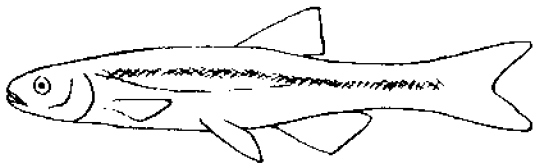
Rosyface Shiner *(Notropis rubellus)*

9-12 anal rays; origin of dorsal fin behind pelvic fin origin; snout sharp, long; pigmentation on sides as far down as lateral line.



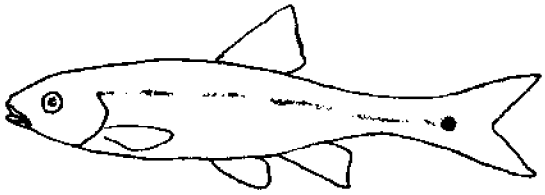
Emerald Shiner *(Notropis atherinoides)*

9-12 anal rays; origin of dorsal fin behind pelvic fins; snout blunt; pigmentation on sides terminating above lateral line.



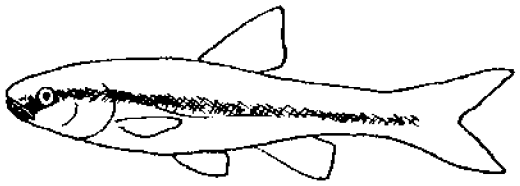
Spottail Shiner *(Notropis hudsonius)*

8 anal rays; large, conspicuous black spot at base of caudal fin; lateral band indistinct or absent.



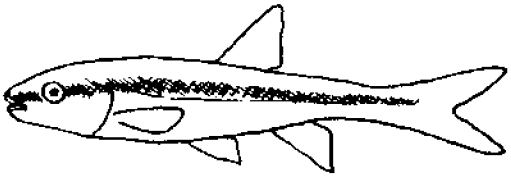
Blackchin Shiner *(Notropis heterodon)*

7 or 8 anal rays; lateral band complete, carried forward onto chin (chin black).



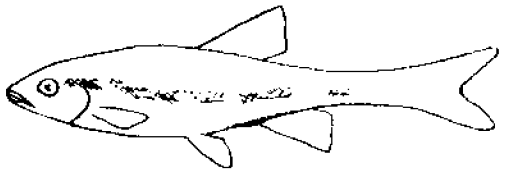
Blacknose Shiner *(Notropis heterolepis)*

7 or 8 anal rays; lateral band complete, carried forward onto snout, but not on chin.



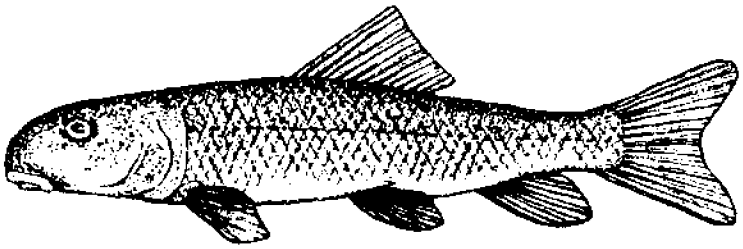
Mimic Shiner *(Notropis volucellus)*

8 anal rays; lateral band indistinct, not carried forward past eye; black pigment around anus and base of anal fin; some pigmentation below lateral line, no dorsal stripe.



Sand Shiner *(Notropis stramineus)*

7 anal rays; lateral band weakly developed, not continued forward past eye; no pigment about anus or below lateral line; thin dorsal stripe.



White Sucker

Sucker Family (Catostomidae)

The suckers are a large family (about 65 species) of bottom-dwelling freshwater fish. Suckers are found throughout North America, in parts of Siberia and in the Yangtse River in China. Although there are as many as 10 different species of suckers in the Lake Michigan drainage, only 2 suckers are common in the Grand Traverse Bay watershed. They are the white sucker *(Catostomus commersoni)* and the longnose sucker *(C. catostomus)*.

The white sucker is the most common sucker found in Michigan, and is able to inhabit a wide range of aquatic habitats including rivers, small streams and the Great Lakes. It reaches its greatest abundance in slow-moving rivers and inland lakes. The longnose sucker prefers the deeper waters of the Great Lakes, with specimens having been taken at a depth of 600 feet in Lake Superior. It is not present in local inland lakes.

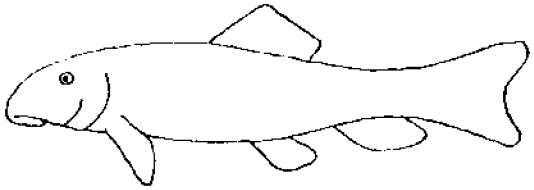
Both suckers spawn in the spring, in streams or on the gravel margins of lakes. The longnose sucker usually spawns earlier than the white sucker, when the water temperature reaches 41°F (5°C). White suckers begin spawning when the water reachers 50°F (10°C), usually after the last of the longnose suckers have left the spawning grounds. During the spawning season both suckers develop a black lateral band, sometimes with a rosy stripe below. There is no nest made although the adhesive eggs find some protection in the spaces between the gravel. Hatching occurs in about 2 weeks, with the young remaining in the gravel for another 2 weeks before moving downstream or to the deeper parts of the lake.

Suckers are bottom feeders, the characteristic sucking mouth being adapted for picking up and extracting food items from bottom sediments. Midge larvae, small clams, and snails are their most important foods. Suckers have been accused of being major predators on the eggs of more desirable species such as trout, whitefish, and walleye, but a number of scientific studies have shown them not to be a serious problem. Most of the suckers examined have had no eggs of any species in their stomachs.

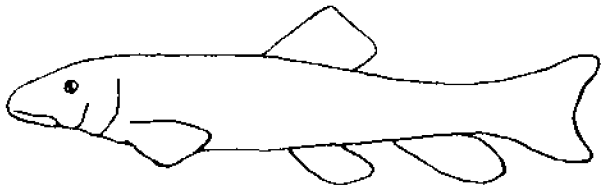
Suckers provide a sport fishery in some areas during the spring spawning runs. These fish are excellent eating after a visit to the smokehouse, but because of the many bones in the flesh, they are not a popular food fish. Suckers have also been taken commercially in the past, referred to by the commercial fishermen as mullet. However, there is no market for suckers at present. Food technologists are attempting to develop processing and marketing techniques which would offer a tasty and profitable product from these abundant, but generally under-utilized fish.

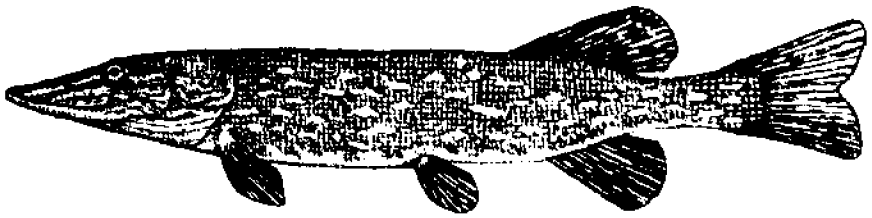
Identification of Suckers

White Sucker *(Catostomus commersoni)*
Fewer than 80 scales in lateral line; rounded snout.



