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A 4510.—A REVIEW OF THE HISTORY AND RESULTS OF THE ATTEMPTS TO
ACCLIMATIZE FISH AND OTHER WATER ANIMALS
IN THE PACIFIC STATES.

By HUGH M. SMITH, M. D.

PREFATORY REMARKS.

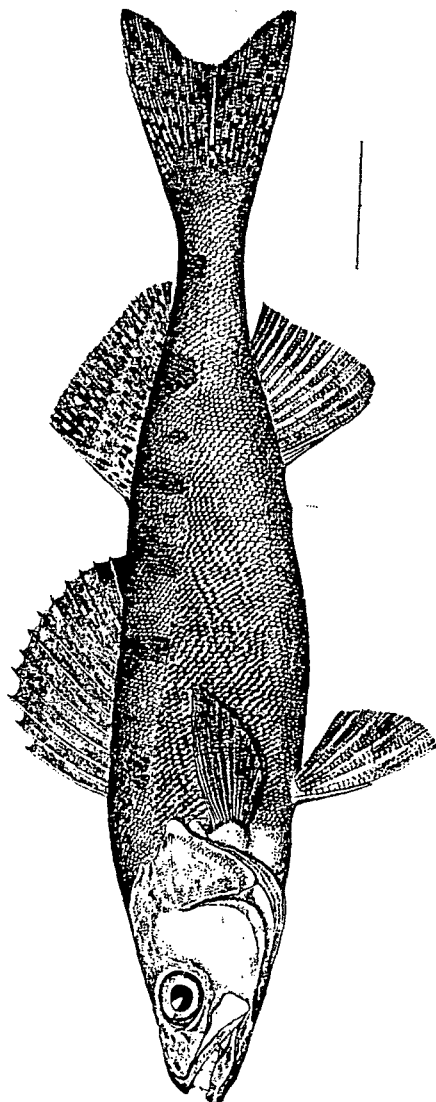
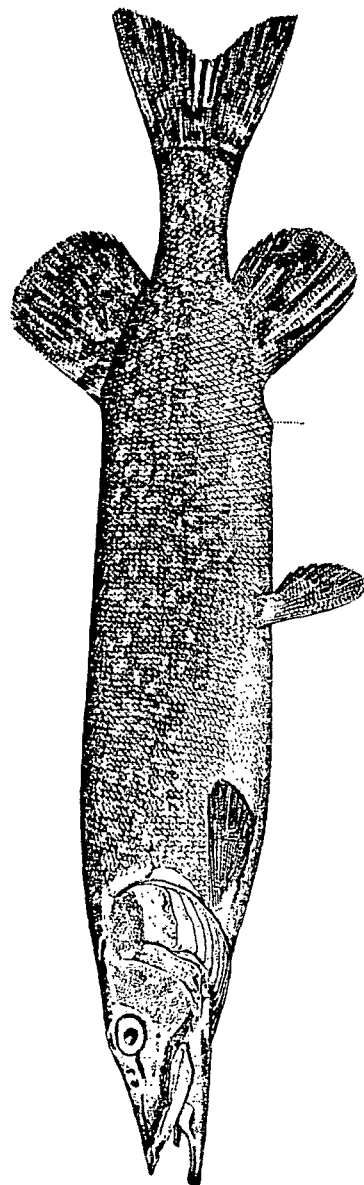
Few subjects connected with the utilization of our natural resources present greater interest than the possibilities for the successful transfer of useful animals from one section of the country to another and their acclimatization in new regions. The benefits that may accrue to a community or section through the introduction of new resources are various, and there are few parts of the country in which valuable non-indigenous animals are not now found.

In the case of water animals, the benefits of successful acclimatization are doubtless proportionally greater than with any other class, owing to the little attention they require after introduction, their extraordinary fertility as compared with land animals, and the slight labor and expense incident to their utilization. At the same time, it is apparent that the difficulties in the way of introduction of fish, mollusks, etc., are greater than with other animals; the drawbacks in the mere transportation are often very serious, especially when long journeys are to be made; while the uncertainties attending the deposition of the animals, the determination of the general results, and the gauging of the economic effects are much greater.

Among other influences militating against the successful introduction of fishes and other aquatic animals into new areas, in addition to those incident to their transportation, are the following: (1) Unsuitable water temperature; (2) unsuitable food; (3) unfavorable topographical condition of the bottom; (4) absence of suitable rivers for anadromous fish; (5) enemies and fatalities acting on a relatively small number of individuals.

The results attending the experimental introduction of aquatic food animals into the waters of the Pacific States must be regarded among the foremost achievements in fish-culture. The striking illustrations here presented of the influence of man over the supply of free swimming anadromous fishes, to say nothing of his ability to affect the abundance of non-migratory species, are of great economic and scientific interest.

Aside from the direct economic results which have followed the introduction of east-coast fishes into the waters of the Pacific States, a very important basis has been furnished for judging of the general effects of artificial methods in regions where the object of fish-cultural operations has been to maintain and increase the abundance of native species. Attention was first drawn to this phase of the subject in an article

PIKE PERCH OR WALL-EYED PIKE (*Stizostedion vitreum*).PIKE OR PICKEREL (*Lucius hutchins*).

contributed by the writer to the issue of *Science* for August 18, 1893, in which the following paragraph appears:

Of scarcely less consequence than the actual results of shad introduction on the west coast is the important bearing which the success of the experiment must have in determining the outcome of artificial propagation in regions in which it is not possible to distinguish with satisfactory accuracy the natural from the artificial conditions. If these far-reaching, and no doubt permanent, results attend the planting, on few occasions, of small numbers of fry in waters to which the fish are not indigenous, is it not permissible to assume that much more striking consequences must follow the planting of enormous quantities of fry, year after year, in native waters? There is no reasonable doubt that the perpetuation of the extensive shad fisheries in most of the rivers of the Atlantic Coast has been accomplished entirely by artificial propagation. On no other supposition can the maintenance and increase of the supply be accounted for.

The zealous efforts of the fish commissioners of California to increase the quantity and variety of food and game fishes of the State deserve special recognition. For more than twenty-five years the energies of the commission have been almost constantly directed to the acclimatization of desirable fishes inhabiting the waters of the Eastern States. Their remarkable success when acting on their own behalf and in conjunction with the New York Fish Commission and the United States Fish Commission entitles them to the great credit and praise which they have received both from the inhabitants of California and from the people of other States and foreign countries. The other States of this section have also exhibited great interest in the improvement of their fish supply through the acclimatization of eastern species.

