Is Our Native Underwater Life Worth Saving?

By Robert R. Miller

Curator of Fishes, Museum of Zoology
University Museums, University of Michigan

Reprinted from *National Parks Magazine*
for May, 1963
Vol. 37 No. 188

Is Our Native Underwater Life Worth Saving?

By Robert R. Miller[1]

DURING THE PAST TWENTY-FIVE years, there has been a steadily increasing application of chemicals to our lakes and rivers for the removal or depression of "undesirable" fishes. Now every State in the United States and all of the provinces of Canada employ this method as a fishery-management tool. Between 1952 and 1962, for example, the U. S. Fish and Wildlife Service, through its Dingell-Johnson program of federal aid to the States for fish restoration, supported the poisoning of some 225,000 acres of lakes and 2,500 miles of streams.

Yet this is but a fraction of the waters so treated because each State carries out its own eradication program. In concentrations as low as 0.5 part per million of 5 percent rotenone, this chemical is toxic enough to kill most fishes and many other aquatic organisms with which it comes into contact (Burdick, Dean, and Harris, 1955) . Death results, to put it simply, from suffocation. Some fishes (e.g., the gizzard shad) are so sensitive that concentrations of 0.10 to 0.15 ppm are fatal. Much higher concentrations are commonly used. Yet little is known of the effects of rotenone-containing products on aquatic insects, floating animal life (zooplankton), and bottom-dwelling invertebrates that are so important to the welfare of higher aquatic animals. A general disregard has been shown for the aquatic community as a whole. This includes not only a variety of fishes, not all of which can be "undesirable," but also entire, complex food chains of organisms, including many that are killed outright and all of which must be adversely affected. And, until very recently, there has not even been any voiced opposition to fish-management programs that involve the wholesale poisoning of large numbers of native aquatic animals. Man so often exercises the kind of foresight and motivation that seeks the biggest immediate gain and display, heedless of the long-term results.

Intentional poisoning[2] of waters by the States as well as by the federal government is said, by these groups, to be necessary in order that "trash fish" populations be removed or depressed, with consequent "rehabilitation" of the waters involved. Unfortunately, the term "trash fish" includes native as well as introduced species. Moreover, native fishes often suffer far more heavily than introduced kinds; the carp, for example, is quite resistant to fish toxicants. Furthermore, such catch-terms as "rehabilitation" are often exploited for propaganda purposes to convince the public that widespread elimination of the fauna of whole river systems is a good thing (Anonymous, 1962; Stone, 1962) . Professional molders of public opinion have thus so slanted their publicity on these programs as to mislead the public. It is to be emphasized that destruction of native forms has been undertaken by conservation departments and fostered by an agency (the U. S. Fish and Wildlife Service) that is charged with conservation of our natural resources. Short-term, economic gains resulting from the temporary increase in numbers of some favored gamefish at times have been given precedence over biological losses by those responsible for the management of our waters.

I do not deny that fish toxins have an application in fishery management that may be both economically and biologically sound, and that wise use of such chemicals is desirable. Examples of such use involve application to particular, limited bodies of water —such as wholly enclosed lakes, artificial ponds, and man-made reservoirs —for the relief of localized specific problems. Excessive stunting, such as not infrequently occurs in the yellow perch, and over-population by an exotic species that leads to interference with reservoir or pond management, are local problems that may properly be relieved by this approach. The tool has also been used beneficially to gain

---

[1] Support for field work on the Green River, given the author by the U. S. National Science Foundation, is gratefully acknowledged.

[2] Some fish managers object to the term poison, claiming that since the organisms are killed by suffocation they are not poisoned. This is nonsense. Any substance that when taken into the system acts in a noxious manner by means not mechanical, so as to cause death or serious injury to health is a poison, by dictionary definition. Moreover, rotenone is given as a dictionary example of a poison.

information on the growth rate or makeup of the total fish population of restricted bodies of water. There is a vast difference, however, between this type of management and the indiscriminate application of highly toxic chemicals to hundreds of miles of main rivers, with resultant destruction not only of fishes but of associated aquatic animals that are so complexly and intimately interrelated to the food efficiency of all organisms inhabiting the river—even to the use of these resources by man himself. Koreover, because of the naturally complex relationship between different ninds of water life in different types of streams, it is not yet possible to make a biologically sound prediction of what may happen in one drainage based on what occurred in a different river.