Longnose Sucker *(Catostomus catostomus)*
More than 90 scales in lateral line; snout bluntly pointed.





Northern Pike

Pike Family (Esocidae)

A group of large predatory fishes, members of the pike family are widely distributed throughout the temperate norther hemisphere. In the Grand Traverse Bay area the family is represented by the northern pike *(Esox lucius)* and muskellunge *(E. masquinongy)*. Although both fish are very similar in appearance, biology, and behavior, the musky is nowhere as abundant as the pike. Whereas northern pike are found in many small lakes and around the shallow margins of large lakes, musky are more limited in their distribution, reaching greatest abundance in the Intermediate Lakes area. Northern pike and muskies hybridize in nature and in hatcheries to produce a faster growing, more robust fish called the tiger muskellunge.

Although fish make up 90 percent of the normal diet of adult pike and musky, they will nevertheless feed on virtually any living vertebrate that can be swallowed, incuding in their diet frogs, muskrats, mice, fish, and ducks. Consistently gluttonous, pike are said to consume enormous amounts of food. One fishery biologist estimated that pike kill 1,500,000 ducks annually in the upper peninsula's Seney Wildlife Refuge (Lagler 1956). Pike are also cannibalistic, and occasionally two pike of almost equal size are found dead with the smaller jammed into the mouth of the larger. A pike can eat a fish about half its own weight, although miscalculation may be fatal, as the pike's backward pointing teeth do not allow it to disgorge prey that are too large.

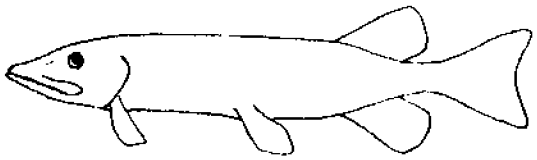
In Michigan, members of the pike family prefer the clear, warm, weedy shallows of lakes and sluggish rivers. They are solitary, sedentary types, who enjoy the cover of vegetation. Lying in wait for its prey behind the cover of water-weeds, the pike strikes out with a powerful stroke of its tail, invariably taking a prey fish sideways in the mouth. A pike often retreats to protective cover before it turns the food item in its mouth and swallows it head first. For this reason fishermen are often advised to let a pike swim off some distance with a bait minnow, waiting for him to take the bait a second time, before setting the hook.

Spawning takes place soon after the ice goes out in lakes during April or May. Northern pike and musky often utilize the same spawning sites, in feeder streams or flooded marshes, laying their eggs over vegetation in water often no deeper than 6 inches. An average female pike lays about 30,000 eggs, while the average female musky contains 4 times as many eggs. Under normal conditions eggs hatch within 2 weeks. Mortality of eggs and young is estimated to be very high, reaching over 99 percent for members of the pike family. A high percentage of eggs are not fertilized. Some are eaten by fish or predacious diving insects, while many are killed by fluctuating water temperatures. The fry grow very rapidly, and within several weeks are feeding on smaller fish, including the young of their own species. Northern pike spawn several weeks earlier than muskies, and in places where the 2 species occupy the same spawning grounds, predation by pike fingerlings upon newly hatched muskies is considered to be a major source of muskellunge mortality.

Both pike and muskellunge exhibit a striking sexual dimorphism. Females grow faster and live longer than males. Consequently all really notable size pike are females. Curiously, pike also seem to grow larger in Europe. In Britain alone at least 8 pike have been caught that exceed the North American record of 46 pounds, 2 ounces.

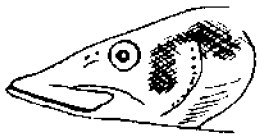
Identification of Pikes

Northern pike and musky may show variation in color and markings from each lake in which they are taken, therefore descriptions are rather general. Tiger muskies have definite dark bars on the sides (hence the name) but other characteristics are intermediate between the two native species.



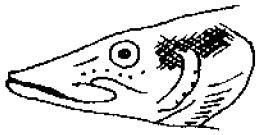
Northern Pike *(Esox lucius)*

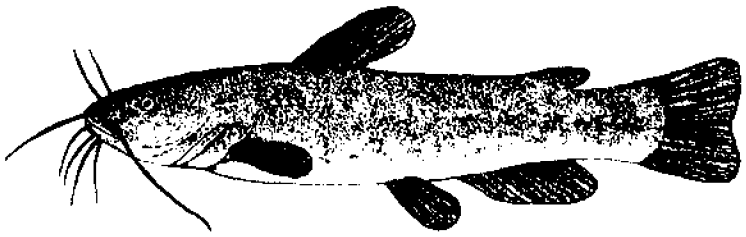
Cheek fully scaled; body markings in the form of light spots on a darker background.



Muskellunge *(Esox masquinongy)*

Cheek usually without scales on lower half; body pattern of dark spots or bars over a lighter background.





Brown Bullhead

Catfish Family (Ictaluridae)

Catfishes are scaleless fish with an adipose fin, and a large flattened head with several pairs of barbels underneath. They have attracted a great deal of interest because of their commercial and pond cultural value, their ability to produce and receive sounds through the use of the swim bladder, and their highly developed sense of taste associated with the barbels. Although the cold, deep lakes and rushing streams that typify our area are not their preferred habitat, catfish are nevertheless represented in our area by the channel catfish *(Ictalurus punctatus)*, yellow bullhead *(I. natalis)*, brown bullhead *(I. nebulosus)*, and the black bullhead *(I. melas)*.

Catfishes spawn in May or June when water temperatures reach 70-80°F (21.1-26.7°C). Shallow nests are excavated, usually in the protection of an underwater obstruction such as a stump, hole, or undercut bank. Eggs deposited in the nest are cared for by one or both parents. They are fanned and occasionally stirred with barbels or fin spines. This manipulation is apparently necessary as bullhead eggs will not hatch without it.

The young catfishes hatch within 2 weeks. They resemble tadpoles, and are brooded by the parents for several weeks, until they are about an inch long. Growth rates are extremely variable and some northern populations of channel catfish may barely grow an inch per year. Catfishes grow twice as fast if water temperatures are fairly warm and food is plentiful. All catfishes are largely nocturnal feeders, using their highly developed sensory barbels to probe the bottom for food. They are scavengers, feeding on almost anything including minnows, crayfish, small invertebrates, and aquatic plants.

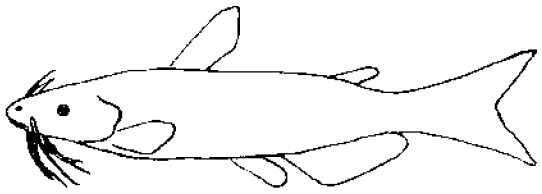
Brown bullhead are by far the most abundant catfish in our area. They usually occur in warm, shallow, heavily vegetated lakes and impoundments. Bullheads are able to survive very high water temperatures (up to 95°F, 35°C), low oxygen concentrations (down to 0.2 ppm in winter), and heavy pollution. In fact, bullheads may reach their greatest abundance in waters that display some combination of these adverse conditions because their tolerance makes them sole beneficiaries of the food resources available in such bodies of water. Channel catfish are not quite as tolerant, avoiding the more turbid vegetated water frequented by the bullheads. They are usually found in the cool clear water of lakes and rivers but have been reported only from Elk Lake in our area.

