

gravelly glacial drift, but are chiefly clay laid down in the old beds of the glacial Great Lakes. Water in the bed rock in these areas is abundant, but commonly contains hydrogen sulphide gas and some salt. However, in places buried delta gravels and the buried Arkona and Wayne beaches, where not entirely destroyed by later lakes, contain water. In the western part of the Northern Peninsula crystalline rocks are generally so near the surface that it is impossible to obtain water, but in places water-bearing sand and gravel formations are found in basins in the crystalline rocks, dumped there as moraines by the glaciers or deposited by glacial streams. In many other localities in all parts of the State supplies of fresh water cannot be obtained because of the texture and thinness of the drift, or the nature of underlying rocks. Generally, however, over the State the glacial drift produces an abundance of good water from sand or gravel beds. Many of the underlying rock formations, particularly sandstones and limestones, produce satisfactory water, although the water is generally harder than from the drift.

SURFACE WATERS

The Michigan Department of Health reports that approximately 50 percent of the State's population depends upon surface waters for its water supply. These supplies are so treated today that they are delivered safe to the consumer, barring accident or occasional cross-connection to an unapproved source, and with a few exceptions, are of acceptable quality and taste. A public water supply is necessary primarily for human needs such as preparation of food, drinking, and personal cleanliness; and for washing away waste and dirt which would otherwise accumulate in our homes and communities; for watering lawns and gardens, extinguishing fires, and for air-cooling and refrigerating systems, as well as for numerous commercial and industrial requirements. All conflicting water uses generally give way to the municipal right to develop an acceptable water supply.* Chemical and aesthetic considerations are frequently as important to public acceptance of a water supply as its pressure or bacterial quality, both of which in this day are taken for granted. Pollution must be constantly guarded against. Of significant importance is the fact that without adequate sewage collection and treatment, the water supply used by one municipality may cause the contamination of the water source of the same or of a neighboring community.

*An exception is the occasional short period injury resulting from dredging or the disposal of dredged material within range of water works intakes from the Great Lakes. This work proceeds under War Department, U. S. Army, jurisdiction in the interest of furthering and maintaining interstate commerce through navigation.

PROBLEMS OF USE AND POLLUTION

But whatever be the source of our water supplies, several problems and many conflicts have arisen regarding its best use and the abundance and purity of the water for each particular use. Now, more than ever

before in our history, numerous incompatible demands are made for the utilization and enjoyment of the same natural assets. With increasing concentration of population, sanitation and pollution have become increasingly important and increasingly a public problem.

The water carriage system of domestic waste and human excreta created by public water supplies and modern sewer systems was one of the great boons to civilization, doing away with plagues and the large-scale epidemics of past centuries. As our populations have become more centralized, as industry has developed, and the public has had greater and greater opportunity for outdoor recreation, pollution and its eradication has become not only state and regional, but also a nationwide problem.

Michigan's problem is one of unusual significance and is only partially met. The international boundary running through Lakes Superior and Huron to Lake Erie is ostensibly protected from pollution by treaty between the United States and Canada. The Detroit and Wayne County sewage treatment plants, recently placed in operation, are discharging their and Michigan's obligation in behalf of the United States' treaty observance. Between the boundary and the mainland, the Michigan Stream Control Commission is charged with the responsibility of protecting not only these but other waters of the State. In addition, the cities and villages are permitted by statute to act to prevent pollution along their separate water fronts. The Department of Conservation is directed "to guard against and prevent pollution," and the Department of Health may require such changes in sewer systems or sewage disposal as are deemed necessary to the protection of public health. Only the drain laws of the State have been equivocal on the subject of pollution, but correction of this defect is being sought.

With ever-increasing progress made in the field of municipal and industrial sanitation, a noticeable problem is beginning to emerge from use of our navigable waters. This is due to sewage and garbage emptied into a few of our rivers and lakes from nearly all types of craft from the small overnight yacht to the largest freighters. In addition, oil bilge and water ballast contaminated with oil or other pollutants is discarded for the most part from tankers, freighters, and oil-burning vessels. Such pollution becomes an increasing nuisance in boat wells, along bathing beaches, on duck marshes, and is otherwise offensive to public and private interests. Although municipalities may by ordinance control the discharge of waste from water craft when in port, few exercise this right. Only a change in the admiralty law of the United States can bring uniformity in approved sanitary practices on vessels in transit on the open lakes and through their connecting waters. The Federal law on oil pollution applies only to the tidal waters of the United States; hence the Great Lakes are excluded from such protection. Pollution from sewage, industrial wastes, and the development of our mineral resources creates a wide category of injuries. Bacterial

contamination of sources of water supply, and the imparting to them of injurious or objectionable chemical constituents impair both public and industrial uses of water.

What has been done and what remains to be done to correct these evils? Because pollution adversely affects nearly all beneficial water uses, its eradication at the earliest possible date is advocated by most thinking persons and organized groups.

Since 1935, Michigan's percentage of urban sewage subjected to treatment has increased from 19 to 83 percent. The remaining 17 percent is divided among 100 municipalities, mostly small. Marginal pollution also exists in and around many cities having sewage treatment facilities, because some outlying sewers or industries have never been connected to the main collecting systems or because their location is so low or remote they cannot be connected.

In the industrial field pollution problems are created by sugar beet processors, pulp and paper mills, milk products plants, tanneries, canneries, refineries, chemical, and certain metal working and plating plants. The development of mineral resources such as oil, copper, iron, limestone, and gravel are definitely concerned with use and pollution, or the conservation of our water resources.

Organized and individual plant research directed toward the elimination of unnecessary waste production is going forward. The first principle in this field is to conserve or utilize salvageable by-products, and re-use the settled or clarified waste wherever possible.

The problem of human conservation and prevention of epidemics may be solved by adequate sewers, sewage treatment, and community sanitation in areas of rapidly increasing human occupancy such as the defense plant areas of southern Oakland and Macomb counties built in 1941, as well as in the older communities.

The State's second industry, its tourist and resort business, depends, among other things, upon the highest possible quality of our natural waters. Our summer climate, fine highways, and state advertising bring people in ever-increasing numbers to the State, but few stay at places plagued by pollution or even where pollution is suspected.

Recently the swimmers' or water itch appeared in our northern Michigan lake sections, but not as a result of sewage pollution. On the contrary, some of the cleanest sand beaches in the State have been infected. Water itch is caused by a parasitic infestation of certain species of snails which unload their itch-provoking cercaria in great numbers just at the peak of the summer resort season. Scientists believe that certain migratory wild life spread the snails. Inasmuch as ducks, gulls, terns, and muskrats cannot be exterminated for the purpose of curbing the damage, the otherwise innocent snail is doomed on infested swimming beaches and in their immediate vicinity. Additional research and much

physical effort and expense are necessary to overcome the problem and keep it under control.



PERCH FISHING, FOX RIVER, STANDISH, ARENAC COUNTY.



THE BOARDMAN RIVER, A TYPICAL TROUT STREAM.

The use of Michigan's waters for game, sport, and pan-fishing is well known. Our commercial fisheries have a tremendously important place in the State's economy. Fishing for sport and for commerce depend, among other things, on satisfactory water quality and stream or lake bottom free of detrimental deposits. Each cubic foot of water at a given temperature contains a minute but definite amount of life-giving oxygen necessary to fish and aquatic life and to the assimilation without nuisance of sewage and industrial effluents. Fish will suffocate for lack of oxygen within their natural habitat, or they may die as the result of contact with certain toxic industrial pollutants, or the physical clogging of their gills. When not killed outright, their resistance may be so lowered by pollution that they become susceptible to disease, or to injury or destruction by their natural enemies. Fish life begins to disappear when spawning or feeding grounds are covered by bottom deposits and scavenger types gain the upper hand. This condition is generally found accompanying pollution. Certain types of chemical plants and paper mill pollution do not kill or drive the fish away, but so taint their flesh that the catch is rendered inedible or of reduced commercial value.

Waste oil, waste chemicals, and sludges frequently destroy the habitat of migratory wildlife. Ducks and other birds which become immersed in a floating oil slick are fortunate if able to fly again.

Nature also causes a certain type of stream pollution. Many of our streams have cut through sandy and clay moraines and have narrow channels with swift current between high steep banks. Rains wash down the banks, the current of the stream may be shifted and undercut the banks, sand or clay slides into the stream, and the clear deep water habitat destroyed. Also such slides may pond a stream and cause upstream flooding on flat areas, or they may divert the stream from its course and damage may be done not only to fish, recreational, farming interests, but also to power projects. To prevent such damage the banks of several streams have been "retained" by protective coverings of vine matting and other measures of stream improvement.

The problem of securing public access to the streams and waters of the State for the non-riparian fishermen and vacationist is a relatively new but important problem. Relying on his presumed right to navigate or fish the "public waters" of the State, planted and protected at public expense, the follower of Ike Walton may find himself an intruder, if not an actual trespasser.

The legislature has not defined the extent of "public waters" or "private waters," and has not acted to make such classification possible; therefore rights to fish our streams (in the absence of public riparian ownership) appear to be grounded for the most part in current court opinion on the fact of their past or present navigability. In the early days a navigable stream was one which would float a log. But just as the early floating of logs in Michigan was in one type of watercourse, and beneficial commerce transported in the usual way on the larger rivers, inland lakes, and the Great Lakes was in another, so today we have different, conflicting, and indefinite conceptions of the extent of navigability, of the public right and interest, and therefore of what lakes and streams are really the so-called public waters.