Mention should be made of the efficient services rendered to fish-culture by Mr. Livingston Stone in successfully taking fishes across the continent at a time when fish transportation was an undeveloped art and when the difficulties encountered would have discouraged one less enthusiastically interested and less competently informed on the general subject. To Mr. Stone more than to any other person is the direct credit due for the introduction of most of those fishes which have since attained economic prominence.

In this report I have considered all those species not already indigenous which have been introduced, or the introduction of which has been attempted, in California, Oregon, Washington, Idaho, and Nevada. Idaho has been included in the discussions because all its water-courses are practically tributaries of the Columbia River, and fish planted in that stream might find their way into the State, while plants in the open waters of Idaho might produce results in Oregon and Washington. The proximity to California of the Nevada lakes and rivers in which new fishes have been planted, and the similarity of the fishery interests of the contiguous parts of the two States, have appeared to warrant the inclusion of Nevada in the list. In the case of a few species having special interest, reference to their acclimatization in Utah has been made.

An interesting chapter might be prepared treating of the experimental introduction of native western fishes into new waters of the region—as, for instance, the acclimatization of the chinook salmon and rainbow trout in landlocked Nevada waters and the successful transplanting of the Sacramento perch (*Archoplites interruptus*) in Nevada—but this subject is foreign to the scope of the present paper.

It is intended in this paper to recount the history of the introduction of each aquatic species; to record the general results of the experiments; to state what is known of the habits of the animals in their new environment; and to give an account

of the economic importance attained and of the fisheries prosecuted. To facilitate the identification of the fish, especially on their appearance in new localities, illustrations of the principal species are included. The reports of State fish commissioners have been freely quoted, either as general information or to bear out the writer's statements regarding the different species.

The importance of this subject and the absence of any special paper dealing with its various aspects make it proper to give to the matter the detailed notice which it receives in the following pages. While the printed references to the subject have been numerous, there are many prominent phases which have not been mentioned, and the full extent of the industry which has been established as a consequence of the acclimatization experiments is unknown even to the people of the States most concerned.

The following fish and other aquatic animals receive special mention and will be considered in the order given:

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|--|--|
| (1) The Bullhead or Horned Pout (<i>Ameiurus nebulosus</i>). 382 | (19) The Crappy or Bachelor (<i>Pomoxis annularis</i>). 440 |
| (2) The White Catfish (<i>Ameiurus catus</i>). 382 | (20) The Strawberry Bass or Calico Bass (<i>Pomoxis sparoides</i>). 441 |
| (3) The Spotted Catfish (<i>Ictalurus punctatus</i>). 382 | (21) The Rock Bass (<i>Ambloplites rupestris</i>). 441 |
| (4) The Carp (<i>Cyprinus carpio</i>). 393 | (22) The Warmouth Bass (<i>Chanobryttus gulosus</i>). 441 |
| (5) The Tench (<i>Tinca tinca</i>). 403 | (23) The Blue-gill or Blue Bream (<i>Lepomis palidus</i>). 441 |
| (6) The Goldfish (<i>Carassius auratus</i>). 403 | (24) The Green Sunfish (<i>Lepomis cyanellus</i>). 441 |
| (7) The Hawaiian Awa (<i>Chanos cyprinella</i>). 403 | (25) The Large-mouth Black Bass (<i>Micropterus salmoides</i>). 442 |
| (8) The Shad (<i>Clupea sapidissima</i>). 426 | (26) The Small-mouth Black Bass (<i>Micropterus dolomieu</i>). 442 |
| (9) The Common Whitefish (<i>Coregonus clupeaformis</i>). 426 | (27) The Yellow Perch or Ringed Perch (<i>Perca flavescens</i>). 442 |
| (10) The Atlantic Salmon (<i>Salmo salar</i>). 431 | (28) The Wall-eyed Pike or Pike Perch (<i>Stizostedion vitreum</i>). 442 |
| (11) The Landlocked Salmon (<i>Salmo salar sebago</i>). 431 | (29) The Striped Bass or Rockfish (<i>Morone saxatilis</i>). 442 |
| (12) The Von Behr or European Brown Trout (<i>Salmo fario</i>). 433 | (30) The White Bass (<i>Morone chrysops</i>). 442 |
| (13) The Loch Leven Trout (<i>Salmo trutta levenensis</i>). 433 | (31) The Tautog (<i>Tautoga onitis</i>). 442 |
| (14) The Lake Trout or Mackinaw Trout (<i>Salvelinus namaycush</i>). 433 | (32) The American Lobster (<i>Homarus americanus</i>). 459 |
| (15) The Brook Trout (<i>Salvelinus fontinalis</i>). 434 | (33) The Eastern Oyster (<i>Ostrea virginica</i>). 464 |
| (16) The Muskellunge (<i>Lucius masquinongy</i>). 437 | (34) The Soft Clam (<i>Mya arenaria</i>). 467 |
| (17) The Pike or Pickerel (<i>Lucius lucius</i>). 438 | |
| (18) The Eel (<i>Anguilla chrysoptera</i>). 438 | Diamond-back Terrapin 471 |

This paper is based chiefly on inquiries made by the writer in May and June, 1894, in the course of an inspection of the economic fisheries of the Pacific States. Acting under instructions from Hon. Marshall McDonald, the United States Commissioner of Fish and Fisheries, special attention was given to those fishes and other aquatic animals which had been artificially introduced into the waters of this region.

Much valuable information has also been obtained from Mr. A. B. Alexander, fishery expert on the steamer *Albatross*, who was detailed in 1893 for an investigation of this subject, and submitted a report embodying his observations on shad, striped bass, and catfish in the vicinity of San Francisco and in the Columbia River. In the following chapters Mr. Alexander's report has been freely quoted.

Use has also been made of the information on the foregoing fishes contained in the reports of Mr. W. A. Wilcox, field agent of the United States Fish Commission,

who has twice made a canvass of the fisheries of the entire Pacific Coast under very favorable circumstances.