Extermination of Native Fishes

The threat that fish management holds to native aquatic animals—insects and other invertebrates" as well as fishes—is particularly ominous in Western North America kr several reasons. Throughout the West and Southwest there are numerous highly distinctive groups of associatzed fishes that often occupy relatively small areas, either single stream systems or just certain parts of the few larger drainage basins. Most of these native species fare poorly in competition with introduced kinds and with other changes that man imposes on them—such as the effects of over-grazing, deforestation, damming and diversions of water, and the lowering of the water table Miller, 1961). Consequently, they are being threatened with extinction at an ever-increasing rate. Indeed, in the relatively few years since I have studied the kinds of fishes inhabiting the American Southwest (since L3-38), no fewer than eight species have already become extinct, and the continued existence of thirty-one othens is in jeopardy. These thirty-nine species constitute nearly 40 percent of the known native, freshwater fishes of Western North America (north of Mexico). Attempts are now being made—we hope they are not too little or too late—to set aside segments of the range, or even the entire known habitat, of some of the more urthreatened of these native fishes.

This brings us to what is probably the most glaring example of misuse of rotenone yet carried out by State and federal conservation groups. I refer to the recent chemical eradication of fishes and aquatic insects in the Green River in Wyoming, Utah, and Colorado, including heavy losses in Dinosaur National Monument—an area set aside by Congress with directions that it be safeguarded and preserved as a complete, natural community of life. The Green River project was the most extensive eradication job of its kind ever undertaken, and since the poison travelled through three States it may justifiably be labeled as interstate pollution that was financed, albeit largely unwittingly, by American citizens. Between September 4 and 8, 1962, more than 20,000 gallons of an emulsified rotenone preparation were applied to nearly 500 miles of this river by more than 100 men. The cost for the poison alone exceeded $157,000. Funds for the project were authorized by Congress in June, 1961, after full approval by the Bureau of Sport Fisheries and Wildlife, of the U. S. Fish and Wildlife Service, of the program proposed by Wyoming and Utah. It is admitted by the fish managers themselves that if only a minimum of six years of good trout fishing results from this project, their objective will have been met.

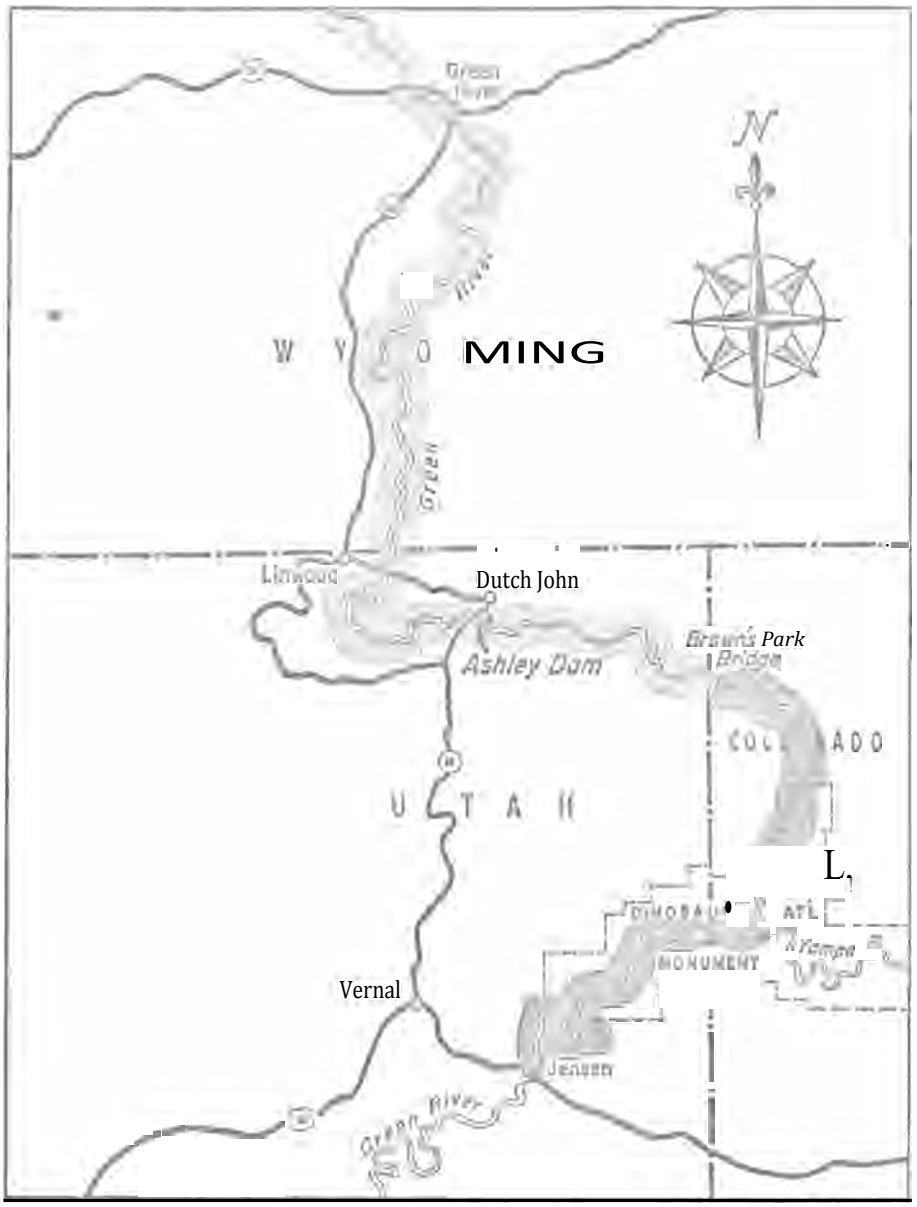
The poison was introduced at the rate of five parts per million of 5 percent rotenone at 17 of 22 stations on the Green River, and was timed in such a way as to insure a continuous flow of toxicant for 86 hours. At stations 18 to 21, the concentration was reduced to approximately 4 ppm and at station 22 to 2 ppm—but even the latter strength is four times that required to kill most fishes. The chemical was also introduced into the drainage system at 15 tributary stations in Wyoming and Utah.