The farmer's relation to the problem of water uses and control is an important one. If a flowing stream traverses his acres, he is obviously entitled to clean water for pasturage of his livestock. The cultivation and cropping of his land will either contribute to water conservation, soil fertility, and erosion control, or to their destruction, depending upon his methods.

The farmer's home water supply and method of sewage disposal may differ somewhat, but no serious public problems are ordinarily presented in attaining them, although on some farms in the oil fields surface and ground water supplies have been impaired by oil field brine pollution. Raw brine has had both serious internal and external effects on cattle. One purpose of the "oil laws" is to prevent any recurrence of this problem.

Water for irrigation is naturally an agricultural use and more farmers are using the waters available to them for that purpose.

It has been stated that from 400 to 600 pounds of water are necessary to the growth of one pound of vegetable matter (dry basis). And if this is not enough of a surprise, just consider that that amount of water is what is estimated to pass through the plant itself, i.e. from root to leaf, and thence to the atmosphere by way of transpiration. It is important to remove excess water from the land, but it is equally or more important to design and maintain drainage so as to maintain the proper elevation of the water table during the growing season. This necessary level varies from two feet below the surface for soil crops to three and one-half or four feet below the surface for orchards. Therefore it is necessary for the farmer to increase the holding capacity of the soil by good tilth and the proper application of humus-producing fertilizer, to control surface run-off by strip cropping, terracing, plowing at right angles to the slopes, to allow the streams on his land to maintain their natural courses; in short to put in use good modern farm practice.

NAVIGATION

The earliest use of Michigan's water was for navigation and as an aid to settling the country. The ordinance of 1787 made the waters of Michigan, in common with those of the Northwest Territory, "common highways and forever free."

Their enthusiasm in the early 1800's must have led some of the early settlers, politicians, and contractors into difficulties in connection with projected canals to traverse the State. Many old canals are now silted water-ways. Recent dredging in the old Clinton and Kalamazoo canal in Utica shows that in 100 years silt from six inches to four feet deep has been deposited. Probably the provision found in Sec. 14, Art. X of our present Constitution, "preventing the State from being a party to, or interested in any work of internal improvement, except in the improvement of public wagon roads and reforestation and protection of lands owned by the state and in expenditure of grants of land or other property," grew out of these early indiscretions. This clause remains today to bar some worthwhile State improvements or to justify attempts to secure Federal funds to finance such improvements.

Excepting the incidental travel by canoe and small boat traffic on Michigan's inland waters, navigation, its control, and the improvements made in its behalf are a Federal function and activity. A greater annual tonnage passes the "Soo" locks than through the Panama, Suez, and all other artificial control works combined.

The War Department through the U. S. Engineer Office defines the limit of navigable waters of the United States in accordance with Acts of Congress and subsequent Federal court decisions. The extent of the navigable waters is subsequent to change from time to time. Problems in this field are capably and effectively handled through the various District Engineer Offices of the War Department located on the Great Lakes and financed by the Federal Government.

Diversions from the Great Lakes, chiefly diversions of the Sanitary District of Chicago, through the old glacial Chicago Outlet channel, during the past 30 years, have, in the opinion of experts, lowered the level of Lakes Michigan, Huron, and Erie some five to six inches. This change in level has been of sufficient importance to lake carriers and to the lake states in general, to warrant their joining in litigation to prevent continuance of the practice. The diversion, including domestic pumpage, at Chicago, has been reduced from about 10,000 cubic feet per second to 1,500 cubic feet per second.

Studies of records of lake levels through the past 125 years show that apparently the lakes pass through definite stages or cycles of high to low levels, with variations of several feet from high to low water. Compensation for the cyclical variations in the lake stages due to natural conditions remains an unsolved problem. Plans are prepared for a compromise solution of the difficulty by means of a series of submerged ribs or weirs across the bed of the St. Clair River at Port Huron and similar works in Niagara River at Buffalo.



FALLS DEVELOP WATER POWER.

WATER POWER

Development of power from Michigan's water resources also dates back nearly one hundred years. Local grants are found among the early legislative proceedings, usually expressed in the form of a permit or of so many "run of stone" where the privilege subject to division among several persons. Most of the private hydro-electric developments of 20 to 30 years ago appear today to be adjuncts of steam power developments, with which they are inter-connected. Steam power projects are dependent upon water-transported coal and generous supplies of water for cooling and condensing purposes.

Certain hydro-electric installations with large size generating units operate only for short periods during the summer months (one to eight hours out of twenty-four, forty-eight, or seventy-two hours). This practice has created stream flow interruption at times which has proved serious and offensive to downstream private and public interests alike. During interrupted flow fish become stranded or suffocate in pools. At such times otherwise satisfactorily controlled waste or sewage effluent becomes offensive in the absence of the usual

flow of the main stream. The cottager may find his view and front yard changed from an expanse of water to dripping rocks and exposed marine vegetation, at times giving off a disagreeable odor. Diversion of streams for power purposes is a greater problem in the Northern than in the Southern Peninsula, owing to the greater fall of the streams and the destruction of scenic value.

Power, agricultural, recreational problems along our rivers can be solved as they have been in southeastern Michigan, particularly the lower Huron, where the "tail" water below one dam almost immediately becomes the "head" water of the dam* next below. Thus in the Huron a series of elongated artificial lakes or ponds have been substituted for the original free-flowing stream. To all intents and purposes this river serves a greater public interest and benefit today than would have been possible in its original undeveloped condition.

However, development like that along the Huron is the exception. Probably in the future utility managements, grist mill owners, and even some municipalities will attempt developments that permit yield of the watershed to flow continuously.

But the State is not in sole sovereign control of its water resources for the production of power. Construction of a dam across a navigable stream for power purposes needs not only the approval of the Board of Supervisors of the county in which the dam is located, but also approval of the Department of Conservation, the U. S. Engineer's Office, and the Federal Power Commission.

*The dams on the Huron are constructed where the river crosses the old glacial lake beaches.

FLOOD CONTROL

Michigan's flood control problems are not general nor serious except at Sebawaing, Mount Clemens, and certain other localized areas. In comparison with the Ohio River drainage area, our contributing water sheds are small, the longest river travels not much more than 200 miles before discharging into the chain of equalizing reservoirs formed by the Great Lakes.

Grand Rapids leads other cities in the State in flood control improvements. The situation at Kalamazoo is aggravated upon occasion by the combination of high water and a lower river stream bed choked with sewage and paper mill solids. The Raisin River at Monroe, the lower branches of the Rouge River at Dearborn, the Grand River at Lansing, Portland, and Ionia, have given occasional proof of the inadequacy of present stream beds to hold high water and the need for high bank control.

Efforts have been made to interest the Federal Government in the Sebawaing and Mount Clemens problems. Surveys have been made or are under way at both places. Some flood alleviation work is under way at Sebawaing under local and State Highway Department auspices.

LOOKING AHEAD

Recent State planning, supplemented by regional planning under the direction of the Water Resources Committee of the National Resources Board has resulted in short term studies and efforts at inventorying regional water resources and needs. However, most of our streams and inland lakes cannot support the many uses made of them, including irrigation, and also serve the public interests, if these uses mean an outright diversion with very little return to the stream within a reasonable time. Various divisions of the Conservation Department, the Stream Control Commission, the State Highway Department, and the Federal Government are working on the problems arising from deflection of water supplies, maintenance of lake levels, and stream flow, to keep within the State adequate and usable water supplies for all the domestic, agricultural, industrial, navigation, and recreational demands upon it. If not disturbed, Nature would eventually drain off all the water left by the melting glacier. Our water resources are more perishable than the forests which can be replaced or renewed. Once gone the waters will not return—we can and should retard, not aid, their going.

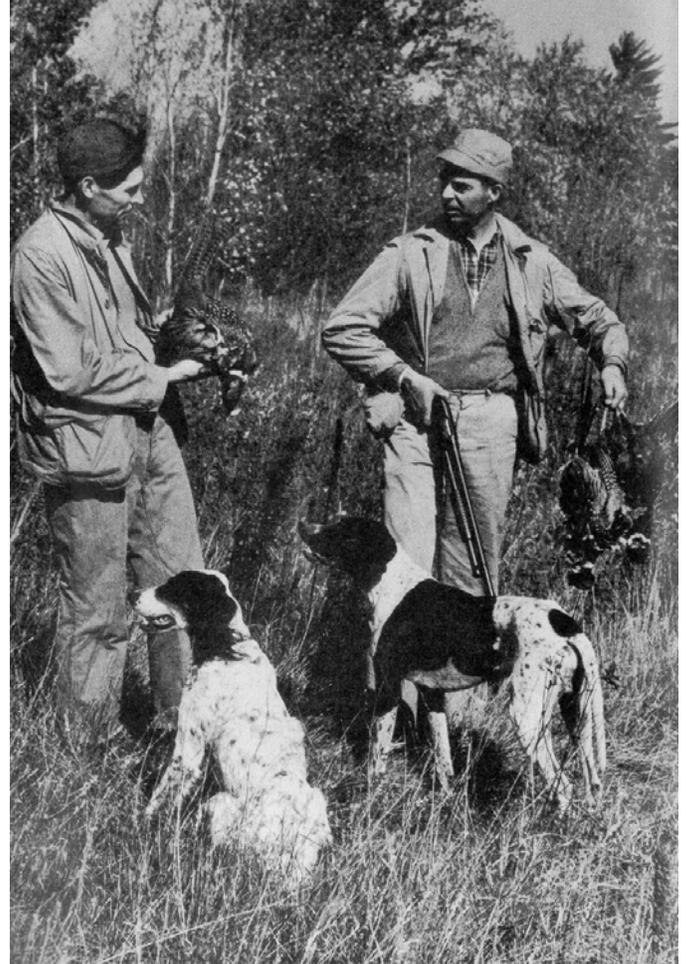


TAHQUMENON FALLS FROM THE AIR—UNHARNESSED BY MAN.