Despite their coarse feeding habits, the larger members of the catfish family make delicious food and are much appreciated as game fish in many states.

Identification of Catfishes

Channel Catfish *(Ictalurus punctatus)*

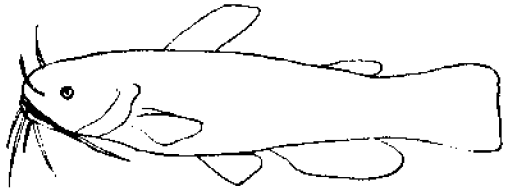
Caudal fin deeply forked; body speckled with dark spots; length up to 24 inches.



Bullheads have round, square, or slightly forked caudal fins. Bullheads are less than 12 inches in total length.

Brown Bullhead *(Ictalurus nebulosus)*

Chin barbels gray to black; pectoral fin spine with strong barbs on the posterior edge (fish can be picked up by grasping the spine between thumb and forefinger).

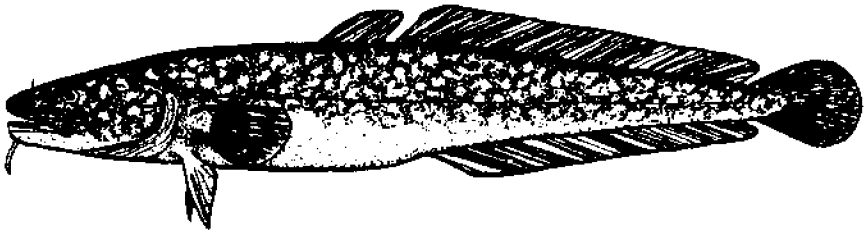


Black Bullhead *(Ictalurus melas)*

Chin barbels gray to black; no definite barbs on pectoral fin spine.

Yellow Bullhead *(Ictalurus natalis)*

Chin barbels whitish; pectoral fin spine with relatively small, weak barbs (cannot be picked up by spine).



Cod Family (Gadidae)

Burbot *(Lota lota)*

Burbot, also known as lawyers, are the only members of the cod family to successfully complete the transition to an entirely freshwater environment. They are a bottom fish, common to the clear, cold waters of the Great Lakes and deeper inland lakes.

Burbot commonly spawn under the ice in late winter over sand or gravel in 1 to 4 feet of water. Actual spawning is said to occur as a dozen or so burbot form an undulating mass several feet in diameter. As the fish move over the bottom, the eggs are sprayed out. No nest is built and no care is given to the young (Scott and Crossman 1973).

Young burbot are nocturnal animals which hide in the cover of stones and roots during the daylight hours, foraging at night for aquatic insects and crustaceans. By mid-summer the burbot have moved into deeper, cooler water. Optimum temperature is about 60°F (15.6°C).

Larger burbot are almost entirely piscivorous. They feed on any available fish including ciscoes, sculpins, smelt, and alewives. Burbot are also known to feed on cisco eggs.

Because of their bottom-dwelling habits, burbot are cast into the role of predators upon, or competitors with, many of our more valuable commercial and sport species such as the lake trout, ciscoes, and whitefishes. Their population was greatly reduced in Grad Traverse Bay by lamprey predation and fishermen's nets, but is now making a steady comeback. Burbot are also occasionally taken in Torch Lake and Elk Lake.

Identification of Burbot

Burbot *(Lota lota)*

Chin with single barbel; elongated second dorsal and anal fins; rounded caudal fin.

Killifish Family (Cyprinodontidae)

Banded Killifish *(Fundulus diaphanus)*

The banded killifish are small fish inhabiting ponds and streams in the Grand Traverse Bay region. They can be seen in schools over sand-bottom shallows, in which case they are usually mistaken for true minnows.

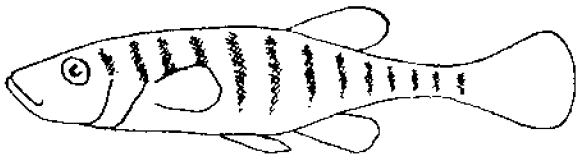
Killifish have an upward opening mouth adapted for surface feeding, although they are also known to feed on bottom-dwehey are also known to feed on bottom-dwelling organisms. Spawning occurs at about 70°F (21.1°C) in quiet weedy areas of ponds or streams. Each female lay about 50 eggs.

Killifish are very hardy and make good live bait. They have been reported to live for hours packed only in wet leaves.

Identification of Killifish

Banded Killifish *(Fundulus diaphanus)*

Rounded caudal fin; 12-20 dark vertical bars usually apparent on sides; mouth small, directed upward.



Silverside Family (Atherinidae)

Brook Silverside *(Labidesthes sicculus)*

The brook silverside is one of the most unusual looking fish of our local fauna. They are almost translucent, with a silvery lateral stripe along the body. The beak-like mouth and twin dorsal fins add to the distinctiveness of this fish.

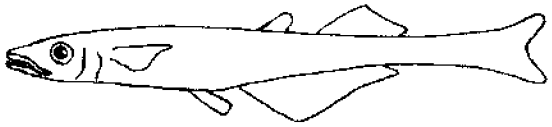
The silverside is our only native fish whose eggs float on the surface of the water rather than sinking to the bottom. Each silverside egg is rafted by oil droplets and attached to a long stickly filament which anchors it to the first object it contacts. Young silverside grow very rapidly reaching maximum size within 1 year. They live through winter to spawn and die the following spring. Few of these fish reach 2 years of age.

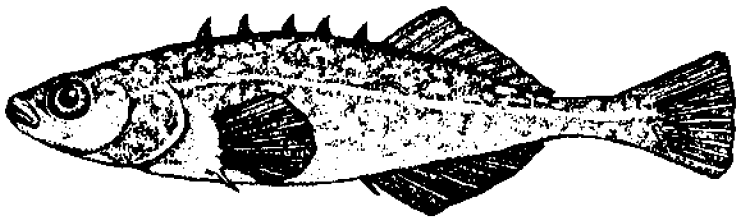
The brook silverside is adapted for swimming along the surface as the development of its fins indicates. With its large, toothed jaws the silverside snaps up insects on the surface. At certain times of the year, up to 40 percent of its diet is composed of flying insects snared by leaping out of the water. This bizarre behavior has earned them the name "skipjack" in some areas.

Identification of Silverside

Brook Silverside *(Labidesthes sicculus)*

Slender, transluscent fish; anal fin much larger than dorsal; mouth turned up.





Brook Stickleback

Stickleback Family (Gasterosteidae)

Sticklebacks are small, aggressive fish with sharp dorsal spines forward of the dorsal fin. They are easily identified by counting the spines. There are two species in our area, the brook stickleback *(Culeau inconstans)*, with three spines and commonly found in streams and ponds, and the ninespine stickleback *(Pungitius pungitius)*, a native to Grand Traverse Bay.