Despite repeated warnings to responsible authorities by individuals and organizations concerned with the possible downstream effects of rotenone on aquatic life—particularly in Dinosaur National Monument—including a 1961 resolution by the American Society of Ichthyologists and Herpetologists condemning the proposed poisoning, the operation was carried out without adequate safeguards and got out of control. This tragedy occtirred even though this was stated to be the most thoroughly planned and rehearsed operation of its kind ever undertaken and even though considerable funds were invested in pre-poisoning surveys and in test runs of the toxicant, and many persons from several agencies were involved in the round-the-clock activity. The general effect of this operation on aquatic animals in Dinosaur National Monument is known to the National Park Service from reports and photographs, and a research report has been released. The damage done is a matter of common knowledge among residents of the region and is further indicated by the information given me by George F. Edmunds and others (see below).

"Rehabilitation" of the River

The Green River treatment has been repeatedly hailed by the States and the federal government as a rehabilitation project—but "rehabilitate" means to restore to a former status, and the establishment of an introduced rainbow-trout fishery does not fulfill the definition. Flaming Gorge Reservoir is now being impounded (since November 1, 1962) in a 91-mile section of the river behind Ashley Dam, extending from Dutch John, Utah, almost to Green River, Wyoming. Native trout are not known to have inhabited this silt-laden stream, although certain cold and clear tributaries once were populated by the Colorado River cutthroat trout, the only native trout in the drainage. That fish is now almost extinct. Elimination of native fishes (of which there are 10 species) and introduced kinds (9 species, including carp and channel catfish) was felt necessary in order to give the rainbow trout (to be planted this year) a chance to build up big populations in the absence of competition from the "trash fish." It is

Dr. Miller is Curator of Fishes at the University of Michigan's Museum of Zoology, in Ann Arbor.



Federal Graphics, Inc.