BEASTS, BIRDS, FISH, BUGS

We have talked of rocks and minerals, of plants and forests—but what of the beasts of the forest, the birds of the air, the fish in our waters—our wild life? All wild life is important in keeping Nature's balance. But

man has upset Nature's plan; he has hastened the extinction of some species, delayed others. By conservation, he is attempting to restore a balance—favorable to him. How do we manage and use our undomesticated animals—mammals, birds, fish? Wild life is one of our replaceable natural resources, but since the public has been slow recognizing responsibility, it has been necessary for wildlife conservation to become a function of a governmental agency.



A HUNTING WE WILL GO.

Michigan's wild life has always been one of the State's most valuable assets, no less as great today as when it provided food and raiment for the Indian, and attracted the first white men to the territory which is now Michigan.

The abundance of furbearing animals along the borders of Michigan's streams and lakes lured traders and trappers. They came from France and later from England, at first to exchange trinkets and useful articles with the Indian for the furs which he caught, but later the traders themselves became trappers. Fortunes were founded on furs. The state's beginnings, its early growth, was based in the traffic in skins.

In "Michigan Fur Trade," Ida Amanda Johnston gives some idea of the volume of the early fur trade:

"To form an estimate of the amount and value of furs in Michigan during the seventeenth century seems an

impossibility, for peltries from posts like Sault Ste. Marie and Michilimackinac are not representative of the furs gathered in Michigan alone, but from other regions, such as Wisconsin, Illinois, and beyond. Pioneer traders kept no accounts of what they gathered in their particular sections. Little care had they for aught else except the beaver pelt. Then, too, Michigan was but a spot in the wilderness, a small part of a great Canadian province of which the fur trade was the chief source of wealth. So estimates were made for the province as a whole and not for some small section of it. For example, Mackenzie says the produce of the year 1798 was 181,150 furred animals of which 106,000 were beavers. To quote prices of furs of this century is of little significance, because in those good old trading days the French soon discovered that the Indian knew little of the value of fur and readily exchanged the costliest peltries for whatever tickled his fancy, even though it were a mere trifle. Out in the woods each trader often set his own prices. So while trade was still in its infancy, an enormous profit accrued to the successful trader, at times a profit of from six to seven hundred per cent."

When large scale lumbering operations were started in the middle of the nineteenth century, wild life assumed new importance. The flesh of wild animals and the fish in the streams, were the food of the lumbermen. Professional hunters were employed. Often one hunter was hired to secure game for a number of lumber camps. Fish were speared or netted by professional fishermen and transported to the camps by the wagonload.

The plow followed the axe. Settlers, ready to farm land denuded of forest growth, followed the departing lumbermen and for the settler also, wild life furnished an important part of food, clothing, barter, and even certain articles of furniture. Those first settlers hunted and fished from bare necessity, not for sport, taking only enough game for their own needs. But as the wilderness was pushed farther back and transportation was developed, markets for game were opened and wild game became a cash crop, and man's thoughtless greed caused the depletion and even extinction of certain species of game animals, fish, and birds.

The story of the extinction of the passenger pigeon, for the abundance of which President Jackson gave thanks, is one of the blackest. Birds were shipped to the markets by the millions. The adults were netted, clubbed, shot and the young birds left to die in the nests. In a short time the passenger pigeon disappeared. Birds whose numbers once darkened Michigan skies during their flights are gone. The last survivor died in the Zoological Garden in Cincinnati in 1914. The fate of the passenger pigeon is but one example, although perhaps the most awesome, of the consequence of uncontrolled killing. It is true that many species of animals have become extinct through Nature's processes but man can, and should, prevent or delay the extinction of wild life directly or indirectly valuable to him. And we are very properly incensed when we read that at a sportsmen's congress in Saginaw in 1882, it was stated that in the fall of 1880 more than one hundred thousand deer had been shipped from northern Michigan by market hunters.

Today wild life plays a new and important role in Michigan's development although the commercial fishing and trapping industries bring to the State annual incomes of over two million dollars each. We no longer estimate the value of wild life only in terms of food and clothing. We now consider its recreational and aesthetic value and recognize the very important place wild life holds in maintaining a balance within nature.

When the first white men arrived, they found more species of wild life than they would find today. However, since the earliest settlement, several species have become extinct and others are greatly reduced in numbers. But a few species, such as the deer and cottontail rabbit, are more plentiful. But wild life no longer has a free range. Settlements, clearing of forests, and lumbering upset the balance, altered the food supply, restricted breeding areas, and caused a redistribution of species.

The heavy and unbroken stands of timber which once covered the State did not furnish an abundance of food for all species of wild life. The grasses, low-growing shrubs, and new reproductions which furnish desirable game food were smothered by the canopy of foliage overhead. Thus, the magnificent primeval forests were practically deserts, considering the amount of food they furnished animal and bird life. Lumbering operations broke the canopy and created openings or "edges", as they are often called, in which desirable game food had an opportunity to grow. The increase of food and cover naturally brought about an increase in wild life population. Game follows forest openings. Pioneer farmers had little difficulty, once the openings were made, in filling the family larder with meat, because game migrated into and concentrated about the openings created by land clearing operations.

On the other hand, as human populations increased and more lands were improved, the desirable habitat for many wild life species became reduced. Some were driven to smaller and less desirable ranges. The beaver and the bear, originally found scattered over all of Michigan, are now largely confined to the northern two thirds of the State. Other species, unable to survive in the complex environment created by man, have become extinct. The wild turkey was common in southern Michigan until half a century ago. It is believed that diseases contracted from domestic fowls may have had as great an effect in destroying Michigan's wild turkeys as the change in habitat.

Before efficient protection had been developed, forest fires, started either by lightning or man's carelessness, burned large acreages of forest each year, destroying both game and game habitat. Many of these large uncontrolled fires occurred during the spring and early summer months when young animals had little chance of escape. In 1871 fires burned over almost the entire Grand Traverse region, destroying not only forests and game but leaving some 18,000 persons homeless. In 1908 fire burned over 2,369,000 acres in northeastern Michigan. These, and many other major fires, destroyed

all wild life over large sections of the State, and by depleting the forest cover, changed the runoff reaching the streams, causing a depletion of some species of fish.

On the other side of the picture, a little well-controlled fire may be an advantage. In some parts of the State the second-growth forests are so dense that game populations are dwindling. If proper logging cannot provide clearings, small well-controlled fires may solve the problem.

Federal, state, and private agencies have drained thousands of acres of swamplands, low lands along river bottoms and inland lakes, and marshes which once were the feeding and breeding grounds of many furbearers and of vast numbers of ducks, geese, cranes, and other water, shore, and song birds. Following the drainage of their breeding and nesting areas, the numbers of many waterfowl decreased noticeably. In some localities, reflooding will prove to be of considerable importance in returning and increasing the waterfowl and furbearer populations.

The establishment of large industrial centers along waterways has caused pollution to become a major factor in diminishing wild life populations particularly of aquatic life and waterfowl, since they come in direct contact with sewage, industrial, and other wastes poured into the waters. This condition is being remedied by the establishment of efficient sewage disposal plants and by the use of more satisfactory methods of disposal of industrial wastes.

Wild life cannot be arbitrarily classified as beneficial or non-beneficial, as species may be considered beneficial in one environment but non-beneficial in another. Also we are likely to value any wild life species according to our personal appreciations and in relation to its scarcity or abundance. For example: Sportsmen consider the rabbit a valuable small game animal but nurserymen and fruit growers consider it destructive. One who has witnessed a skunk raiding a game bird's nest may believe that the species should be exterminated, forgetting or not knowing the value of skunks in destroying thousands of insect pests and ignoring their value as fur bearers. From the earliest times, man has waged war continuously against those species which in his opinion are undesirable. The wolf has been condemned, probably since the time when man and wolf were competitors for food. At one time the sturgeon was considered undesirable, because it destroyed the nets of commercial fishermen and because it had a low market value. Today, sturgeon have a high market value and the fullest protection is given them. Because of this variation of opinion and value, it has become necessary, as the State developed, to devise and promulgate laws which would regulate, in so far as man can, the numbers of valuable and noxious species.

Game and fish laws have two definite objectives: (1) To insure a surplus of game and fish at the end of each season sufficient to guarantee a future supply through

natural reproduction. (2) To protect those species which are in danger of extinction.