In 1895, Mr. William Barnum, of the United States Fish Commission, visited parts of Idaho, Utah, Oregon, and Washington, and obtained information regarding non-indigenous fishes of those States that has been incorporated in this article.

The writer desires to express special obligations to Mr. John P. Babcock, chief deputy of the California Fish Commission, for numerous courtesies which have contributed to the completeness and accuracy of this paper. Mr. Arthur G. Fletcher, of the same commission, has also furnished a number of interesting notes.

Messrs. Babcock and Fletcher, cooperating with the writer, were able to secure accurate figures showing the monthly receipts of shad, striped bass, carp, and catfish in 1893 and 1894, which information is given elsewhere.

To the following fish-dealers of San Francisco acknowledgment is due for their kindness in according free access to their books, from which an accurate statement of the extent of the trade in the species under discussion could alone be obtained: American Union Fish Company, J. H. Kessing, A. Paladini, Pioneer Fish Company, G. Camilloni, S. Tarantino, B. Cato, and P. Gusmani.

The following-named gentlemen have courteously responded to inquiries and supplied useful data: Hon. George T. Myers, Portland, Oreg.; Mr. James Crawford, fish commissioner, Vancouver, Wash.; Mr. F. C. Reed, ex-fish commissioner, Astoria, Oreg.; Mr. Charles F. Lauer, The Dalles, Oreg.; Mr. George T. Mills, fish commissioner, Carson City, Nev.; Mr. W. H. Ridenbaugh, Boise, Idaho.

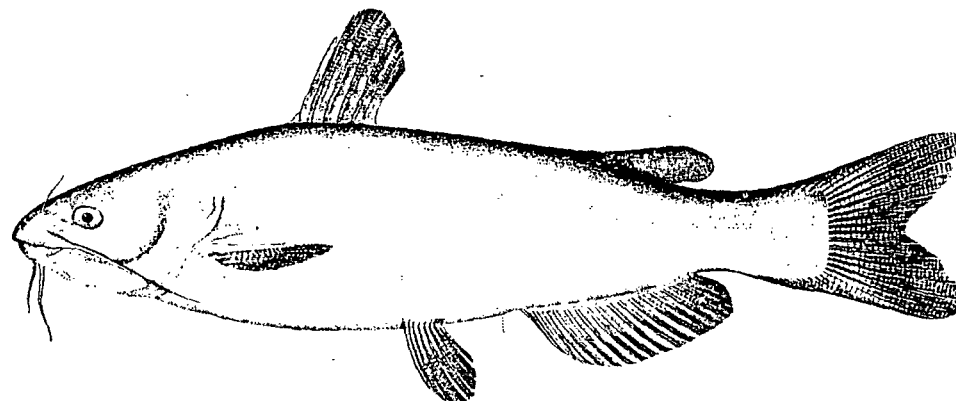
THE CATFISH.

INTRODUCTION TO PACIFIC STATES, AND RESULTS.

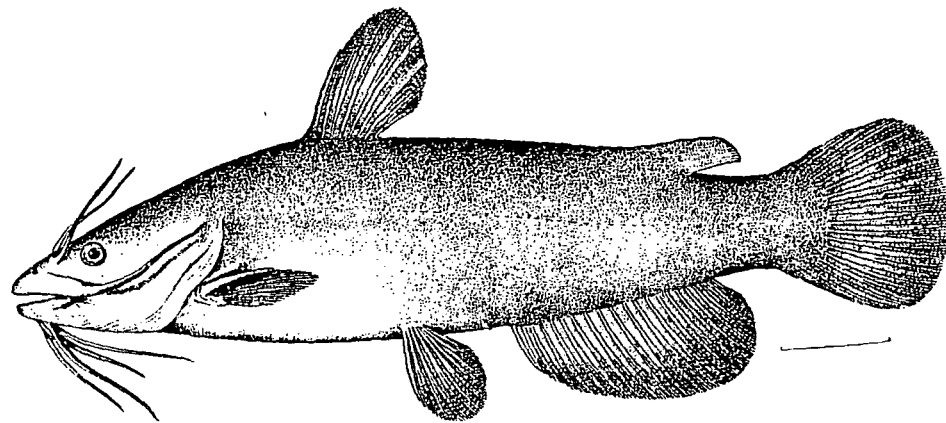
At least three species of catfish—the white catfish (*Ameiurus catus*), the yellow catfish or bullhead (*Ameiurus nebulosus*), and the spotted catfish (*Ictalurus punctatus*)—inhabiting parts of the United States east of the Rocky Mountains have been transferred to the Pacific States. Catfish were taken to California in 1874 by Mr. Livingston Stone,* of the United States Fish Commission, and subsequently one or two species were introduced into Oregon and Washington. Mr. Stone's assortment of eastern catfish consisted of 56 large Schuylkill catfish (*Ameiurus catus*) from the Raritan River, New Jersey, and 70 hornpouts or bullheads (*A. nebulosus*) from Lake Champlain, Vermont. The large white catfish were deposited in the San Joaquin River, near Stockton, Cal., and the bullheads were placed in ponds and sloughs near Sutterville, Sacramento County, Cal.; both plants were made on June 12, 1874.

It appears from Mr. Stone's account of his trip across the continent in 1874 that at Fremont, Nebr., on the Elkhorn River, he took on board some catfish from that stream, and that 18 of these were placed in the San Joaquin River, near Stockton, in conjunction with the other large catfish from New Jersey. Mr. Stone refers to these as "Mississippi catfish," but this designation is not definite enough to conclusively fix their identity; and as no specimens have recently been observed, and as no examples are preserved in collections, the ichthyological status of this fish must be considered unsettled. Recent collections in the Elkhorn River and neighboring waters by the

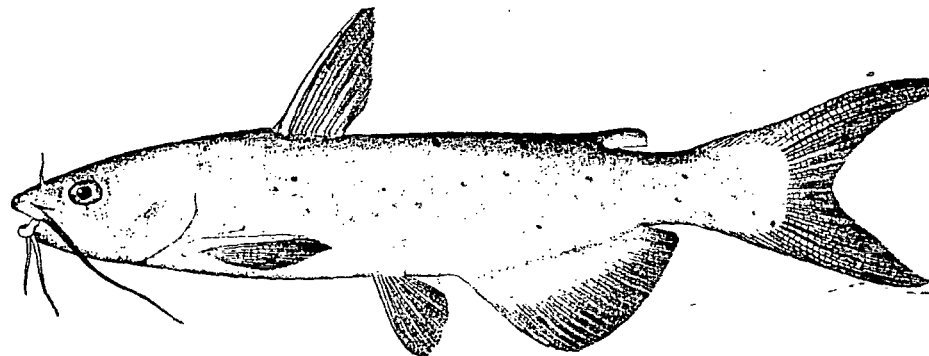
* See Report California Fish Commission, 1875-76, pp. 5, 6, 22, 30, 32.