In the map above, lighter stippling indicates the lower portion of the Green River in which rotenone was used preliminary to stocking the Flaming Gorge Reservoir, now filling, with sport fish. When full, the reservoir will extend from Ashley Dam nearly to Green River, Wyoming. Rotenone was introduced into the Green River from its headwaters (far to the north in Wyoming, not shown on map) and its tributaries above Ashley Dam, nearly to the dam itself. A detoxification station was to have been set up at the base of Ashley Dam; actually, it was set up at Brown's Park Bridge, only 16 miles above the northern boundary of Dinosaur National Monument. Failure of the detoxification attempt caused heavy destruction of aquatic life in the Green River above and through the monument, and at least as far south as Jensen Bridge near Jensen, Utah (that portion of the river indicated by heavier shading).

claimed that, without the "rehabilitation" project, Flaming Gorge Reservoir would provide ideal conditions for a coarse-fish population explosion, and that it was also necessary to treat tributaries to prevent "recontamination" or "reinfestation" of their natural environment by the native, as well as the introduced, kinds. Unquestionably, there is evidence to support the hypothesis that some native as well as introduced fishes do compete with certain prized gamefishes, and that a reduction in the population of such competitors, followed by appropriate stocking, has led at least temporarily to increase —occasionally to spectacular increases —in the angler's catch. In approving such measures, however, biologists should balance the possible harmful effects against the benefits, which typically are of short duration.

The Colorado River basin, of which Green River is a major tributary, contains a higher percentage of endemic species than does any other river in Western North America. Eighty-seven percent of its native, freshwater fishes are found nowhere else. Some of the most unique of these animals are now seriously threatened with extinction from man's activities. Included in the section of Green River that was affected by this poisoning project were places ideal for the maintenance of four of these rare kinds: the Colorado squawfish *(Ptychocheilus lucius);* the humpback chub *(Gila cypha);* the swift-river form of the bluehead sucker *(Pantosteus delphinus),* and the humpback sucker *(Xyrauchen texanus).* The squawfish is the largest member of the minnow family in this hemisphere **and** one of the largest in the world, once attaining lengths approaching six feet and weights nearing 100 pounds. The humpback chub is one of the most bizarre fishes of this continent, being extraordinarily specialized for life in torrentially swift waters. The swift-water form **of** the bluehead sucker is likewise admirably adapted, and the humpback sucker is similarly specialized, but is the least threatened of the four.

Study of Colorado Squawfish

During the past thirteen years I have gathered information on the former size and abundance of the squawfish, on its present distribution in the Colorado River basin, and on anything I could learn of its life history. At the time of the poisoning, the only place known where the species could be taken in abundance was in *the* Green River, from Hideout Canyon (eighteen river miles above Ashley Dam) down through Dinosaur National Monument and in the lower part of its major tributary, the Yampa River of Colorado. The humpback chub similarly was common only in the swift portions of the Green River and in suitable tributaries. The status of these fishes in the Green River is now uncertain and will not be known until careful surveys are made.

Other rare and poorly known aquatic animals also inhabited Green River between Hideout Canyon and Vernal, Utah. George F. Edmunds, Jr., of the University of Utah. has, since 1947, been studying the insect life in Green River, between Green River, Wyoming, and Vernal, Utah. These animals are of great biological interest, for several mayflies reach the western limits of their distribution in this river, others are related to kinds that live far to the south of Utah, and others are known only from this section of Green River. In his investigation of these animals in the river between Split Mountain (near the lower end of Dinosaur National Monument) and Vernal, Utah, made three weeks after the poisoning project terminated, Professor Edmunds found disappointingly few aquatic insects. Many attempts at recovery, using hand screens, yielded no insects at all. He took neither dobsonflies (of which the larvae are the hellgrammites familiar to fishermen and others) nor dragonflies. Both of these types of insects require more than one year to develop, so that their absence cannot be explained by assuming that they had already emerged from the water. He concluded further that the mayflies—of great importance in the food cycle of many fishes—were present in less than 10 percent of their normal populations, except that one kind that burrows deeply in the sand escaped the lethal effects of the rotenone.

Verbal reports relayed to Dr. Edmunds indicated that fishes also had been seriously affected by the rotenone as far as 110 river miles below the terminus of the poisoning project. (It is 108 river miles from Ashley Dam—where the operation should have terminated—to the bridge at Jensen, Utah.) The tragedy of the Green River project to the scientific study of insects was twofold: (1) Since Dr. Edmunds and others were "assured" that the poison would not affect insect life below Ashley Dam, they made no attempt to work in the river during the poisoning operation; and (2) the tens of thousands of valuable specimens killed were not preserved, including many kinds that are difficult to collect, and it is not unlikely that some species were exterminated. Nothing seems to. be known of other invertebrates of the river, especially microscopic forms, and of how they fared in this tragedy. However, it is known that the effects of rotenone on such life in freshwater lakes are considerable (Almquist, 1959; Kiser, Donaldson, and Olson, 1963). It is quite possible that some species adapted to the swifter waters were eliminated *even* before having been collected.