In order to secure these objectives, regulatory measures must: (1) Insure protection to all desirable species during their mating seasons. (2) Insure protection to desirable species during the time when the young are being reared. (3) Establish bag limits which promise a supply sufficient for each hunter and fisherman without permitting a slaughter of the species, the bag limits depending upon the supply and rate of reproduction of the individual species. (4) Establish hunting and fishing seasons, the length depending upon the supply and rate of reproduction of individual species. (5) Prohibit all unsportsmanlike or wasteful methods of securing game. (6) Insure adequate protection to those species which are in danger of extermination.

Prior to 1887, when Michigan's first game and fish warden was appointed, enforcement of the few existing game and fish laws was the responsibility of local law enforcement agencies. But people had little understanding of the need for such regulations. Because the jobs of these local law enforcement officers depended entirely upon their ability to secure votes, many were not inclined to enforce any law which their neighbors disliked.

The task of the first game and fish wardens, who did enforce the laws, was difficult and occasionally dangerous. Veteran officers relate many interesting stories concerning the resistance and resentment which they encountered, and ruefully tell of the loss of the good will of friends and neighbors.

Today, enforcement of all Michigan conservation laws is the responsibility of the Field Administration Division of the Michigan Department of Conservation. (See p. 96 oil and gas). Some two hundred full-time conservation officers are included in office and field personnel. In order to carry out its functions most efficiently, this Division has established three regional and sixteen district offices at strategic points over the state. A conservation officer is assigned to each county and in some of the larger counties two officers may be employed. Each officer is responsible for approximately 500 square miles of territory. Officers are recognized as local authorities in all matters concerning the protection of wild life, lands, forest, streams, lakes, minerals, and timber.

Michigan's conservation law enforcement program receives financial support from the game protection fund, revenue received from the sale of hunting, fishing, and trapping licenses.

Realizing that state laws were ineffective in preventing the transportation and sale of game, the United States Congress, on May 25, 1900, voted a federal measure, the Lacey Act, which prohibits the transportation across state lines of birds and animals killed illegally or shipped contrary to law. The original intent of the law was to curb the shipment of deer, grouse, quail, and other game

from one state to another. Its present greatest effectiveness is in curbing the illegal traffic in furs.

Because state laws were ineffective in protecting migratory birds, the Lacey Act was expanded in 1913 to include the Migratory Bird Law which gives the Federal Government the power to regulate the hunting of geese, ducks, woodcock, and other migratory birds. The federal legislation is more effective than state laws, because the regulations of the various state laws were not uniform. Birds protected in one state were slaughtered in another where protective measures were inadequate.



PUBLIC HUNTING GROUNDS.

The Migratory Bird Law was strengthened in 1918 when the United States signed a treaty with Canada which established regulations covering the taking of migratory birds in the two countries.

An important means of protecting wild life has been the establishment of refuges and sanctuaries. A "game refuge" is a unit of land on which hunting is prohibited but which is open to the public for other recreation purposes.

Michigan's game refuge system was initiated in 1913 with the establishment of the Hansen state game refuge in Crawford County. The primary purpose of the first refuges was to furnish all-year protection for all wild life, but particularly for deer. During recent years, food in winter deer yards in several of the refuge areas has been eaten out, since protection afforded deer during the hunting seasons has tended to increase the concentrations in yards. As a result, in some areas deer have starved and several of the refuges have been abandoned and converted into public hunting grounds.

The acquisition of lands for refuges and public hunting grounds is an important function of the Conservation Department. One dollar and fifty cents of the revenue received from each deer license sold is set aside for the acquisition and maintenance of public hunting grounds and refuges. Michigan operates thirty-nine public hunting grounds and refuges with a gross area of over a million acres. Of the thirty-nine, three are closed to all hunting, two are closed to all except deer hunting, one is

a combination waterfowl and game refuge, and thirty-three are maintained as public hunting grounds. Each administered state park is a game refuge since in it all hunting and trapping are prohibited.

The first action on the part of the State to encourage private landowners to establish wild life sanctuaries where state protection would be guaranteed on privately owned lands was taken in 1913. The original act was repealed in 1929 with the enactment of the law under which sanctuaries now operate.

To establish a wild life sanctuary, one must make application to the Conservation Commission. The Commission then orders an investigation to determine if the area is suitable for the purpose. Applications are not approved for areas of less than twenty acres nor more than 1,500 acres, nor for periods of less than five years. When accepting areas for dedication as sanctuaries, the Department of Conservation considers the interests of the hunter and trapper and restricts such areas so far as is practical to localities where surplus wild life will become available to the sportsman.

Federal wild life refuges or preserves are of two types: Those maintained for the protection of big game and those maintained for the protection of migratory and non-migratory birds. These protected areas include the refuges proper and other administered areas where hunting is prohibited—national parks, national monuments, and areas of national forests.

Michigan has only one federal big game preserve within its boundaries—Isle Royale in Lake Superior which has been acquired by the Federal Government and designated a National Park. Here the largest herd of moose on Michigan soil is maintained.

Some eighty-three units scattered throughout the United States and its possessions are administered by the Fish and Wildlife Service (formerly the United States Biological Survey) as national bird refuges. Four are in Michigan—the Huron Islands and the Siskiwit Island, located in Lake Superior, the Seney migratory waterfowl refuge in Schoolcraft County, and a refuge in Lake St. Clair which is maintained in cooperation with the Department of Conservation which looks after maintenance and protection.

At times, it has been found desirable to introduce exotic species (foreign species, or species living in a different environment or habitat) to replace native species which have been unable to survive under the complex conditions brought about by man's occupation and development of lands and the exploitation of resources which originally constituted their home ranges. The pheasant, the Hungarian partridge, and the trout, carp, and smelt are introduced exotics in Michigan.

Originally the pheasant was introduced in all parts of the State. It was soon found that it could not survive on the snow covered cut-over lands of the north but that it is well adapted to the agricultural lands in the southern

counties where it has become the most important game bird.

The Conservation Department is conducting experiments with the Hungarian partridge in an attempt to establish the bird in Michigan. The Hungarian partridge, it is believed, may fill a gap in farmland environment not occupied by the pheasant or bobwhite quail.

Much of the early fisheries work carried on in the State was devoted to the introduction of exotic species to replace the grayling which was fast disappearing from the streams in the northern portion of the Southern Peninsula during the latter half of the nineteenth century. Most of the early plantings were of brook trout secured in the rivers and streams of the Northern Peninsula where they were abundant. Later the rainbow trout was imported from California where it is known as the Shasta trout, and the German brown trout was imported from Germany. Experiments have been carried on with the Dolly Varden trout of Oregon, the cutthroat trout of the Columbia River, the black spotted trout of Colorado, and the Loch Leven trout of Scotland and Germany.

Introduction of the carp is comparable to the story of the house or English sparrow. Each species was valuable in its native habitat but became undesirable in the too-favorable habitat of North America. Now the carp is classed with the dogfish and garpike as nuisances and their removal permitted. Experiments made at the hatcheries may prove the carp useful—he is being caught and ground up for food for fish in the rearing ponds. The smelt has so increased in numbers that its annual "runs" have proved a valuable tourist attraction.

Although the natural reproduction of an established species is most important in maintaining a supply, artificial propagation may have its merit. Artificial propagation is applied most effectively in establishing new species of birds, mammals, and fishes, and in the process of restocking heavily fished waters of the State. The state game farm near Mason was established primarily for the artificial propagation of pheasants for stocking purposes. Today, releases of artificially reared pheasants from the game farm have little effect on the total population, since the wild stock has multiplied sufficiently to maintain a supply through natural reproduction.

The artificial propagation of wild life now carried on in Michigan is principally fish propagation. The State maintains nineteen fish hatcheries, fourteen trout rearing stations, and thirty-two bass and bluegill rearing stations which are operated cooperatively with local agencies. Over 200,000,000 fish are planted in the inland waters of the state annually.

The importance of improvement of wild life habitat has only recently been recognized in practical game management. In the beginning, game management stressed protection from poachers and predators where a new species was introduced or artificially propagated, because it was believed that these activities brought the

best returns and also were proceedings visible to the public at all times. Legislation or regulation continues to play an important part in managing game and fish surpluses, but artificial restocking and predator control are now considered of less importance and function only when synchronized with habitat improvement.

Modern game and fish management is comparable to farm or forest management and even to petroleum production. Following the principle of sustained yield each year, a surplus of the various species that may be safely harvested by hunting or fishing is produced. Providing the harvesting of this surplus is wisely done, ample breeding stock will be left for the following year. (Compare with laws protecting our forests and regulating exploitation of one of our underground resources—oil.)

The wild lands, farm lands, lakes, and streams all have rather definite carrying capacities for various species, but all lands do not produce their maximum supply of wild life. On the contrary, few locations are actually producing a maximum yield, as wild life is produced incidental to other uses of the land. On the farm, for example, the major portion of the land is devoted to crop production. The crazy quilt of fields devoted to the production of corn, wheat, beets, hay, pasture, or other crops, provides the homes for wild life. Likewise, in the wild cut-over areas of the north, the trees, shrubs, and ground cover form the habitat. It is within these habitats and within a rather limited area that the wild animals must find protection and food. Farmers can restore habitats for small game and birds by not cleaning out all the hedge and fence rows, stone piles, and wind breaks, and by leaving some uncut grain.

Conditions of habitat vary in cycles. We have learned that dense forests are barren of wild life, that game migrates to the clearings. But second growth comes along and before many years, the clearings are so densely overgrown, that game food disappears, and the wild life dependent on it either migrates or starves. Therefore the problems of game management and forestry habitat go hand in hand and also bring up the problem of the best use of the land of any given area—is it best suited for agriculture, forests, game cover?