Male sticklebacks build nests from dead grass or aquatic vegetation, sticking the fibers together with a special kidney secretion. The finished nest is tunnel-shaped and rests on aquatic vegetation. Each species of stickleback employs an elaborate courtship ritual by which the male entices the female into his nest. The male brook stickleback is a surly character, who when mating butts the female with his head until she sinks passively to the bottom. He then swims into the nest, and she follows. The male ninespine stickleback makes similar rushing advances but usually doesn't touch the female. Each male stickleback, having enticed the female to follow him, waits at the entrance of the nest while the female lays her eggs, and then goes in to fertilize them. The male guards the nest and fans the eggs until they hatch in 8 to 9 days.

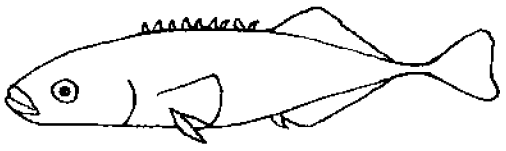
Both species of sticklebacks feed on a variety of aquatic insects and crustaceans. Life expectancy is about 3 years.

In our region the territories of these two species appear to be mutually exclusive. Brook stickleback are found in ponds and brooks where they can be seen sculling around with their pectoral fins and occasionally darting to the bottom for some food morsel. Ninespine stickleback are reported from only a few inland lakes in Michigan, but are abundant in Lake Michigan at depths to 360 feet. The ninespine stickleback was a common food of lake trout in northern Lake Michigan.

Identification of Sticklebacks

Brook Stickleback *(Culaeu inconstans)*
Five dorsal spines.

Ninespine Stickleback *(Pungitius pungitius)*
Nine dorsal spines.



Trout-perch Family (Percopsidae)

Trout-perch *(Percopsis omiscomaycus)*

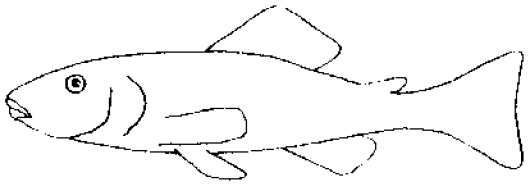
As implied by the name, trout-perch combine characteristics of the more primitive trout-like fish with those of the more advanced spiny-rayed fish. The surviving members of the trout-perch family, only two species, are considered relicts of a larger family group now extinct. One species occurs in our area.

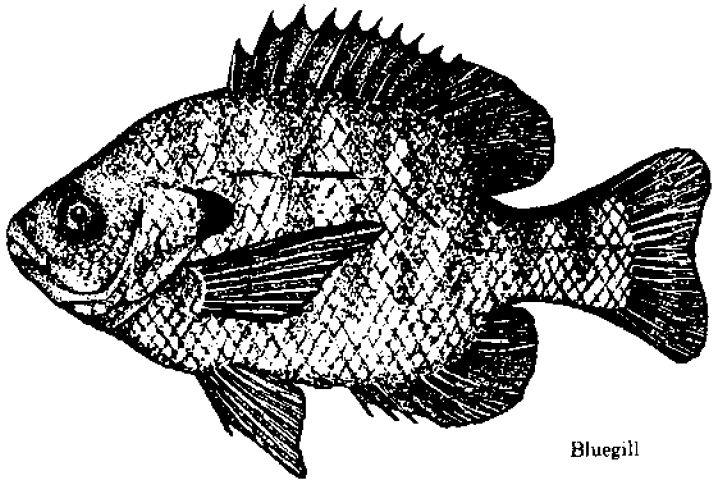
Trout-perch are normally found in the shoal waters of large lakes where they feed at night, returning to deeper waters at dawn. This marked nocturnal movement is noted wherever the fish has been studied. Trout-perch spawn in the lower reaches of streams, or over the gravelly shoal waters of large lakes in late spring. They are considered to be good forage fish for trout, pike, and bass. Collected in Torch Lake, Intermediate Lake, and the west arm of Grand Traverse Bay by University of Michigan biologists in the 1930's, trout-perch have not been reported from this area in recent years.

Identification of Trout-perch

Trout-perch *(Percopsis omiscomaycus)*

Adipose fin present; 2 spines in dorsal fin; 5 rows of dark spots along body.





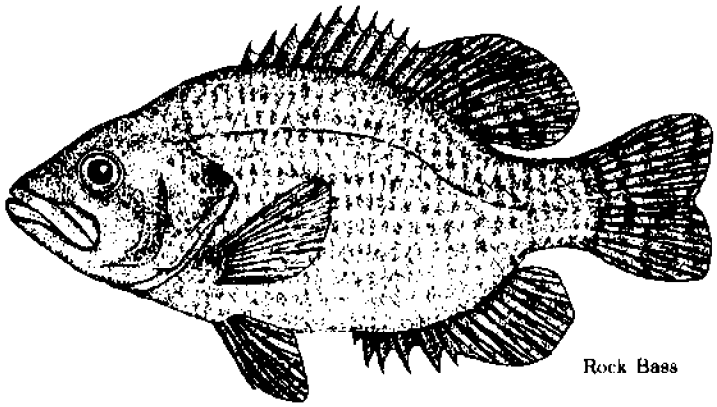
Bluegill

Sunfish Family (Centrarchidae)

Sunfishes are among the most conspicuous and attractive fishes of warmer lakes and ponds in the Grand Traverse Bay region. This important family of exclusively North American fish is represented in our area by the bluegill *(Lepomis macrochirus)*, pumpkinseed *(L. gibbosus)*, longear sunfish *(L. megalotis)*, green sunfish *(L. cyanellus)*, black crappie *(Pomoxis nigromaculatus)*, rock bass *(Ambloplites rupestris)*, largemouth bass *(Micropterus salmoides)*, and the smallmouth bass *(M. dolomieui)*.

Although varying considerably in appearance, all members of the sunfish family possess similar anatomical features, habitat requirements, and behavioral characteristics. They are small to moderately sized, and disc shaped. The head and mouth are generally quite small, with the mouth bearing small teeth. The most distinctive feature of sunfishes is the single dorsal fin comprised of 2 parts. The anterior part has 6-13 hard spines while the posterior part is composed of soft rays. Some sunfishes exhibit a more or less distinct division between the 2 parts of the dorsal fin, as in the basses, but there are never 2 separate dorsal fins.

Spawning behavior among members of the sunfish



Rock Bass

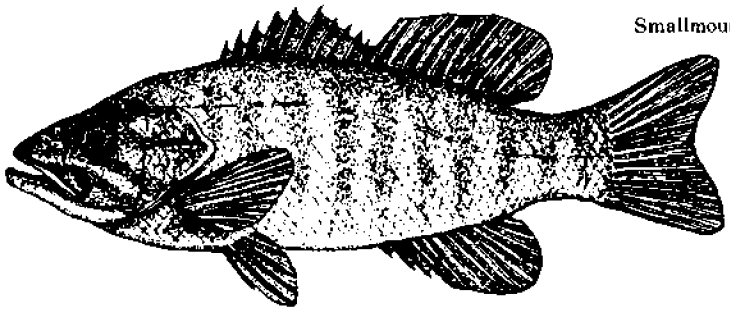
family is remarkably similar. Males appear on the spawning grounds in late spring or early summer, and begin nest-building in shallow water. Nests are usually constructed in the vicinity of logs, rocks, or submerged vegetation, presumably to provide protection for the young sunfishes. Covering several square feet, the completed nests are either hollow depressions or simply areas swept clean of silt and debris, which resemble shallow craters when viewed from above. During the spawning period male sunfishes are intensely territorial, each species guarding a set amount of territory against the incursions of other fish, particularly other sunfishes. The size of the protected domain determines the spacing between individual nests. For instance, largemouth bass maintain a spacing of at least 30 feet between nests, while bluegill and other smaller sunfishes spawn in colonies with up to 30 nests in an area of 160 square feet.