WHITE CATFISH OR SCHUYLKILL CATFISH (*Ameiurus catus*).



YELLOW CATFISH OR BULLHEAD (*Ameiurus nebulosus*).



SPOTTED CATFISH (*Ictalurus punctatus*).

United States Fish Commission have disclosed the presence of a number of species of catfish, any or several of which might have been obtained by Mr. Stone. Among these are the spotted catfish, blue catfish, or channel catfish (*Ictalurus punctatus*); the fork-tailed catfish (*Ictalurus furcatus*); the mud catfish or yellow catfish (*Leptops olicaris*); the great fork-tailed catfish or Mississippi catfish (*Ameiurus lacustris*), and the black catfish or bullhead (*Ameiurus melas*). The first, third, and fifth named species are known to be common in the river in question, and only these are recorded from Fremont. It is therefore probable that specimens of one of these were secured by Mr. Stone.

The spotted catfish is probably the best of the tribe, and is the principal one distributed by the United States Fish Commission. In food value it is regarded by Jordan and Evermann as not inferior to the black bass. Several plants have in recent years been made in the Pacific States. In 1892 the following adult and yearling catfish were deposited in Washington waters, in response to requests: Seventy-five in Clear Lake, Skagit County; 125 in a private pond near Vancouver; 50 in Deer Lake, in Stevens County. In 1893, 100 were placed in the Boise River, Idaho, a tributary of the Snake River. Ten were put in the Balsa Chico River, California, in 1895. Plants of yearlings were made in Lake Cuyamaca and Feather River, California. In 1891, each water receiving 250 fish.

The results attending the introduction of catfish in California were immediate and marked. As early as 1875, the State commissioners reported on the matter as follows:

The Schuylkill catfish and the Mississippi catfish, placed in the San Joaquin River, have grown rapidly and spawned, but several of the large fish and many of the young ones have been caught by the fishermen near the San Joaquin bridge, and have been returned to the river. The fishermen at that point are much interested in their successful cultivation, and seem desirous that they should be preserved. By another year they will be so numerous that they may be caught with safety and shipped to market, as it would be impossible to exhaust the river by ordinary fishing. The hornpouts, a species of small catfish from Lake Champlain, which were placed in the lakes near Sacramento, have increased so abundantly that nearly one thousand have been caught and transported to the various lakes and sloughs in the Sacramento Valley. We caused several hundred of them to be placed in lakes containing brush and dead trees, in which it would be impossible to seine them. The acclimatization and perpetuation of these fish in the Sacramento Valley is assured, as they are now so situated that no amount of fishing will exhaust them.

In their report for 1876-77, the fish commissioners stated:

The 74 Schuylkill catfish imported in 1874, and placed in lakes near Sacramento, have increased to a vast extent. They already furnish an important addition to the fish food supply of the city of Sacramento and vicinity. From the increase we have distributed 8,400 to appropriate waters in the counties of Napa, Monterey, Los Angeles, Fresno, Tulare, Santa Cruz, Shasta, Solano, Alameda, San Diego, Yolo, Santa Barbara, and Siskiyou. These, should they thrive and increase as they have in Sacramento, will furnish an abundance of valuable food in the warm waters of the lakes and sloughs of the interior, and replace the bony and worthless chubs and suckers that now inhabit these places. It may be proper to call attention to the fact that these fish have become so numerous in the lakes near Sacramento that they can now be obtained in any quantity for stocking other appropriate waters in any part of the State.

In 1878-79 the California commissioners distributed 39,000 Schuylkill catfish to public waters in 22 counties, and reported as follows about the fish:

These have increased to millions and furnish an immense supply of food. They have become so numerous that they are as regularly on sale in the city markets as the most abundant native fish, and are sold at about the same prices. They thrive in our rivers and lakes, and in the still-water sloughs of our plains, as well as in the brackish sloughs in our tule lands. They appear to be equally at



home in lakes on the mountains and in artificial reservoirs in the valleys. Many farmers who have natural ponds on their farms, or who have surplus water from windmills and have made artificial ponds, have stocked them with this excellent fish. The produce of the few fish of this species, imported in 1874, now annually furnishes a large and valuable supply of fish food to people in the interior of the State. The value of all the fish of this species now caught annually and consumed as food would more than equal the annual appropriation made by the State and placed at the disposal of the fish commissioners. This variety of catfish has valuable characteristics which admirably fit it for wide distribution and for self-preservation in the struggle for existence.

The report of the California Fish Commission for 1880, from which the following extract is made, shows that over 24,000 catfish were distributed in the State waters, and that the fish had become so numerous and widely scattered that further attention from the commission was hardly demanded:

The 74 catfish imported from the Raritan River in 1874 have increased and multiplied, and this increase distributed, until now we believe there is no county in the State, from Del Norte to San Diego, that has not been supplied with a greater or less number of these fish. They are regularly sold in all the markets at the same prices as our most abundant fish. They are admirably adapted to the sloughs and warm waters of the great valley, and in them have so multiplied as to furnish a large supply of food. The aggregate value of this fish alone, sold in the markets of San Francisco and Sacramento annually, would more than equal the appropriation annually made by the State for fish-culture. How constant has been the demand made upon us for the wide distribution of this fish may be seen in our report of expenditures, which shows quite a large amount paid for their capture and in sending them by express to different parts of the State. These fish are now so numerous and widely distributed that probably the time has arrived when their further distribution should be left to private enterprise, and the money of the State heretofore used for this purpose be employed in importing some other equally valuable fish.