Qualification of a locality for wild life production depends upon many factors: Methods of cultivation, cropping programs, the soil, the forest types, the origin of the lake or stream, determine largely the number and kinds of wild life. Where farming is intensive or forests are mature, wild animals suffer through loss of food supplies. If streams are polluted, fish life suffers. When attempting to actually improve habitat for wild life, all of these factors plus many more must be considered. And as all degrees of wild life productivity depend on the way the present use of the land affects various species, habitat improvements in a game management program is usually a local problem.

WILD LIFE RESEARCH

In order to solve the many problems involved in wild life management, it is essential that studies of food habits, distribution, migrations, life habits, and economic relationships of all species be made. This work has progressed rapidly until now it is one of the most important phases of wild life management.

People interested in better agriculture have for years maintained experimental stations for intensive studies of soil types, diseases, insects, and other factors related to the production of farm crops. It has only been during the last few years that people interested in wild life management have been doing the same sort of thing in relation to the problems with which they are continually confronted. As a result, the greater part of the wild life problems still remain unsolved, since the work now in progress must be done on an experimental basis and because precedents are lacking.

Wild life research is assurance that fewer mistakes will be made in the future than were made in the past. Once, problems were solved on a trial and error basis. If an idea did not work, it was charged to experience. The introduction of reindeer into Michigan is a good example of the trial and error method. Thinking that the cut-over lands in northern Michigan would be ideal for reindeer, the Department of Conservation imported eighty mature animals from Norway in 1922 at a cost of \$125 each. The herd consisted of ten bulls and fifty cows. The animals were released in the Hansen refuge in Crawford County and the Lake Superior state forest in Luce County. The first year, twenty-six calves were born but from that time on the herd gradually decreased until all the animals disappeared.

Problems of wild life management are the problems of the Federal Government as well as of the State. Accordingly both the State and Federal Governments have agencies which are engaged in wild life research in Michigan.

The Game Division of the Michigan Department of Conservation is responsible for the management and protection of the State's game and non-game birds and mammals. In order to carry on these functions with the greatest efficiency, the Division has a staff of trained wild life technicians on whose researches the policies and conclusions relative to the management of wild life are largely based. The Division operates the state game farm and several experiment stations where research is carried on.

The state game farm in Ingham County contains some 220 acres of land. It was purchased in 1916 for the purpose of propagating pheasants for stocking purposes. This unit is responsible for the establishment of pheasants in Michigan, since most of the birds which have been released in the State were raised there. At present, this land is devoted to the artificial production of pheasants, ducks, and hungarian partridges, and to research. Approximately 200 male and 1,000 female pheasants are retained each year as foundation stock.

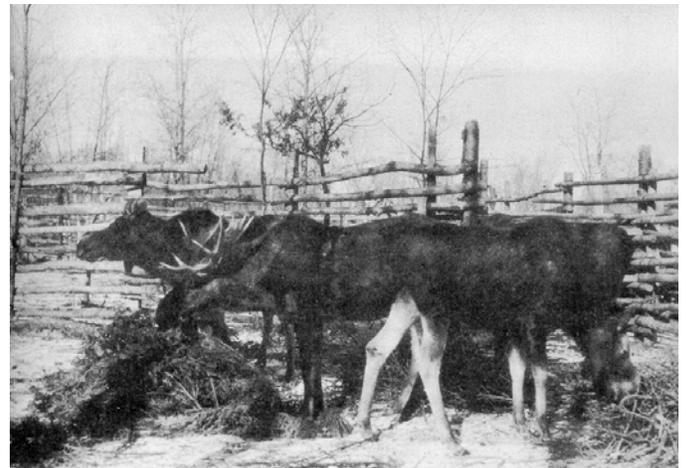
Each year, approximately 10,000 birds are hatched and 20,000 eggs are distributed for hatching. Many eggs are distributed to 4-H club members who are enrolled in the 4-H club pheasant raising project.

Rose Lake Experiment Station in Clinton County was established in 1938. It is typical rolling morainic southern Michigan farm land which is ideal for farm-game management research. And is therefore used as a demonstration game area where farmers, sportsmen, extension agents, and others are conducted on educational field trips that they may discover the value of contour farming, strip cropping, erosion gully control, restoration of soil fertility, and the relationship between agricultural productivity and wild life. The rearing program for Hungarian partridge, "hunkies," is conducted at this station.

The Federal Farm Security Administration owns 8,956 acres in Saginaw County which the State was invited to use as a "controlled hunting" area. This is the Prairie Farm Project. The area is desirable for the purpose since it is accessible by two roads only, and affords opportunity for setting up checking stations to determine the actual kill in the area.

Michigan State College owns and operates the W. K. Kellogg farm and sanctuary which is located near Battle Creek. Important research work relative to farm-game and waterfowl management practices is being carried on.

The Cusino wild life experiment station located in the Cusino game area in the Northern Peninsula was established in 1936. Some important research relative to deer and moose has been carried on there and the solution of many problems of management of Northern Peninsula mammals and birds are being sought at the Cusino station.



MOOSE FEEDING, CUSINO GAME REFUGE.

Creek Wild Life experiment Station includes approximately 5,000 acres of sub-marginal land in the center of Allegan State Forest. Objectives of the research problems of this station are to increase the available game on submarginal lands and to determine the interrelation of game species with standard and

experimental practice. In March, 1940, the Department of Conservation procured a fifty year lease with two fifteen-year possible renewals of the Swan Creek tract from the United States Department of Agriculture, thus insuring a long-time study of wild life and testing and application of new ideas and practices. To obtain information for, and on the results of, experimental work, fox squirrels, cottontails, raccoons, ducks, opossum are live-trapped, studied, tagged or banded, and released. Intensive studies on the management of cottontail rabbits, fox squirrels, and raccoons have been made.

Sixteen areas covering 1,082,614 acres of wild lands, known as state game areas, are scattered about the state. Although extensive management research is not carried on in these areas, data on current game conditions is secured by which the Department is enabled to recommend adjustments in game season and bag limits. These game areas are the Cusino and Escanaba River and Munuscong Bay areas in the Northern Peninsula and the Gladwin, Hanson, Iosco, Midland, Ogemaw, Lunden, Arenac, Cedar River, Muskegon River, Luther-Baldwin, Norway, Sage River and Wolf Creek areas in the Southern Peninsula.



KELLOGG BIRD SANCTUARY NEAR AUGUST, KALAMAZOO COUNTY.

The Game Division also operates a laboratory to facilitate research on various diseases of game birds and animals. During the hunting season, supplementary direct research in the field is made possible by use of a trailer laboratory.

Several waterfowl refuges are maintained by the State. The Lake Lansing, Ingham County, Gull Lake, Kalamazoo County, Goguc Lake, Calhoun County, and Harbor Beach, Huron County, refuges were established by state law; the Pine and Orchard Lake, Oakland County, Wildfowl Bay, Huron County, Munuscong Bay, Chippewa County, and Little Bay de Noc, Delta County, were established by Conservation Commission order under the Discretionary Powers Act of 1925. The W. K. Kellogg Bird Sanctuary on Wintergreen Lake in Kalamazoo County was a gift from W. K. Kellogg. In addition, many of the two hundred and fifty and more dedicated wild life sanctuaries and the state game refuges contain marsh areas and wildfowl habitats which have been useful in the study of waterfowl problems. A few privately owned sanctuaries have been established and some farmers who permit no hunting on their lands on which are lakes have undesignated refuges. Wildfowl

habitats in the various refuges range from the bulrush marsh, remnant of once larger great lakes, to the landlocked kettle lakes of the ground moraine filling with lilypads and sedges.

The Pittman-Robertson Act of 1937 is the most important federal legislation affecting wild life enacted since the Migratory Bird Treaty took effect in 1918.

This act provides for the setting aside of revenue from the federal excise tax on sporting arms and ammunition to be used in the conservation and management of wild life resources within the several states. One half of each state's allotment is made on the basis of the state's area and the other half is allotted in proportion to the number of hunting and fishing licenses sold within the state.

The type of projects for which the money can be spent is strictly defined under the act. In general, three types of projects are acceptable to the Federal Government: (1) Purchase of land for wild life rehabilitation. (2) The development of newly acquired lands or lands already in state ownership to make them more suitable for wild life. (3) Practical management research.

Under the provisions of the Pittman-Robertson Act, studies are being made: On raccoon and fox squirrel management; the relation of game management to farm practices; the effect of forest fires on vegetation successions and game populations; on the population and habitat of ringneck pheasant, Hungarian partridge and muskrat; and waterfowl survey in the eastern lake shore marshes.



HATCHERY BUILDING AND REARING PONDS, MARQUETTE.

The Fish Division of the Michigan Department of Conservation is responsible for the promotion, protection, regulation, and development of the state's fish resources. These are problems of real magnitude since Michigan's water resources include shore line on four of the Great Lakes, some five thousand inland lakes and some twenty thousand miles of streams. Eleven fisheries districts cover the state with headquarters at Watersmeet, Thompson Oden, Harrietta, Grayling, Harrisville, Paris, Comstock Park, Wolf Lake, Hastings, and Drayton Plains. Rearing ponds and hatcheries are maintained within each district. Trout, bass, bluegills,

pike-perch, are reared for restocking our lakes and streams.