Ripe females are attracted to the nests by males who may employ various courtship maneuvers and displays. During the spawning act, the male sunfish remains upright with the female lying at a 45 degree angle to his body, so their ventral surfaces touch. Small numbers of eggs and sperm are released in each spawning act, and the female may move on to spawn with several males in several different nests. The male remains to guard the nest and fan the eggs until they hatch in 3 to 10 days.

Spawning success depends upon a great number of factors including fecundity of the individual fish, fertility of the eggs, fungal infection of the eggs, changes in water temperature, wind, waves, and predation by other fishes. Often 40 percent of smallmouth bass nests are complete failures, with the most successful nests producing only about 2,000 fry. By comparison, bluegill may produce 250,000 fry from a single nest.

Sunfishes grow quite rapidly in their early years, feeding on a variety of planktonic and benthic creatures. As they grow larger the young sunfishes begin to show more specialization in feeding. Bluegill are quite versatile feeders, ingesting some plant material as well as the usual invertebrates and small fish. Large sunfishes, especially the basses, feed more heavily on crustaceans and small fish. Crayfish comprise 60-90 percent of the diet of some populations of adult smallmouth. Largemouth bass are generally shallow-water feeders, taking fish, crayfish, frogs, and fish fry. Sunfishes do their heaviest feeding in waters of 70°F (21.1°C) or more. In winter when water temperatures fall below 50°F (10°C) most sunfishes congregate in schools near lake bottoms, grow sluggish and feed very little. For this reason sunfishes grow more slowly and reach sexual maturity at a later age in northern waters.

The Grand Traverse Bay region lies near the northern edge of the range for many sunfishes. Those



Smallmouth Bass

fishes which are able to spawn and remain actively feeding at slightly lower temperatures than their close relatives enjoy a definite survival advantage in our area. It is no accident that our most abundant and widely distributed sunfishes, the rock bass, bluegill, and smallmouth bass, spawn in relatively cool water (60-65°F, 15.6-18.3°C) and are versatile in their habitat requirements.

Competition among the sunfishes for available spawning sites and food is sometimes severe, and for this reason many lakes fail to establish well developed sunfish populations. Some lakes contain only 1 or 2 species, and population explosions of these fishes often create a population of stunted fish, especially in the absence of larger predators. These conditions may be remedied by the introduction of predator fishes, or by poisoning and restocking of a lake.

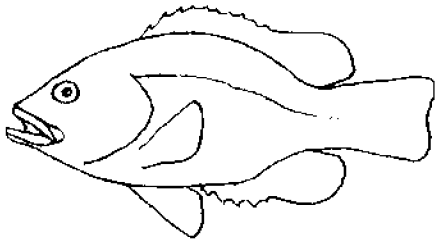
Grand Traverse Bay holds sizable populations of smallmouth bass and rock bass. Before recent salmonid plants, smallmouth bass were the primary game fish of the bay. Now most anglers ignore this fish, concentrating their efforts on the more glamorous trout and salmon. Those interested will find good smallmouth fishing over the rocky bottoms near Old Mission Point, off Raft's Camp, and north of Norwood.

Identification of Sunfishes

Two species of sunfish have six anal spines.

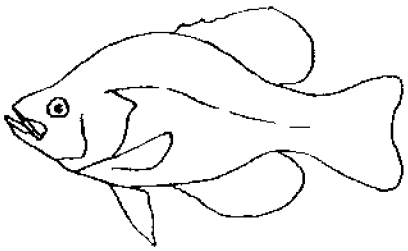
Rock Bass *(Ambloplites rupestris)*

6 anal spines; 10-12 dorsal spines; head and mouth quite large for a sunfish; not brightly colored. Red eye; dark spots form rows along body.



Black Crappie *(Pomoxis nigromaculatus)*

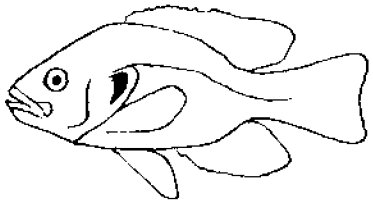
6 or 7 anal spines; 7 or 8 dorsal spines; irregular mottling on sides. Dorsal fin and anal fin approximately same size.



All other members of the sunfish family have 3 anal spines.

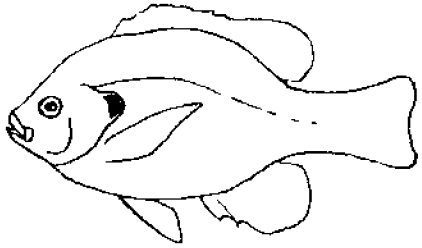
Green Sunfish *(Lepomis cyanellus)*

Gill rakers long and slender; pectoral fins short and rounded; black area on opercular (ear) flap edged in red or yellow.



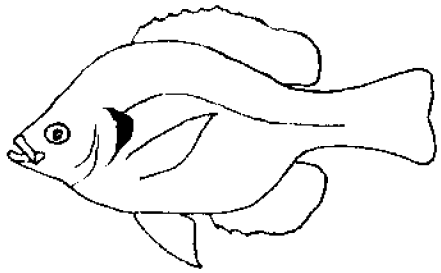
Pumpkinseed *(Lepomis gibbosus)*

Gill rakers short and knobbed; pectoral fins long and pointed; black area on opercular flap edged in white with a single scarlet spot.



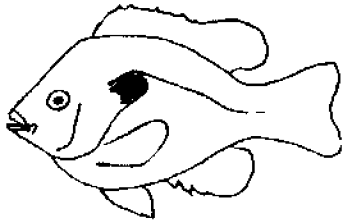
Bluegill *(Lepomis macrochirus)*

Gill rakers long and slender; pectoral fins long and pointed; black area extends to edge of opercle (no border).



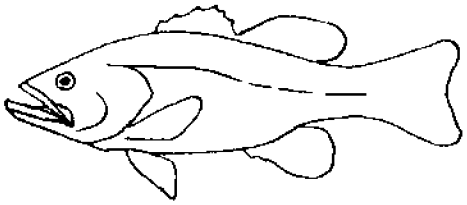
Longear Sunfish *(Lepomis megalotis)*

Gill rakers short and knobbed; pectoral fins short and rounded; black area of opercular flap turned upward, edged in red or yellow.