The Detoxification Program

An attempt was made to detoxify the rotenone, but not at the base of the dam in Flaming Gorge (Wyoming Game and Fish Dept., 1962, p. 3, notwithstanding)—beyond which point there was no justification for destruction of aquatic animals. Instead the station was placed 30 miles downstream from the Dam, at Browns Park Bridge in Colorado, and only 16 miles above the upper boundary of Dinosaur National Monument. In his letter of October 12, 1961, to Representative Bob Wilson (California) —who had expressed concern over the threat to aquatic life in Dinosaur National Monument—Daniel H. Janzen (then Acting Commissioner of the U. S. Fish and Wildlife Service) assured Mr. Wilson that there was no such danger in the following words: "This treatment would affect the Green River and its tributaries only within the States of Utah and Wyoming. Some effects may extend a few miles downstream from the dam, but it is not likely that they will reach Colorado. Rotenone is rather unstable in solution and is effective for only a short time. In streams, it may become non-toxic within ten miles from where it is introduced." Earlier, on September 20, 1961, in his letter to Dr. Carl L. Hubbs, Mr. Janzen (then writing as director of the Bureau of Sport Fisheries and Wildlife) stated: "As you are no doubt aware, the Colorado River Wildlife Management Committee, as well as the fish and game departments of Colorado, Utah, and Wyoming, have subscribed to the Flaming Gorge fish eradication program to follow closure of the dam." Despite these two statements, (1) no attempt was made to detoxify the poison until *after* it had entered Colorado, (2) the effects of the rotenone carried for more than 115 miles below the last station (about 8 miles above Ashley Dam) where it was introduced, despite attempts to eliminate the toxicity of the chemical, and (3) when it was known that there would be a delay in closure of the dam (which occurred on November 1, 1962), the project was carried out anyway, thus allowing a greater quantity of rotenone to pass downstream.

Although large quantities of potassium permanganate were applied to the river at Browns Park Bridge, Colorado, from about 6 **A.M.** September 7 to about 5 **P.M.** September 11, 1962, this failed to provide downstream protection for aquatic animals into, through, and beyond Dinosaur National Monument. Despite this failure, which was known to authorities on or before September 15, the Utah Department of Fish and Game authorized the publication in November of the following statement: "One unique feature of the treatment was the successful operation of a detoxification station to neutralize the rotenone-bearing river water before it reached Dinosaur National Monument. Detoxification on this scale had not been considered feasible before but was necessary on the Green River to insure that fish species within the Monument would remain unchanged." (Regenthal, 1962). Although careful tests and checks of the effectiveness of rotenone to kill Green River fishes were carried out by Wyoming and Utah prior to the start of the eradication project, no such advance precautions were taken to determine whether the toxicant would be detoxified by potassium permanganate under the field conditions where it was applied. In fact, no adequate research had been carried out in this country on the detoxification ability of potassium permanganate in rivers approaching the size and the physical and chemical characteristics of Green River, and hence there was no advance assurance that it would do the job there. That it failed is not, therefore, surprising.

Research and Cooperation

Conservation departments need to find out what the rare, threatened, or scientifically important species are so as to avoid the possibility of exterminating populations before undertaking the application of toxicants. By doing this and by notifying interested

The humpback sucker (Xyrauchen texanus). From the Green River in Hideout Canyon, Utah, July, 1959. Total length, 18 inches; weight, 2 pounds.

The humpback chub (Gila [illegible]). From the Green River near Hideout [illegible], Utah, July, 1959. Total length, 13 inches.

Photographs above [illegible] by Phil Brown

persons of their plans for specific treatment of waters, much of the potential danger to aquatic life in our rivers and lakes could be alleviated. Fortunately there are now two active groups in the American Society of Ichthyologists and Herpetologists to which these organizations can turn for such information: a Committee on Fish Conservation, chaired by Carl L. Hubbs (Scripps Institution of Oceanography, La Jolla, California), and a Herpetological Conservation Committee, chaired by Frederick R. Gehlbach (Museum of Zoology, University of Michigan, Ann Arbor, Michigan). A list of rare, restricted, and/or endangered species of fishes, amphibians, and reptiles has been compiled by these two committees and is available for reference by local, State, and federal agencies as well as by private conservation organizations and other interested persons.