Research in the promotion of Michigan's fisheries resources is a function of the Institute for Fisheries Research of the Fish Division. This organization works in cooperation with the University of Michigan; the funds are furnished by the Department of Conservation and the University provides the office and laboratory facilities.

Important work of the Institute for Fisheries Research includes study of the following fundamental problems:

- (1) Food supply and production of unit areas.
- (2) Lake and stream inventories. These include studies of physical, chemical, and biological characteristics of lakes and streams. Given this information, stocking and improvement operations can be carried on profitably.
- (3) Creel census. Card reports filled in by Conservation Officers and fishermen supply much valuable information concerning the take of important fish species on individual lakes and streams.
- (4) Tagging operations. By tagging different species of fish, information has been secured concerning the growth rate of fish in different waters and migration habits of different species.
- (5) Predator investigations. Detailed investigations are carried on to determine the damage done by predators, that is damage done to game fish by other fish (carp?) which prey on them.
- (6) Forage fish studies. Much information has been gathered on the food and feeding habits of fish which will be useful in establishing workable procedures for increasing the supply.
- (7) Age and growth studies. By collecting scale samples and length data for important game species, great variations of growth of fish in different waters have been demonstrated.
- (8) Fish nutrition. Studies have been conducted at Michigan State College in cooperation with the Institute in the development of diets which may help to reduce the cost of fish food for hatcheries.
- (9) Winter studies. Extensive studies are carried on each winter when considerable attention is given to food supplies, protection and shelter, and methods of decreasing and eliminating suffocation under the ice due to the lack of oxygen.

The Institute for Fisheries Research has set up a field laboratory, the Hunt Creek Experiment Station, on Hunt Creek, a tributary of Thunder Bay River, near Lewiston, Montmorency County. Hunt Creek with its ten tributaries and three lakes located nearby supplies an ideal situation for the study of fishes, particularly trout, in their natural environment.

The United States Bureau of Biological Survey and Bureau of Fisheries have been united as the Fish and

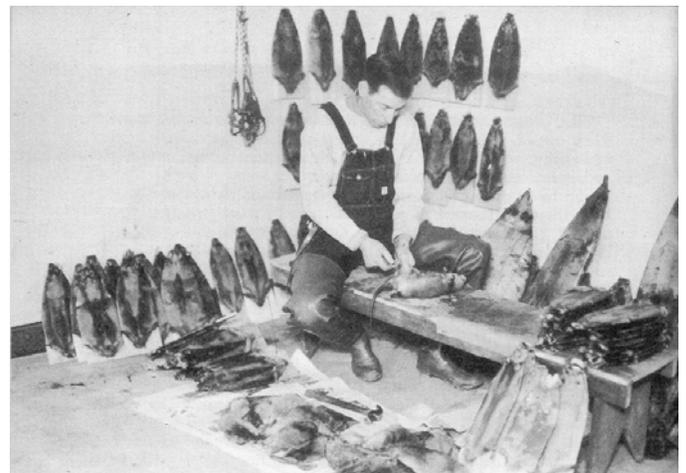
Wildlife Service, the agency of Federal Government which directs Federal fish and game activities. It combines the functions of the former Biological Survey and Bureau of Fisheries. Since establishment of the Biological Survey under the United States Department of Agriculture in 1885, much valuable information has been gathered concerning the food habits, distributions, migrations, and inter-relationships of American birds and mammals. In relation to migratory species, the Bureau has been able to carry on research work that was impossible for individual states.

The research carried on in connection with the Great Lakes fisheries is the function of the United States Bureau of Fisheries which was established in 1871 and was administered by the United States Department of Commerce. The functions of the Service include propagation of fishes, fisheries research, and the administration of the salmon fisheries of Alaska and the fur seal rookeries of the Pribilof Islands. In Michigan, its chief function is the research work which it does in connection with the Great Lakes Fisheries. Michigan headquarters are in Ann Arbor.

The Service maintains hatcheries at Northville and Charlevoix. The most important federal hatchery on the Great Lakes is located at Duluth.

VALUE OF WILD LIFE

Aesthetic and recreational values of wild life are difficult to estimate in dollars, as the revenue derived is seldom in the form of direct returns. However, Michigan's second largest industry—the tourist and resort industry—is in large measure dependent upon the abundance of fish and game. The greater number of our tourists come to hunt or fish, or both. Others find enjoyment in driving or tramping through the forests and fields to observe, study, or photograph wild life in its natural environment.



TRAPPER SKINNING MUSKRAT, LIVINGSTON COUNTY.

In many localities, especially on the lands unsuited to agriculture, residents are partly or wholly dependent on the tourist industry for their livelihood. Guides, resort operators, and others directly dependent on it generally

are busy only during the period between the opening of the fishing season and closing of the hunting season. Local business men in vacation areas do a much larger volume of business during that period than at other times.

Each year an average of 550,000 small game hunting licenses, 170,000 deer hunting licenses, and 850,000 fishing licenses are sold in Michigan. However, many more than 850,000 persons fish in our waters, as minors and wives of resident fishermen are not required to buy licenses.

It has been estimated that deer hunters spend between four and five million dollars in the State during each sixteen-day deer hunting season. As deer hunters form a minority group, this sum is only a small part of the total amount of money spent by sportsmen.

The value of the trapping industry is more easily determined. Michigan's annual fur take amounts to approximately \$1,500,000. This value varies, however, with fluctuations in the fur market. The greater share of our annual fur crop is harvested by farmers who find time to trap during the fall and winter months when routine farm work is slack. The numbers of furbearing animals taken in the southern third of the State are nearly three times the number taken in the northern two-thirds. Each year approximately 24,000 general trapping licenses and 1,800 beaver and otter trapping licenses are purchased.

The Great Lakes are the most important source of fresh-water fish in the world, furnishing 65 per cent of the total marketed. Several thousand individuals in the forty-one counties of Michigan which border upon the Great Lakes are supported in whole or in part by commercial fishing. The Michigan commercial fishing industry has an investment of more than \$4,000,000, furnishes livelihood for some 3,000 fishermen, and produces an annual revenue of approximately \$3,000,000.

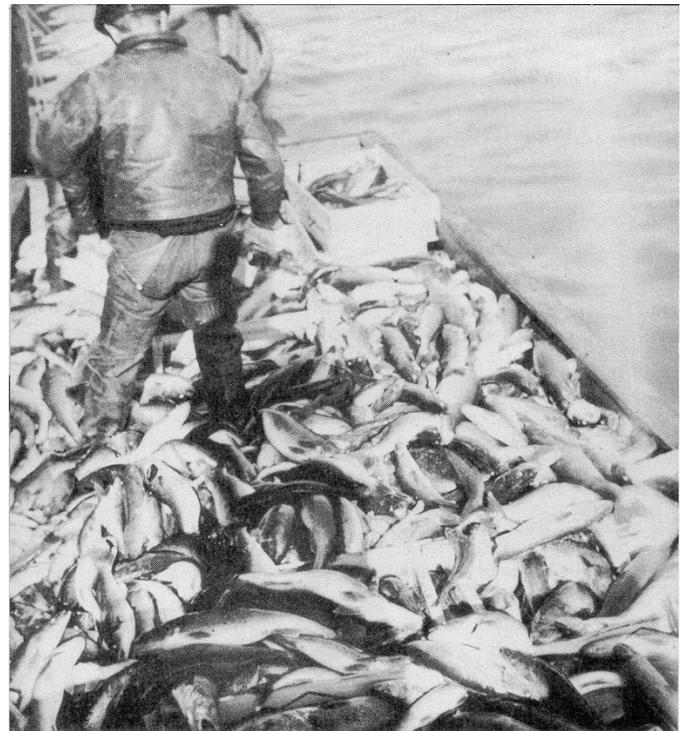
History reveals the importance of fish and fishing in the life and progress of men and nations. Indian communities in the Great Lakes area, and later the early missions and fur-trading posts—Detroit, Mackinac, and Sault Ste. Marie, were established at those commanding sites, partly because the abundance of the fisheries in the adjacent waters guaranteed a food supply for the forts and settlements. Prior to 1830, Indians and employes of the fur companies were the chief commercial fishermen, supplying local needs. Compared with modern fishing gear, their equipment was crude, consisting of spears, dipnets, seines, hooks and lines. As the population increased and transportation improved, a larger market for the fisheries was developed. Whitefish were in greatest demand, the market for lake-trout, pike-perch, and herring was low.

The fish supply, once believed inexhaustible, decreased. New types of nets, powered boats, pollution of waters by industrial projects and communities, and dredging for navigation accelerated the decrease. Artificial culture

and planting of fish and restrictive legislation became necessary.



COMMERCIAL FISHING GEAR.



VANISHING WHITE FISH.

No statistics on the commercial fisheries prior to 1879 are available but many historical references prove their original abundance. Recent statistics of the United States Bureau of Fisheries show that 93,000,000 pounds of fish or sixty-two per cent of the United States' yield of fresh-water fish were produced in 1934 in the eight states bordering upon the Great Lakes. Michigan waters alone produced 28,648,600 pounds or 30.8 per cent of this total. The average annual Michigan production for the years 1920 to 1937 was 26,-089,726 pounds.