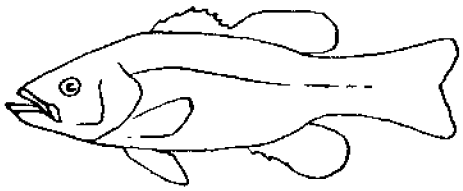
Largemouth Bass *(Micropterus salmoides)*

Dorsal fin almost divided; upper jaw extends beyond hind margin of eye. Black lateral stripe prominent in young.



Smallmouth Bass *(Micropterus dolomieui)*

Shortest spine of dorsal fin more than $\frac{1}{2}$ the length of longest spine; upper jaw extends to middle of eye; 7-13 broad stripes usually apparent on sides.

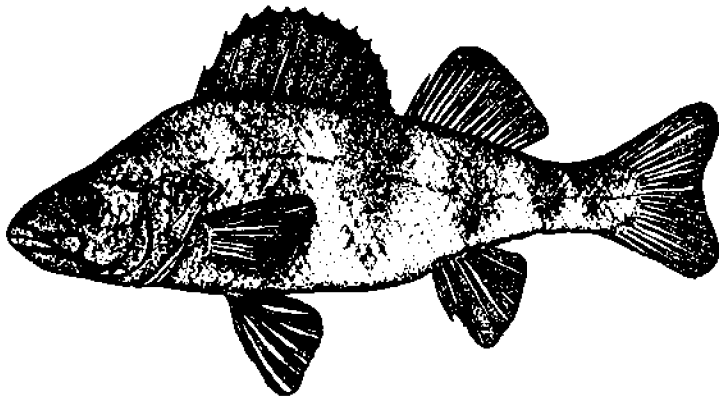


Perch Family (Percidae)

The perch family contains 121 species worldwide, in both fresh and salt water. There are 5 representatives of the family in our area. Walleye and yellow perch are popular game fish, while logperch, Johnny darter, and Iowa darter are small bottom-dwelling fish, seldom seen by the casual observer.

Members of the perch family have two distinctly separated dorsal fins, the first with spiny rays and the second with mostly soft rays. The gill covers have a single flat spine and the scales have noticeably rough edges.

Young perch and walleye have a small tube connecting the swim bladder to the throat. Several days after hatching, they rise to the surface and gulp air to fill the swim bladder. Darters do not have swim bladders, as they are not needed by fish that stay on the bottom of lakes or streams.



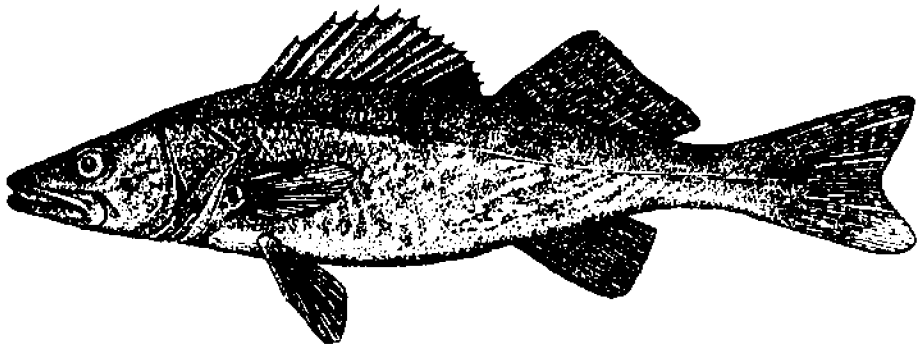
Yellow Perch *(Perca flavescens)*

Perch are one of the most adaptable and abundant fishes of our lakes and ponds. They are a rather sedentary fish, often found in large schools around weed beds or underwater obstructions in 6-20 feet of water. The coloration of a perch indicates something about where he has been, and it is possible to distinguish the white-bellied perch of deep, poorly lit waters from the more yellowish fish of shallow vegetated lakes.

Spawning occurs during the spring, in shallow areas where there is dense vegetation or roots, when water temperatures reach 40-50°F(4.44-10°C). Perch eggs have a heavy mucous layer, giving them a sticky consistency. This allows the female to expel them in long threads, which she winds around plant stems and twigs. The egg masses are aerated by water currents and if the weather remains good for 2 to 3 weeks, hatching success is usually very high.

Young perch feed on plankton and disperse throughout the upper water layers. If the food supply is low, many of the young will either die or grow very slowly, resulting in a population of stunted perch. With an adequate food supply of small crustaceans and small fishes, the young perch should be 5 to 7 inches long after 2 years.

Adult perch feed on aquatic insects, especially dragonfly nymphs, crayfish, and small fishes. Perch are a favorite food of loons, mergansers, and larger fishes such as walleye, bass, and northern pike.



Walleye *(Stizostedion vitreum)*

The walleye is the largest member of the perch family (up to 25 pounds) and has the greatest latitudinal range of any North American fish, inhabiting waters as far south as the Alabama Gulf Coast and as far north as the Mackenzie River's arctic drainage. The walleye is a much sought-after game fish, well known for the fine taste of its flesh.

Walleye spawn during April or May over rocky areas in rivers or on the rocky wave-swept shoals of lakes. Each female is usually attended by several males, and she may release up to 500,000 eggs. Water movement is required for incubation of the eggs, which are left untended and hatch in 2 to 3 weeks.

Walleye usually occupy large shallow lakes or shallow bays of the Great Lakes. They prefer a habitat intermediate to that of the deep cold lakes characterized by salmonid populations and the warmwater lakes and ponds usually containing sunfishes. Walleye are generally found in association with yellow perch, northern pike, and smallmouth bass. In our area they are found throughout the Chain-O-Lakes but are most abundant in Intermediate and Bellaire Lakes.

Although aquatic insects may form a large part of their diet at certain times of the year, walleye are primarily fish eaters. They prey on a wide range of smaller fishes, especially perch, sunfishes, and immature pike. Walleye are a very desirable food and game fish, yet management officials hesitate to plant them in many lakes because of walleye predation on other desirable fishes, particularly bass and trout.

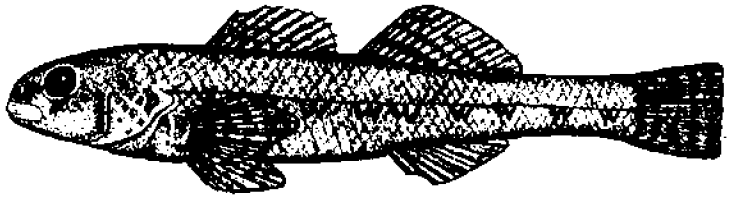
Logperch *(Percina caprodes)*

Although seldom detected due to their small size (usually 3 to 4 inches) and camouflage coloration, logperch are common in our larger inland lakes and Grand Traverse Bay. Often mistaken for young perch, logperch can be distinguished by their squared off tail and much more elongated body.

Logperch spawn in late spring, when males congregate in large schools over sand shallows. The females lie in deeper water, occasionally swimming through the school of males, extruding 10-20 eggs with each pass. During the spawning act males and females vibrate together which helps to bury the eggs in the sand. Eggs which are not buried are quickly devoured by nonspawning male logperch, or by other fish.

Inhabiting deeper water than the other darters, logperch are most often found along the bottom in water 4-12 feet deep. They feed mainly on aquatic insects and small crustaceans. Logperch become the food of large piscivorous fishes, having been found in the stomachs of trout, walleye, and northern pike.