An awareness of endangered kinds, and an appreciation of the value of all native wildlife—without undue emphasis on those offering food or sport—could result in saving many aquatic animals from needless extinction. I have recently pointed out to the Arizona Department of Fish and Game that a peculiar, and now very rare, minnow, the Little Colorado [illegible], is nearing extinction in eastern Arizona, and that its continued existence may well depend upon the activities of this conservation group (Miller, 1963). One way to save such animals, if nonspecific toxicants absolutely must be used, would be to remove a breeding stock of the species prior to chemical treatment, hold the animals during the operation, and then reintroduce them to their native stream once the poison has dissipated. This method could be effective only if the habitat remained sufficiently unmodified after the treatment so as to support the species.

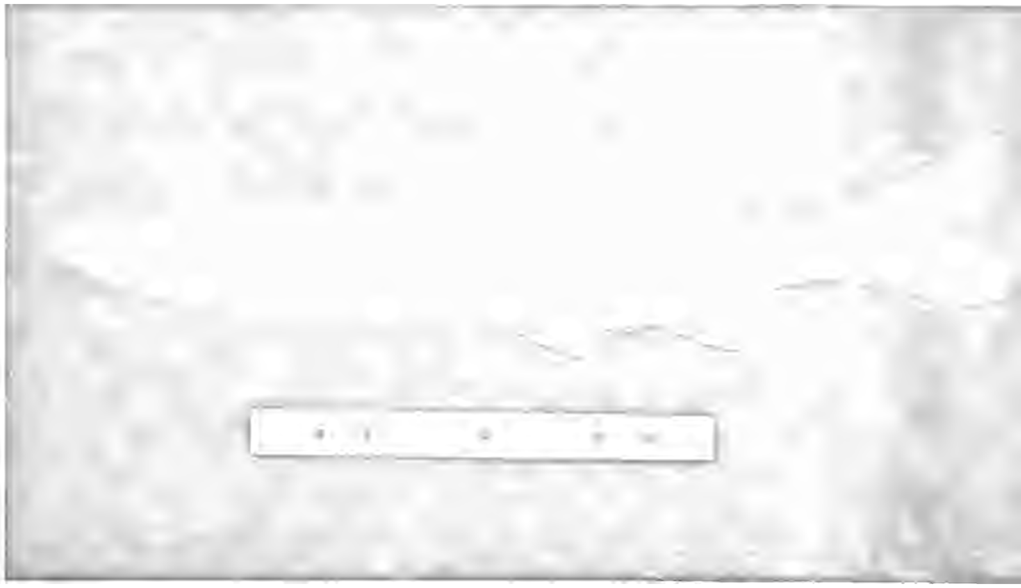
The development of specific toxicants designed to eradicate certain non-native fish, such as carp, is a step in the right direction. The U. S. Fish and Wildlife Service's Division of Sport Fisheries is operating a laboratory at La Crosse, Wisconsin, that is seeking such compounds and is capable of performing more than 600 bioassay tests per week. One of the best and most encouraging examples of the development of a chemical for the specific control of a destructive fish is the compound used against the sea lamprey of the Great Lakes (Applegate, Howell, and Smith, 1958). However, even here the selectivity in part depends on cumbersome and costly logistics in application.

A vigorous educational program undertaken by conservation departments through their popular magazines would alleviate the undue pressure now brought to bear on them by sportsmen. Such pressure leads "biologists" to employ [illegible] and drastic management methods rather than to develop the sophisticarxd ones that are called for. It is biolc cally crude, as well as unnecessary to demolish and upset whole balances of aquatic communities, and we must expect to suffer the consequences of such programs if they are not sharply curtailed. In the words of Paul Sears (1957) : "The earth is fit for (mart and he for it not only because of what he found here but of what went on here during the millions of years before his advent. Surely it behooves man to think twice before causing too much disruption." We already have enough trouble with pollution by nature than fish managers. Let them not pollute, too.

Provision for Consultation

A recent sign of awakening towards some form of control in this direction is the bill (H.R. *2857)* introduced on January [illegible] 1963, by Representative John D. Dingell (Michigan). This provides for advance consultation with the U. S. Fish and Wildlife Service and with State wildlife agencies before beginning any federal program involving the use of [illegible] or other chemicals designed f mass biological controls.