Some thirty species of fish inhabit the Great Lakes. The importance of individual species has varied from time to time as the abundance of some species declined and fishing effort was then directed to other less desirable species. The fifteen species which total more than

100,000 pounds in the annual catch, listed in the order of their recent total production, are herring, lake trout, smelt, white suckers and mullet, white-fish, pike-perch, carp, perch, chubs, red suckers, pilot or menominee, saugers, catfish, sheepshead, and bullheads. The catch of each of the first nine species exceeded 1,000,000 pounds and in the aggregate approximate 97 per cent of the total take.

As with other wild life resources, specific regulatory measures must be established to protect these valuable fish resources from complete exhaustion. Closed seasons during the spawning periods must be enforced. Mesh of fishing nets must be large enough to permit the escape of small fish. A minimum size of fish which may be taken must be determined to prevent the destruction and marketing of immature fish. Refuge areas in which valuable species spawn and feed unmolested by nets are set apart.

Many problems are involved in the proper management of the fisheries—variations in the character of the Great Lakes waters, differences in the spawning times of a single species, overlapping of the range and spawning period of various species. Of no less importance is the economic dependence upon the fisheries of a large part of the population who live in areas where other means of livelihood do not exist.

Each state, including the province of Ontario, Canada, bordering on the Great Lakes has regulations to govern commercial fisheries. In 1883, the first Great Lakes Interstate Conference was called at Detroit by the Michigan Fish Commission to discuss the need for uniformity in fisheries regulations. Many conferences have since been called for the same purpose. Despite these efforts, the objectives of uniform control laws have not been realized, although some progress has been made and public concern in official and unofficial quarters holds promise of continued advance towards adoption by all the Great Lakes states and Ontario of uniform regulations for all the Great Lakes waters.

Sport trolling for lake or mackinaw trout in the waters of the Great Lakes has become a major recreational attraction. Fishing for perch, bass, pike-perch, ciscoes, and smelt also annually attracts more people who fish for sport.

THE FUR BEARERS

We cannot discuss all wild life in this book but let us find out what has happened to some of the furred, feathered, scaled creatures that were here when the white man came and to others he brought with him. In Michigan, we had and have kept much of the wealth of our resources in big game, small game, fur bearers, small animals, upland game birds, waterfowl, song birds, fishes, amphibians, reptiles, insects.

FOR THE BIG GAME HUNTER

What can we offer the big game hunter for his camera or gun? Black bear, elk, moose, deer.

The black bear, a native of Michigan, is the "problem child" of the north country. In 1939, the legislature voted payment of accumulated claims for damages caused by bears' attacks on livestock and then removed protection on bear but conferred authority in the Conservation Commission to restore such protection if it were requested by the county boards of supervisors. Protection to bears has been restored in all but seven Michigan counties as the animals found defenders who insist that the bears' value as a tourist attraction outweigh their potential capacity to cause damage. Protection does not always keep things in balance for black bear—he may increase in numbers over his food supply. If the berry crop is small, if few flowers bloom and fewer bees make less honey, or if man exterminates insects and grubs—then less natural food is available, the hungry bears raid the farmer's supplies—and then he is in trouble. Approximately 600 bears are killed annually by hunters during the sixteen-day deer season.



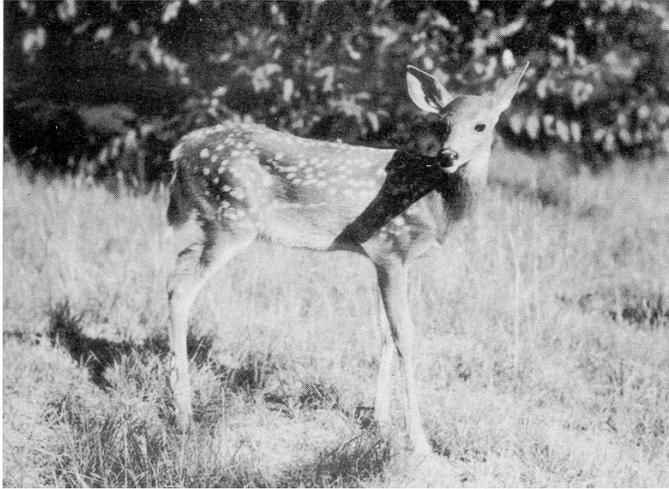
BLACK BEAR CUB STARTS EXPLORING.

The native elk disappeared from the Michigan area soon after the arrival of the white man, as settlers killed them for their own use and to sell for food to logging camps in the southern part of the State.

In 1918, the Department of Conservation secured thirty elk from Wyoming and released them in Roscommon, Otsego, and Montmorency counties. In 1932, twenty more were secured and released in the Houghton Lake State Forest in Roscommon County. The gradually disappeared from all the areas except the Pigeon River State Forest in Otsego County. Today this herd is estimated to include between 300 and 500 animals. It is doubtful that the elk will ever increase to such numbers that hunting can be permitted.

The moose is native to Michigan. The largest herd within the borders of Michigan is on Isle Royale in Lake Superior. At one time the Isle Royale herd numbered approximately one thousand animals. Preservation of

the moose was a determining factor in designating the island a national park in 1935.



WHITETAIL FAWN.

The moose is a browsing animal and depends upon balsam fir, other coniferous vegetation, and some deciduous browse for its winter food supply. The island herd's increase a few years ago so reduced the food supply that many animals starved. Attempting to relieve the situation, the Department of Conservation live-trapped and transported sixty-nine animals to the Northern Peninsula during the years 1934-37. The moose, transplanted, have indicated ability to establish themselves in their new environment.

The white tailed deer is our best known large animal although it is not a native but is a migrant from the Virginia seaboard, pushed westward as settlement encroached on its browsing range. Few of the early explorers, trappers, surveyors record deer, but the deer came as the forests were destroyed and browse increased.

The deer has become the most important big game animal found in the State. Efficient law enforcement, improved methods of combatting forest fires, and the one-buck law have operated to build the biggest deer herd in the State's history. From the results of deer drives conducted in representative areas scattered over the 34,000 square miles of deer territory, it is estimated that Michigan has nearly a million of these animals. Almost 50,000 bucks are killed by some 170,000 hunters during the annual sixteen-day deer season.

This large deer herd presents a difficult management problem. The deer, strictly a browsing animal, spends the winter months in swamps and other densely wooded areas which furnish food and protection from the cold. The winter food consists chiefly of cedar and other browse. In those areas where heavy concentrations of deer are found, much of the available browse has been eaten and as a consequence deer starve during severe winters. Reduction of the herd in overbrowsed areas may prove to be the only solution to the problem of over population. It is interesting also that Michigan deer have

been shipped to the east—its original habitat—to restock deer ranges.

SMALL GAME

Hares, rabbits, and squirrels are our small game animals.

The snowshoe rabbit, or varying hare, is found in plentiful numbers north of an imaginary line drawn from Bay City to Muskegon. Because of its abundance, and because it affords both sport and food, the snowshoes rank as the most important small game animal of northern Michigan.



WITH HORNS IN VELVET.



FARM CROP DAMAGE BY DEER, ALLEGAN COUNTY.

For some unexplained reason, varying hare live in cycles of abundance and scarcity. They may be plentiful for a period of two or three years, then, extremely scarce for a time. Approximately 500,000 hares are killed annually.

Only the farmer paid much attention to the cottontail, the gray rabbit, until about 1900. Since then, rabbits have become the most important game animal in the southern part of the State. The annual kill is approximately four times the kill of varying hares. The cottontail, unlike the snowshoe, does not depend entirely upon swamps and thickets for protection but uses also abandoned dens of woodchucks, badgers, and other animals. Because it is adapted to the agricultural lands in southern Michigan, it is worthy of important consideration in farm game management practices.

Squirrels have always been hunted, for both food and fur. The largest squirrel in North America, the fox squirrel, is scattered over most of Michigan—the larger concentrations are in farm woodlots on agricultural lands in the southern part of the State. Many towns protect their squirrel population—the graceful, saucy, frisky creatures are an attraction and amusement for towns people.

The somewhat smaller gray squirrel is also found in Michigan. The animal commonly called the black squirrel is a color variation of the gray squirrel.



RABBIT LIVE TRAP.

FOR THE TRAPPER

The first white settlements in the state were fur trading posts and for some time fur trading was the leading industry. It declined but much of the fur-bearing population remained—in greatly depleted numbers. The bear, rabbit, and squirrel are classed as game animals but they are also valuable fur bearers.

Michigan's largest fur-bearing animal other than the black bear is the gray or timber wolf of the Northern Peninsula. Wolves have been so reduced in numbers that comparatively few are left. The decrease in the wolf population has been largely due to the reduction of their wilderness range by the development of networks of highways. Although reports from time to time state that wolves have been seen or killed in the Southern Peninsula, no authentic proof has been given that they are now found south of the Straits of Mackinac. It is believed that coyotes are mistaken for wolves. A bounty on wolves is paid by the State. Bounties were paid on thirty wolves in 1935, seventeen in 1936, thirty-six in 1937, forty-five in 1938 and thirty-three in 1939.

Coyotes were found originally in the Southern Peninsula of the State, but they were trapped and shot in such numbers that they were almost extinct for several years. During the first quarter of this century, coyotes increased until they became a serious problem to sheep growers, several of whom suffered great losses from coyote depredations. But although the same bounty is paid for coyotes as for wolves and it is rather profitable to shoot or trap them, they are now holding their own and somewhat extending their range although their surplus numbers are being held in check, enough brood stock

being left to prevent their extinction. Bounties were paid on 3,128 coyotes in 1935; 2,920 in 1936; 2,573 in 1937; 2,593 in 1938 and 2,066 in 1939.