Logperch are present in Grand Traverse Bay and the Chain-O-Lakes.



Johnny Darter *(Etheostoma nigrum)*

Johnny darter are inhabitants of clean streams and the sand and gravel margins of lakes. Though sometimes mistaken for minnows, they can be distinguished by their paired dorsal fins and rounded caudal (tail) fin. The Johnny darter can also be identified by the series of W-shaped marks along its sides.

Spawning occurs in the spring, with the male preparing a nest under rocks. After spawning, the male guards the nest, fanning the eggs to provide aeration and prevent siltation. Hatching occurs in 1 to 2 weeks.

Midge and mayfly larvae are the most important food sources for the Johnny darter, although zooplankton and other small organisms are also consumed.

Often found in association with logperch, Johnny darter are common in Grand Traverse Bay and in the Chain-O-Lakes.

Iowa darter *(Etheostoma exile)*

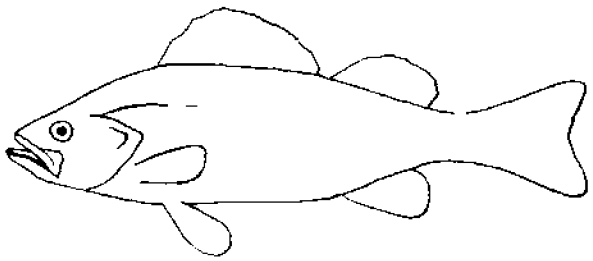
Iowa darter are bottom dwelling inhabitants of clear, cool streams and the margins of lakes. They prefer a bottom of sand or mud with rooted vegetation for hiding and obtaining food items. The Iowa darter is somewhat more tolerant of cold water and has been able to extend its range to areas not occupied by our other two darters (the logperch and Johnny darter). It is the only darter found in the Boardman River valley.

Iowa darter deposit their eggs over mud bottomed areas having roots or other organic debris as the water warms in late spring.

Adult Iowa darter feed on zooplankton and aquatic insect larvae. They may live 3 years and grow to a length of 2.5 inches.

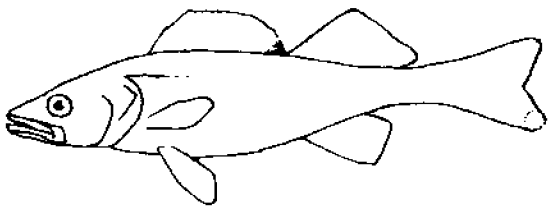
Identification of Perches

Yellow perch and walleye have distinctly forked tails and large mouths, the upper jaw extending to the midpoint of the eye or beyond.



Yellow perch *(Perca flavescens)*

Anal fin with 2 spines and 6-8 soft rays; teeth in lower jaw of about equal height (no canines); 6-8 dark vertical bars usually apparent on sides.



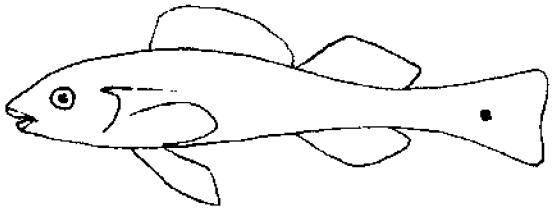
Walleye *(Stizostedion vitreum)*

Anal fin with 2 spines and 12 or 13 soft rays; canine teeth present on lower jaw; lower lobe of caudal fin with light blotch; black spot at posterior base of first dorsal fin.

Darters (genera *Percina* and *Etheostoma)* have squared or slightly rounded tails and small mouths. They are never over 6 inches long.

Logperch *(Percina caprodes)*

13-16 spines in the first dorsal fin; anal fin large, equal in size to second dorsal; tail squared; black spot at base of caudal fin.

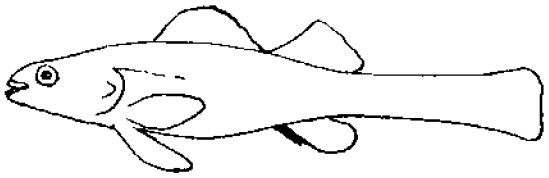


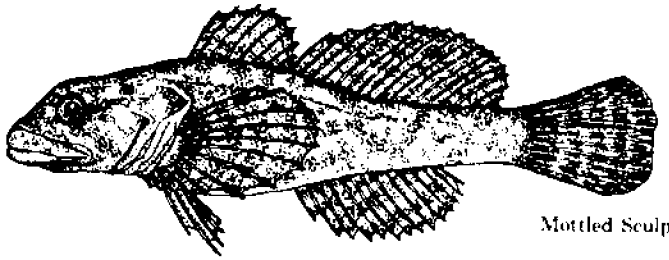
Johnny Darter *(Etheostoma nigrum)*

8-9 spines in first dorsal fin; anal fin smaller than second dorsal fin; one anal spine; distinct X, M, or W-shaped markings on sides.

Iowa Darter *(Etheostoma exile)*

8-10 spines in first dorsal fin; anal fin smaller than second dorsal fin; caudal fin rounded; two anal spines; 10-12 vertical bars on sides.





Mottled Sculpin

Sculpin Family (Cottidae)

Although seldom seen, sculpins are nearly ubiquitous inhabitants of cold clear waters from the smallest trout streams to the deepest recesses of the Great Lakes. They hug the bottom of rushing streams and cold lakes darting about in search of aquatic insect larvae. Although considered by many to be bizarre little fish because of their reclusive habits and flattened shape (miller's thumb is a rather imaginative common name), they nevertheless are important members of the fish fauna.

Two sculpins are common inhabitants of our local trout streams and cold lakes. The mottled sculpin *(Cottus bairdi)* and the slimy sculpin *(C. cognatus)* are so similar in habit and appearance that trained professionals have difficulty differentiating the 2 fish. In general, the slimy sculpin prefers slightly colder water than the mottled sculpin. The slimy sculpin is usually found in the upper reaches of trout streams or in the deeper, colder parts of lakes. The mottled sculpin is common in the mid-reaches of streams and along the shores of lakes.

Both of these sculpins spawn in the spring. Males select the nesting site under a submerged rock or log. Usually more than one female will be attracted to the nest. After brief courting, a single female enters and while upside down deposits her adhesive eggs on the roof of the nest. She leaves or is chased out while the male remains to guard the eggs and fan them with his pectoral fins. Details of the growth and development of sculpins are not well known, but sculpins usually spawn at age 3 when they are several inches long.

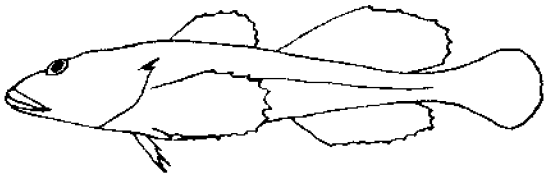
The deepwater or four-horned sculpin *(Myoxocephalus quadricornis)* is a unique and important member of the Great Lakes benthic community. It has been reported in the U.S. only in Torch Lake and the Great Lakes. Surveys of Lake Michigan conducted by the U.S. Fish and Wildlife Service in 1961 reported deepwater sculpin in water from 150 to 600 feet, being most abundant from 240 to 300 feet deep. Little is known about these fish, except that they feed largely on *Mysis*, copepods, and chironomids, and in turn are preyed upon by lake trout and burbot.