On this and the preceding page are shown three of the rare fishes which are found only in the Colorado River or certain of its tributaries. Their continued existence has been seriously threatened by river management"; that portion of the Green River—the major tributary of the Colorado—which was affected by the recent "trash-fish" poisoning program afturded ideal habitat for maintenance of the three.



The Colorado squawfish (Ptychocheilus lucius); ***a*** *preserved specimen. From the Flaming Gorge of the Green River, 1961.*

Photograph by Robert R. Miller

This is a step in the right direction, and it is hoped that these orETnizations will also consult with the two committees mentioned above th= are actively seeking information on threatened cold-blooded vertebrates.

Finally, the American fisherman and those charged with providing him with the relaxation that fishing brings are failing to take advantage of our rich heritage of native fishes. Many of these could well become eagerly sought by sportsmen. **It** seems ludicrous, for example, to condone the dec....ation of the Colorado squawfish for replacement by rainbow trout. The average size of the squawfish is larger than that of the rainbow, and with the present trend in fishing philosophy aimed toward the sport value of fishing for fun (rather than primarily fcr food or trophy) this particular native species, already fished for by those who know it, could provide- hours of enjoyment.

One devoted American son of Izaak Walton, Professor of English Marcus Seldon Goldman of the Uniyersity of Illinois, has spent his fishing hours fishing for "species" and not for "trophies." He has found the challenge of taking small darters and sculpins on artificial flies to be far greater than that of seeking trout. **Europeans are** far ahead of us on this score; carp and other minnows and other native kinds *are* eagerly sought and eaten, or returned to the water. The number of fishermen increases tremendously)early, and we cannot possibly hope to keep supplying these enthusiasts with what are now the only accepted game fish. Eventually, it is likely that we will find ourselves turning to native species. But if, in the interim, we kill off many or most of these potential native sport fish by chemical eradication and other methods, the fishery biologists of the future will look back on the activities of their predecessors as having been singularly short-sighted.

References

Almquist, Elisabeth
1959. Observations on the effect of rotenone emulsives on fish food organisms. Institute of Freshwater Research, Drottningholm, Sweden, *Rept. No. 40,* pp. 146-160.

Anonymous
1962. Mission accomplished. Good fishing ahead. *Wyoming Wildlife,* Vol. 26, No. 11, pp. 12-17, illus.

Applegate, Vernon C., John H. Howell. and Manning A. Smith
1958. Use of mononitrophenols containing halogens as selective sea lamprey larvicides. *Science.* Vol. 127, No. 3294 (14 Feb.), pp. 336-338.

Burdick, G. E., Howard ***J.*** Dean, and Earl J. Harris
1955. Toxicity of emulsifiable rotenone to various species of fish. *New York Fish and Came Jour.,* Vol. 2, No. 1, pp. 36-67, figs. 1-7.

Kiser, R. W., John R. Donaldson, and Paul R. Olson
1963. The effect of rotenone on zooplankton populations in freshwater lakes. *Trans. Amer. Fish. Soc.,* Vol. 92, No 1, pp. 17-24, figs. 1-3.

Miller, Robert Rush
1961. Man and the changing fish fauna of the American Southwest. *Papers Michigan Acad. Sci., Arts, and Letters,* Vol. 46, pp. 365-404, fig. 1.
1963. Distribution, variation, and ecology of *Lepidomeda vittata,* a rare cyprinid fish endemic to eastern Arizona. *Copeia,* 1963, No. 1, pp. 1-5, figs. 1-2.

Regenthal, Albert
1962. Treatment complete. *Utah Fish and Game,* Vol. 18, No. 11 (November) pp. 3-5, illus.

Sears, Paul B.
1957. The ecology of man. Condon lectures. Oregon State System of Higher Education, Eugene, Ore., 1957, pp. 1-61, figs. 1-15.

Stone, Rod
1962. Tri-state treatment. *Utah Fish and Game,* Vol. 18, No. 9 (September), pp. 10-11, illus.

Wyo. Game and Fish Dept.
1962. *For Wyoming, a New Fishery.* A 3-page mimeographed leaflet distributed at Jackson Hole, Wyo., on Sept. 10, 1962, during the annual meeting of the American Fisheries Society.