In considering the question of the economic value of the catfish and of the effects of its introduction on the native fishes, the fish commissioners make the following comment in their reports for 1883-84 and 1885-86:

It has been stated by fishermen that they would destroy all the native fish. It is our opinion that it was a timely act on the part of the former State commissioners to plant them just when they did, as our native fish were giving out. . . . They are coming more into favor with our citizens every year. The prejudice that existed at the time of their introduction is fast dying out, and the majority of our people claim that they are a better food-fish than the carp. Whether such be the fact is a matter of taste. The idea that they would destroy our native fish is a fallacy, as in the last two years statistics tend to show that such is not the fact.

Catfish are coming more into favor with citizens as food, and by a large class of consumers are preferred to carp. The planting of these fish was regretted by many and approved by more.

Catfish have been successfully introduced into the Columbia River and its tributary, the Willamette, but the full history of the planting is not recorded. Mr. F. C. Reed, of Astoria, contributes the following note on the origin of the catfish in the Columbia:

The extent of my knowledge of the history of this fish is as follows: About eight years ago [1888], when I was fish commissioner for Oregon, these fish were reported to be in Silver Lake, Washington. How they came there, I never was able to find out. When I heard they were in the lake, I was told they could not get out of the lake into the Columbia River; this was in reply to a request I made on the Washington authorities that I be allowed to go over to the lake and kill the catfish for fear they would get in the river and be another enemy to our salmon. It was only a year or two after this that during an unusual rise in the lake the fish were sent into the Cowlitz River, and from there to the Columbia. I thought at the time they were the real catfish, and would grow large enough to eat a 20-pound salmon, but now I do not think they will injure our salmon very much, as I have never seen them near the spawning-grounds, and think they prefer still and warmer water.

The history of the introduction of catfish into the waters of Nevada is very interesting. It appears that in 1877 Mr. H. G. Parker, the State fish commissioner, obtained from the Sacramento River, California, a large number of "Schuylkill" catfish (*Ameiurus calus*), which were deposited in Washoe Lake, the Truckee, Carson, and Humboldt rivers, and several sloughs, 25,000 yearlings being placed in the Humboldt alone. In all these waters the catfish rapidly became acclimatized, and in his report for 1879 and 1880 the commissioner states:

Nothing can be more satisfactory than the evidence I have of the increase and growth of the several lots of catfish I put in Washoe Lake and Carson, Truckee, and Humboldt rivers. Washoe Lake is so fully stocked and the fish of that size and vigor that further experiments would be useless. Over one hundred a day have been taken by one fisherman, none less than 14 inches long, and weighing from 1 to 14 pounds. Of those planted in Carson River, at Schultz's ranch, several have been caught at Woodfords, 30 miles up the river from where deposited, and others 60 miles down the river from place of deposit, the latter having passed through all the poisonous substances flowing into the river from mining operations. Advices from the Truckee and Humboldt rivers warrant me in reporting equally as favorably as from those planted in Washoe Lake, and with another year's growth, or on the opening of the rivers in the coming spring, I have no hesitancy in stating that good and profitable fishing may be had. . . . In December, 1880, I distributed catfish in Washoe, Humboldt, Churchill, Lander, Eureka, Elko, Nye, and White Pine counties. . . . In all, I planted fish at 81 different places. Outside of the Truckee and Humboldt rivers, Pine Creek, and Newark Valley, the plants were in lakes, sloughs, streams, and larger springs, but in every place public waters.

In the report of the Nevada commissioner for 1881 and 1882 it is stated that 2,000 catfish were distributed in various waters in those years, and that the results had been marked in all the waters stocked, thousands of pounds of catfish being taken from Washoe Lake with hook and line in 1882. From the reports for 1883-84 and 1889-90 the following extracts are taken, which refer to the value of the catfish in waters where better fish can not flourish and to the economic importance which the fish have attained in Nevada.

From nearly every plant of catfish I have reports several times a year, and in every instance I have been complimented on the introduction of this very prolific and superior food-fish. Its hardy nature so well fits it for our saline and muddy waters, that in localities where the trout can not flourish this fish is sure to thrive and multiply far beyond any of our transplants. In Washoe Lake, Carson and Humboldt rivers, they are now found in such great numbers that anglers of all ages and sexes never abandon the pleasure until well-filled baskets and sacks mark the day's sport. For two years the Carson and Virginia markets have been to a great degree supplied with these fish from Washoe Lake. They find a ready sale at the highest prices. It has been my custom, and I now have on hand over 1,000 yearlings ready for distribution, in lots from 50 to 100 fish. The species of catfish herein mentioned were taken from the Schuylkill River, Pennsylvania, where it is unusual to find them to exceed 1 pound in weight, while in this State many are caught weighing over 2 pounds, thus showing the favorable results from transplanting fish.—(Report for 1883-84.)

The introduction and planting of the Schuylkill River blue catfish by our first fish commissioner, Mr. H. G. Parker, was commenced in August, 1877, the first deposits being made in Washoe Lake, Carson and Humboldt rivers. In two years these fish had increased to such numbers that the commission was enabled to stock other waters from the supply furnished in Washoe Lake. Thousands of pounds have been taken annually for the last eight or ten years, every family living near these waters supplying their table for about seven months of the year, while the markets of Carson and Virginia cities, although receiving large consignments, find such large sale that their stock is exhausted long before the most desirable salt-water fish find a purchaser. Add to this the fact of the number engaged in fishing for the market, and it will be seen that an industry has been developed, not only giving employment to quite a number of men and boys, but furnishing a food-fish of a most desirable and salable quality, and this through the workings of the Nevada fish commission.—(Report for 1889-90.)

Mr. W. H. Ridenbaugh, of Boise, Idaho, in 1895 took with a minnow net a few small, spotted catfish in Natariorum Lake, in Boise, thus indicating that the fish planted in 1893 have spawned.

DISTRIBUTION AND ABUNDANCE OF THE CATFISH.

It is not possible to assign to each species of catfish its present distribution in the Pacific States. There is nothing in the habits of the two kinds known to have become acclimatized that would prevent both inhabiting the same waters, although the yellow catfish or bullhead (*A. nebulosus*) is probably more likely to be found in warm, muddy ponds, sloughs, and ditches than is the other species, which, on the east coast, is commonly known as the channel catfish, in allusion to its habit of frequenting the deeper, colder, and clearer parts of the rivers.