That cunning, courageous animal of the chase—the red fox—is one of the important fur-bearing animals in Michigan. It is found throughout the state and by many people is considered an important game animal, as it affords the excitement of the chase. Many acres of our submarginal morainic hills are being converted to hunt clubs. According to compiled information from trappers' reports, approximately 3,000 foxes are taken in Michigan annually. The cross, silver gray and black foxes are color variations of the red fox. Once his cousin, the gray fox, the only other fox native to Michigan, was numerous but has become almost extinct.

"Varmints"—bobcat and lynx—bothered the early settlers but they also fell before the ax, plough, and gun. However, fairly large numbers of predacious bobcats in the northern part of the State became such a nuisance that bounty payments were authorized in 1935. But by 1937, they had become so reduced in numbers that it became necessary to protect them by removing the bounty. This so-called "predator" is hunted, like the fox, for sport with specially trained dogs. More than 500 bobcats are taken in Michigan annually.

The Canada lynx originally not uncommon in the isolated wilderness of the State was probably exterminated. Today no authentic records prove they are not extinct—reported lynx turn out to be bobcats.

The badger held on but is not numerous, although found over most of the State. According to compiled information taken from trappers' report cards, approximately 500 are taken in Michigan annually.

The beaver lured the French trapper to the upper Great Lakes, opened the country to settlement, founded great eastern fortunes. They were found throughout most of the State and during the reign of the fur trader, their pelts were the important article of trade. By 1920, the animals had been exterminated over most of their original range and it became necessary to prohibit beaver trapping. Protected, beavers gradually increased, went about their engineering projects, quite unconcerned about the damage they rendered their protectors, until property owners and sportsmen complained of the damage they were doing and an open season was established in 1931. The beaver cut down trees, built dams across streams, causing damage to highways, to farm crops, and timber which were flooded as the result of their dam building. In many places, the flooding caused damage to other forms of wild life. Where damage was being done, the animals were live-trapped and transported to other areas where they could do no damage. Seven to eight thousand beaver skins are taken annually. During the ten seasons from 1931 to 1940, a total of 43,859 was taken.

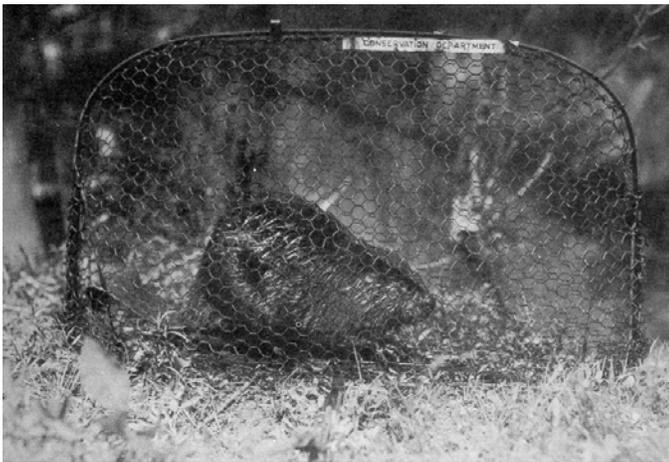
Almost any swamp or flooded marsh area is dotted with the conical tops of houses of the muskrat, the most valuable fur-bearing animal in Michigan, if we consider

the gross value of pelts taken by trappers. It is found in all sections of the State where the habitat is suitable. Approximately 750,000 muskrats are taken in Michigan each year.

Mink, otter, fisher and marten were once second only to the beaver in numbers and value. The mink is found in all parts of Michigan but is probably most abundant in the southeastern part of the State. It continues to rank as one of the most important fur bearers. The take is approximately 17,500 each trapping season.



ADULT MALE BEAVER.



ADULT BEAVER CAUGHT IN LIVE TRAP, COLE CREEK, ANTRIM COUNTY.

But the otter, originally found throughout Michigan in areas which afforded proper habitat, were so extensively trapped that it was on the verge of extermination. In 1925 so few remained that it was necessary to impose a year-around closed season. By 1940, the otter had so increased over much of its former range in the northern part of the State that an open season was permitted.

The fisher, once found in the northern part of the State, and the marten, which originally roamed over most of the State, are now extinct. The marten became extinct, and before legislation prevented, the pelt of the skunk was sold for marten. The skunk is one of the commonest of

our fur-bearing animals, particularly on the farm lands of the southern counties of the State. Approximately 35,000 skunks are trapped in Michigan during each season.



BEAVER CUTTING AND CANAL.



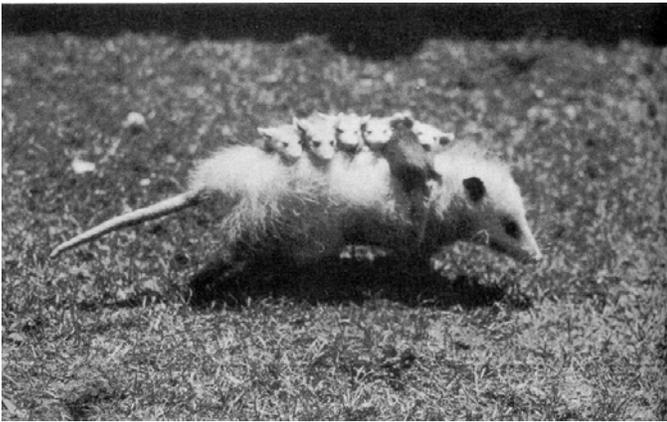
MUSKRAT HOUSES IN POND IN GLACIAL MORAINE.

With the development of the farm lands in the southern section of the State, the opossum migrated into the region and has established itself over most of the southern one third of the Southern Peninsula. Approximately 18,000 are trapped annually.

The smallest and most furtive of our furbearers, excepting the mole, is the weasel. 30,000 of the three species that live in Michigan are trapped during each season.

The raccoon is found over all of the State but it is more plentiful in the southern one-third. It is important as a game animal as well as a furbearer. During the average season, approximately 6,500 are trapped and approximately 33,000 are taken by hunters.

The salt hunting porcupine, a nuisance around camps, serves his purpose in the forest economy. The woodchuck roams over all the State, his value as food dwindled with the Indian population.



THE OPOSSUMS "SHARE THE RIDE PLAN"

SMALL MAMMALS

The fields and forests are the habitat of numerous small mammals that are too small to be considered either game or fur-bearing animals—field mice, moles, shrews, bats, ground squirrels, flying squirrels, chipmunks, and red squirrels. Although their values are not visible in the form of direct returns, these small mammals in most environments are of considerable value to mankind. Certain species, the bats and moles, are insectivorous and help man by killing millions of insects each year.

Small mammals, especially mice, more numerous than all others, are an important part of the diets of predacious species. Deprived of these small mammals, the predacious species would feed upon game and fur-bearing animals.

At times, and—places, it may be necessary to control these small animals in those environments where the damage which they do more than offsets their value.

Perhaps the commonest and most dangerous of our wild animals lives in the towns and cities—the disease and vermin carrying rat. Extermination of the rat should be a civic duty. Breeding places can be destroyed and, more importantly, garbage as well as good food made inaccessible to the pest.

THE FEATHERED POPULATION

Much has been reported in this book of the changes nature and man have made on the face of Michigan. Naturally, all the man made changes in tilling the soil, cutting the forests, draining the wet lands, have been done far more rapidly than nature could make the same changes and has more rapidly upset the wild life—animals, birds, insects, forests, flowers,—upset their way of living so rapidly that many have not time to become adjusted to the change and therefore do not survive it, and become extinct or removed to more suitable habitats. Man has also introduced species that found the new habitat so favorable they have upset the native wild life. Birds, insects, and wild flowers respond to these changes more quickly than mammals, fishes, and the larger plants.



A STARTLED RACCOON.

In Michigan, we have a great diversity of land surface or topography, wet land, dry land, high land, low, sand dunes, clay banks, swamps, marshes, lakes, rivers, hardwood uplands, pine plains, cultivated fields, orchards, and wild lands—a variety of conditions that produce a variety of insect and bird population as well as a great variety of small plant and animal populations all interdependent. Change any one of the land conditions and a change is brought through the whole range of life forms from the lowest bacteria to the highest mammal. The habitat and way of life of the birds is upset most of all and has the least possibility of quick restoration in the short life of the bird, thus many species have become extinct since man arrived as well as those species that become extinct in the one hundred and seventy million years that birds have been on the earth. Queer birds those first birds were, more like reptiles. They had teeth and used their wings and feet to climb about the trees. From those awkward creatures, all our modern streamlined birds have descended, and with few exceptions they are man's friends. They help to keep in check those natural enemies—insects, rodents, and weeds—which work destruction by destroying food. They help to maintain a balance in nature that man destroys, and they have helped to plant the waste and barren places and to distribute plants about the earth. Since man learned to twist a vine into a snare, birds have been a part of his food supply, but today the value of birds in affording recreation far outweighs their importance as food.

UPLAND GAME BIRDS

Three hundred and twenty-eight species of birds have been identified in Michigan, some rare, some numerous, some that have disappeared, others that are disappearing. Many of the game birds of the upland,