The spoonhead sculpin *(C. ricei)* is a lake inhabitant of which little is known. They are apparently intermediate in depth distribution between the slimy sculpin and the deepwater sculpin. This fish has been found in the stomachs of lake trout from Grand Traverse Bay.

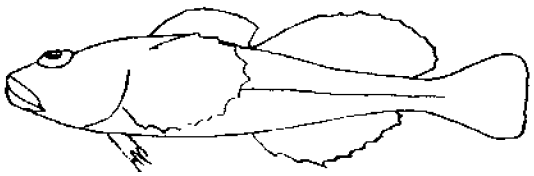
The sculpins are of considerable interest to biologists because they form an important link in the food chain between small aquatic organisms and large, bottom-feeding predators. Lake trout in particular feed heavily on sculpins, and with the recent decline in deepwater cisco populations, the sculpins may be one of the most stable and readily available food sources for the trout.

Identification of Sculpins

Deepwater Sculpin *(Myoxocephalus quadricornus*
Dorsal fins not joined



Spoonhead Sculpin *(Cottus ricei)*
Dorsal fins joined or touching; lateral line complete.



Slimy Sculpin *(C. cognatus)* and **Mottled Sculpin** *(C. bairdi)*

Dorsal fins joined or touching; lateral line incomplete. Differentiation of these two sculpins is extremely difficult.

GLOSSARY

Adipose fin	A small fleshy fin found on the back of some fish, located between the dorsal and caudal fins.
Algae	Simple, usually microscopic, non-vascular plants. Algae form the basis of the aquatic food chain.
Ammocete	The larval form of lampreys.
Anadromous	Ascending streams to spawn.
Anterior	Forward, toward the head.
Benthic	Living on the bottom of lakes or streams.
Copepods	Small crustacean zooplankton. These minute creatures are important food items for small fishes.
Crustaceans	Small aquatic animals of the phylum Arthropoda, including crayfish, amphipods, copepods, shrimps, and water fleas.
Dorsal	Referring to the back, or top, of fish.
Lateral line	A sensory system along the sides of fish. See External Features Section.
Midges	Two-winged flies of the order Diptera, having aquatic larval stages.
Mysis	A small shrimp-like invertebrate animal found on the bottom of deep cold lakes. An important food item for some species of fish.
Omnivorous	Feeding on any type of available organic material.
Ovipositor	An extension of the female genitals used to insert eggs in the stream or lake bottom.
Parr marks	Dark vertical marks on the sides of young salmon and trout.
Pectoral fin	Paired fins located most anterior (forward) on fish. See External Features Section.
Pelvic fin	Paired fins located between the pectoral and anal fins. See External Features Section.
Pharyngeal teeth	Bones in the throat of some fishes, used for crushing food.
Phytoplankton	Plants, floating or suspended in the water column.
Planktonic	Floating or suspended in the water column.
Pontoporeia	Amphipod or scud living on the bottom of lakes. An important food item for fish. Common in Grand Traverse Bay.
Posterior	Toward the rear of a fish.
Riffle	Area of swift moving water in a stream, usually with a cobble or gravel bottom.
Sexual dimorphism	The difference in appearence of male and female in some species.
Smolt	A growth stage of salmonids, at 1 to 3 years, depending on species, at which time the fish migrate downstream into the lake or sea.
Swim bladder	Also called gas bladder and air bladder. A gas-filled sac in the body cavity of most fishes used to regulate bouyancy. It also aids in the respiration of some fishes.
Ventral	The bottom, or lower, area of a fish.

REFERENCES

Baldwin, N.S., and R. W. Saalfeld. 1962. *Commercial Fish Production in the Great Lakes, 1867-1960.* Great Lakes Fishery Commission, Ann Arbor, Michigan. Technical Report No. 3.

Chiotti, T. L. 1973. Food habits, reproductive biology, and lamprey scarring of planted lake trout *(Salvelinus namaycush)* in the inshore waters of Lake Michigan at Ludington, Michigan. M. S. thesis, Michigan State University, East Lansing, Michigan.

Cleland, C. E. 1966. *The Prehistoric Animal Ecology and Ethnozoology of the Upper Great Lakes Region.* University of Michigan, Ann Arbor, Michigan. Anthropological Paper No. 29.

Colby, L. 1971. *Grand Traverse Bay in the Great Lakes Basin, a History of a Changing Area.* Michigan Sea Grant Program, Ann Arbor, Michigan.

Dorr, J. A., Jr., and D. F. Eschman. 1970. *Geology of Michigan.* University of Michigan Press, Ann Arbor, Michigan.

Downs, W. 1974. *Fish of Lake Michigan.* University of Wisconsin Sea Grant College Program, Madison, Wisconsin.

Great Lakes Fishery Commission. 1975. *Annual Report for the Year 1973.* Ann Arbor, Michigan.

Hubbs, C. L., and K. F. Lagler. 1964. *Fishes of the Great Lakes Region.* University of Michigan Press, Ann Arbor, Michigan.

Lagler, K. F. 1956. The pike, *Esox lucius* Linnaeus, in relation to waterfowl on the Seney National Wildlife Refuge, Michigan. Journal of Wildlife Management. 20(2): 114-124.

Lake Survey Center. 1974. *Great Lakes Pilot.* U.S. Department of Commerce, National Ocean Survey, Lake Survey Center, Detroit, Michigan.

Leach, M. L. 1883. *History of the Grand Traverse Region.* Traverse City, Michigan.

Michigan Department of Natural Resources. 1974a. *Status of Selected Fish Stocks in Michigan's Great Lakes Waters and Recommendations for Commerical Harvest.* Lansing, Michigan.

Michigan Department of Natural Resources. 1974b. *Michigan Fisheries Centennial Report, 1873-1973.* Fish Management Report No. 6, Lansing, Michigan.

Michigan State Board of Fish Commissioners. 1879. *Third Report of the Superintendent of the Michigan State Fisheries Commission for 1877-8.* Lansing, Michigan.

Parker, P. S., and R. E. Lennon. 1956. *Biology of the Sea Lamprey in its Parasitic Phase.* U.S. Fish and Wildlife Research Report No. 44.

Reighard, J. E. 1910. Methods of studying fishes with an account of the breeding habits of the horned dace. in *Bulletin of the Bureau of Fisheries 28, Document 710:* 1111-1136.

Scott, W. B., and E. J. Crossman. 1973. *Freshwater Fishes of Canada.* Fisheries Research Board of Canada, Ottawa, Canada. Bulletin 184.

Vincent, R. E. 1962. Biogeographical and ecological factors contributing to the decline of the arctic grayling, *Thymallus arcticus,* in Michigan and Montana. Ph.D. thesis, University of Michigan, School of Natural Resources, Ann Arbor, Michigan.

SPORT FISHES OF SELECTED AREA LAKES