In California the catfish have a more general distribution than any other fish. The State commissioners in 1880 asserted that there is no county in which these fish were not found; the wide distribution which the fish had given themselves had been supplemented by the efforts of the commissioners, who, from 1877 to 1879, planted them in 30 counties.

In California catfish are most numerous in the valleys of the Sacramento and San Joaquin rivers, where the conditions are very favorable for their multiplication. They are found in most of the tributaries of those streams and in the sloughs connected therewith. They have ascended the Sacramento River as far as Kenneth, a station 17 miles above Redding, and the San Joaquin to Tulare Lake. In 1886, Mr. William Utter, writing from Campo Seco, Calaveras County, reported that there were millions of catfish in the Mokelumne River, which joins the Sacramento River a short distance below Sacramento. Catfish are also found in several of the coast rivers of California.

In a "List of the fishes inhabiting Clear Lake, California," by Jordan and Gilbert, printed in the Fish Commission Bulletin for 1894, the bullhead (*A. nebulosus*) is recorded as very abundant, and the white catfish (*A. catus*) is reported as occasionally taken with the other species. In Lake Cuyamaca, near San Diego, catfish are reported as abundant, and some weighing 1½ pounds have been taken with lines.

Catfish are generally distributed in the Lower Columbia River and in the Willamette and other tributaries. The limits of their range in the Columbia basin have not been determined. They are very abundant in the sloughs connected with the Willamette River below Portland. Mr. F. C. Reed, of Astoria, states that the catfish of the Columbia basin is the bullhead, and that the catfish proper (that is, the fork-tailed form) does not occur. He recently obtained and forwarded to the Fish Commission a specimen of Oregon catfish; it was secured in Portland and was evidently caught in the Willamette River. It is 8 inches long, and Mr. Reed states that it is about the average size of those taken in the Columbia basin, although rather smaller than the usual run of those now saved for the markets, which are 10 to 12 inches long. An examination of this example shows that it is referable to the species known as the black catfish or bullhead (*Ameiurus melas*); it has the square tail and other features found in the common bullhead (*Ameiurus nebulosus*) and closely resembles the latter species, but differs from it in having a flatter head, a rather stouter body, and a shorter anal fin. In this specimen the length of the head is contained 3½ times in the body length, and the greatest depth 4½ times in length; the anal fin has 17 rays, including rudiments, and its base is contained 5½ times in body length. In *A. nebulosus* the anal rays number

22. This specimen adds to the doubt existing as to the origin of the catfish in the Columbia basin. The supposition that the original stock in Oregon and Washington may have been obtained from California must be discarded, as the existence of *A. melas* in the latter State has not been determined, although this may have been the fish obtained by Mr. Stone in the Elkhorn River, Nebraska, in 1874, as previously suggested.

The quotations previously made from the reports of the Nevada fish commissioner are sufficient to show the wide distribution and great abundance of the catfish in that State.

SIZE AND WEIGHT.

The average weight of catfish taken for market in California is under 1½ pounds. There is a great abundance of very small fish in the Sacramento and San Joaquin rivers, and many seine hauls might be made in some places without yielding any over 10 inches long. Those weighing 5 pounds and upward are quite uncommon. Specimens of both species caught with a line by the writer at Collinsville, in June, 1894, were all 8 inches long or under. These were taken from the muddy waters of the Sacramento, and partook to a great extent of the color of the water; some were almost milk-white, others pale green or yellowish green.

Up to May 31, 1895, Mr. Babcock had observed no catfish in the San Francisco markets weighing over 3 pounds; on that day, however, he saw an 8-pound fish from the Sacramento River, in the American Union Fish Company's market, and heard of a 15-pound fish that had been received the same day.

Salmon gill-net fishermen of the Sacramento and San Joaquin rivers, using nets with a 7½ or 8 inch mesh, sometimes take large catfish. A salmon fisherman on Sherman Island, in the San Joaquin, informed the writer that he had caught several catfish weighing 10 pounds.

Mr. Charles Cuneo, of the American Union Fish Company, states that a few catfish weighing 6 to 8 pounds are received by San Francisco dealers, but that 15 or 16 inches is the usual length.

Mr. Alexander reports as follows on the size and weight of the catfish in California and the Columbia River:

The average weight of the catfish sold in the markets of San Francisco is 1 pound. Occasionally fish weighing 7 and 8 pounds are brought in, but few fish of this size meet with a ready sale, and there is little inducement for fishermen to save them. The average length of catfish is about 12 inches. In the Columbia and its tributaries the fish run somewhat smaller, three-quarters of a pound being a fair average in weight and 10 inches in length.

FOOD OF CATFISH.

The catfish have the reputation among the California fishermen of being large consumers of fry and eggs of salmon, sturgeon, shad, and other fishes. This accords with their known habits in other waters. Mr. Alexander's examination, however, of the contents of several hundred stomachs of catfish in California and Oregon yielded only negative results as to the presence of young fish and ova.

Writing of the bullhead in Clear Lake, California, Jordan and Gilbert say that it is extremely abundant and is destructive to the spawn of other species. The scarcity of the valuable Sacramento perch in that lake, which they attribute to the carp, here as in the Sacramento River may be partly due to the more numerous catfish, which feed almost exclusively on animal matter.

By some persons the catfish are held responsible for the scarcity of Sacramento perch in the Sacramento and San Joaquin rivers. Mr. Babcock writes that he is informed by reliable men living above Colusa that up to 1880 perch were very common there and catfish were seldom taken, but since that time the catfish have increased beyond all belief and the perch have almost disappeared. The supposed influence of the catfish on the abundance of the perch arises from the spawn-eating propensities of the catfish.

Mr. A. Paladini, an extensive and long-established dealer of San Francisco, believes that catfish are especially injurious to salmon in the Sacramento River, where he thinks they destroy large quantities of ova and fry. This matter is sufficiently important to warrant careful attention. It would seem that the centers of abundance of catfish are probably remote from the spawning-grounds of salmon.

ASSOCIATION WITH OTHER FISH, ENEMIES, ETC.

In California and Oregon catfish inhabit to a great extent waters in which few other fish could or do exist. In the lagoons and sloughs connected with the San Joaquin, Sacramento, and Willamette rivers, but few fish besides catfish are taken with the fyke nets and set lines. When fishing is done in the main streams, a number of varieties are caught with catfish, among which are split-tails (*Pogonichthys macrolepidotus*), hardheads (*Ptychocheilus oregonensis*), and carp (*Cyprinus carpio*), and, in the Columbia basin, young sturgeon (*Acipenser transmontanus*).

Few enemies and no diseases disturb the catfish in Pacific waters, according to Mr. Alexander. No fish are known to prey on them except the striped bass, and even that species must do so very rarely. In some instances the ingestion of catfish by striped bass results in the death of the latter, the formidable spines piercing the stomach and entering the abdominal walls of the bass.

ORIGIN AND GENERAL EXTENT OF THE FISHERY.

From the extracts from the reports of the California fish commission previously quoted it may be seen that very soon after the introduction of the catfish a fishery was inaugurated. The practice of taking the fish for market from public waters has probably increased from year to year, although no statistics are available for any early years. At present it is probable that more catfish are caught for local and home consumption than for sale in the large marketing centers, but no accurate idea of the extent of the desultory and semiprofessional fishing can be formed.

The catfish fishery is not of large proportions in either California or Oregon. Only a small amount of capital is invested in it, but few persons are regularly engaged, and the catch is insignificant compared with the yield of many other fish taken in the same waters. The industry is more extensive in California than in Oregon.

The commercial fishery, in California at least, has probably reached its height, if it is not already on the decline. The receipts of catfish by the San Francisco dealers in 1894 were nearly 30 per cent less than in 1893; the decrease was due wholly to the lack of demand, the fish being more abundant. The large receipts of shad in the markets in recent years have doubtless put a check on the value of catfish and the expansion of the fishery.

FISHERMEN, APPARATUS, AND METHODS.

Fyke nets and set lines or trot lines are the apparatus chiefly employed for taking catfish. Both these appliances are used in California; but in Oregon Mr. Alexander reports that only fyke nets are set. Considerable quantities are in some localities incidentally taken in drag seines. In the semiprofessional fishing, hand lines and dip nets are also employed. The catfish fishery of California is carried on by a few persons who make a business of taking those fish throughout the year. It may be followed with some regularity for a time, but is seldom allowed to interfere with the capture of salmon, striped bass, and other more valuable species.

The number of persons who may be regarded as catfish fishermen in 1893 was about 100. These made their headquarters at Red Bluff, Fremont, Sacramento, Knight's Landing, Isleton, Bouldin Island, Jersey Landing, and other points on the two rivers. More than half the regular fishermen were Chinese.

The apparatus used in the catfish fishery of California in 1893, as determined by Mr. Alexander, consisted of 750 fyke nets, valued at \$8,500; 100 trawl lines, valued at \$150, and 15 drag seines, valued at \$375. The number of boats used for lifting nets and trawls was about 60, with a value of \$900. It should not be understood that all of the apparatus shown is used at one time. A few nets or trawls may be set for a few days or weeks, taken up, and not employed again for several months or possibly not until the next year.

The catfish fishery in Oregon is carried on by seven fishermen in the vicinity of Sauvie's Island, situated in the Willamette River, a short distance below Portland. Mr. Alexander reports that a Mr. Mitchell is more extensively engaged in the business than anyone else, and that the Portland dealers look to him for their supply of catfish. He lives, with his family and hired men, in a small portable house on the bank of a slough where the fishing is done. The house is so constructed that it may easily be put on a float and moved from place to place, as occasion requires. Another structure, 15 by 30 feet, is built on a scow, in which the skinning, dressing, and boxing of the fish for market are done. The fish as caught are kept in three live-cars until needed for shipment. Four fyke nets are employed by this crew; they are set at the ends of two leaders and are valued at \$160; small skiffs are used to tend the nets. The aggregate investment in the fishery at this place is \$445. Six other persons were in 1892 more or less regularly engaged in taking catfish, but less extensively than Mr. Mitchell. They had 5 scows, 9 skiffs, 12 cars, and 8 nets, with leaders, which property was worth about \$1,615, making \$2,060 the total value of the apparatus, boats, etc., devoted to the fishery.

The following account of the fyke-net fishery of California and Oregon has been furnished by Mr. Alexander:

The fyke net has been found to be the most economical device yet employed for carrying on the catfish fishery. It has many advantages over the drag seine. The fyke net can be set and left remaining in the water for an indefinite length of time without the fish dying or making their escape. With the drag seine, the fish caught at each haul must be cared for immediately if they are to be kept alive, which involves considerable extra labor.

The fyke nets employed on the Pacific Coast do not differ materially from those used on the Atlantic seaboard and on the Great Lakes. They are from 12 to 20 feet in length, the size largely depending on the locality. In places where the current runs swiftly, smaller nets are used than in localities where there is little or no current. The usual type consists of a tapering bag distended by four hoops from 3 to 4 feet apart. The hoop at the mouth is about $3\frac{1}{2}$ feet in diameter, the one at the end 12 to 16

inches in diameter. As a rule, there is only one funnel, situated nearly in the middle of the net. There is no rule for the size of net, mesh, or hoops; each fisherman carries out his individual ideas as to what is best suited to the conditions. The size of mesh is usually 2½ to 3 inches, but the nets used by the Chinese have much finer meshes, those near the apex measuring not more than half an inch. Most of the fyke nets used in California for the capture of catfish are set without leaders; if the latter are used, they vary from 15 to 25 feet in length.

The average cost of such fyke nets as the Chinese use is \$15; those employed by the white fishermen cost \$10 or less, having a larger mesh.

In setting a fyke net the ends are fastened to stakes driven into the bottom, the leader—if one is used—being kept in position in the same way. In places where there is little current, the bag end of the net is made fast to a stake, but where the current runs swiftly it is allowed to swing freely by its mouth fastenings. Where the tide ebbs and flows, the mouth of the net is changed at each turn of the tide.

In Oregon the fyke net is used wholly for the purpose of taking catfish, although other species are frequently caught in it. The nets are of the same pattern as those of California. In most cases they are set double—that is, one leader directs the fish into two nets. The leaders are 150 to 200 feet long, and 16 feet deep. The bag end of the nets is made fast to stakes to keep them in shape and position, the water being still where this method is used.

The leaders are so made that they can be easily converted into drag seines, which is often done, and hauled over the same ground where the nets were set. This practice is only resorted to when the catfish become scarce or other fish are desired.

At Antioch, Courtland, Bouldin Island, and many other places on the San Joaquin and Sacramento rivers, trawl lines (locally known as trot lines) take catfish for the city markets, local consumption, and family use. The length of the lines varies with the river or slough in which they are fished. In the narrow sloughs and upper courses of streams they are about 100 feet long, with hooks at intervals of 2 or 3 feet, but in the wide sloughs and the lower parts of rivers they are often 700 to 800 feet long, with 250 to 300 hooks. When the current is swift, a wire ground line is used, but in other situations the bottom line is of twine. The hooks are small, being about the size of mackerel hooks employed in the New England fisheries. One end of the trawl is made fast to the shore, the other end to a stone which serves as an anchor. The line is placed either about parallel with the shore or, if the current be not swift, directly across the course of the stream or slough. The hooks are baited with fish or meat, beef hearts being a favorite bait.

In the aggregate, considerable quantities of catfish are taken with hand lines. Fish thus caught are rarely marketed, except those obtained by the Chinese. Many of the catfish sold in the Chinese fish markets of Portland are taken with hook and line. At places on the Sacramento River drop nets or dip nets, baited with meat or fish, are fished from wharves. Often large hauls of catfish are made in this way. Such nets are usually operated by boys, and the fish taken are apt to be small.

Catfish are usually dressed by the fishermen before they are sent to market, the cleaning being done on the fishing-grounds. The nets are hauled two or three times a week, usually in the afternoon, according to the demand for and abundance of fish, while the forenoon is spent in dressing and boxing the fish, which are kept in the live-cars until required. The fish are prepared for market by removing the skin, head, and viscera, and packed in boxes holding about 150 pounds, no ice being used.

The fishermen supplying the Sacramento market usually deliver their fish alive to the dealers, who have live-cars conveniently located and can dress the fish as needed. The San Francisco and Portland fish markets are so far from the water front that the dealers can not keep the fish alive.

THE FISHING SEASON FOR CATFISH.

In California, fishing for catfish is done throughout the year, with but little variation from month to month, as the receipts of the San Francisco dealers given on page 393 will show. The catch is, however, smallest in July and August. Mr. Alexander reports that from October to June a few fishermen find employment in Oregon in taking catfish for the Portland market. During the summer months, when salmon are very abundant, there is little demand for catfish.

QUANTITY AND VALUE OF THE CATCH OF CATFISH.

As much the largest part of the catfish yield of California is consigned to San Francisco, Sacramento, and Stockton, figures showing the receipts in those cities will give a fair idea of the quantity caught. Mr. Alexander's inquiries at Sacramento and Stockton and the writer's examination of the books of the San Francisco dealers showed that in 1893 the shipments to those places were as follows:

	Pounds.
San Francisco	43,975
Sacramento	59,025
Stockton	36,000
Total	139,000

The quantity of catfish sent from the principal shipping centers on the Sacramento and San Joaquin rivers, as determined by Mr. Alexander, were as follows, the difference between these and the foregoing figures, amounting to about 33,000 pounds, representing the aggregate of a number of minor shipments of which no record could be obtained:

	Pounds.
Red Bluffs, Fremont, and Knights Landing	40,000
Courtland	13,550
Isleton	12,000
Rio Vista	2,200
Bouldin Island	23,000
Jersey Landing	15,000
Total	105,840

The catch by persons who make something of a business of fishing for catfish was not under 150,000 pounds in 1893, and fully 50,000 pounds additional would not more than cover the catch by farmers, boys, and fishermen in other branches, most of which is consumed locally.

The gross value to the fishermen of the catfish caught for market was \$6,358, and the total value of the fish to the State in the year named may be estimated at \$8,500, making a very moderate allowance for the catfish used for home consumption.

The quantity of catfish taken for sale in the Columbia basin in 1893 was about 90,000 pounds, with a value to the fishermen of \$2,800. Comparatively large numbers were also consumed by lumbermen, farmers, and others who fished for their own use. The receipts of catfish in Portland in 1893 amounted to 75,000 pounds.

The contention of the California fish commissioners in several of their reports already cited, that the value of all the catfish caught annually and consumed as food would more than equal the annual appropriation made by the State in the interests of the fisheries and fish-culture, has probably been verified in a number of years. In 1893, when the fishery is known to have been less extensive than formerly, the appropriations exceeded the value of the catch by only \$1,500.

EDIBLE QUALITIES OF CATFISH.

While the consumption of catfish in California is not large, the fish are well-liked by many people; others, however, regard them as very inferior fish. When taken from the cooler, deeper waters, they have a good flavor, and deserve to rank high among the resident fresh-water fishes of the Pacific States, but when caught in warm, shallow, muddy sloughs and ditches they naturally have little value as food.

Mr. Alexander says that fishermen, with few exceptions, have little praise to offer in behalf of the catfish. Nearly all with whom he conversed said their edible qualities were of a low grade. He believes, however, that many people think differently, and that the quantity of catfish eaten in some localities indicates that the fish are rather popular. The amount consumed can not be due to the cheapness of the fish, for at times other fish reach so much lower prices that it would seem no catfish would be bought. Mr. Alexander thinks that, while a large part of the catfish is eaten by Chinese and the poor of the numerous nationalities found on the west coast, considerable quantities must be consumed in restaurants under fictitious names, just as sturgeon and sharks are served as "tenderloin of sole."

The dealers in San Francisco and Portland do not attach much importance to the catfish and do not value its edible qualities highly, but in Sacramento they speak well of the fish.

Drs. Jordan and Gilbert regard the bullhead as the best food-fish found in Clear Lake, California, with the exception of the Sacramento perch and rainbow trout.

THE CATFISH TRADE.

The principal marketing centers for catfish are San Francisco, Sacramento, Stockton, and Portland. The last-named place has the most extensive trade. In proportion to its population, San Francisco receives much fewer catfish than any of the other cities mentioned.

Catfish can not be said to be common in the San Francisco markets. The demand is usually very limited. At times, however, when other fish are scarce, they meet with ready sale at good prices. In 1893 the average daily receipts were less than 150 pounds, and in 1894 under 100 pounds. In no month during those two years did the daily receipts run over 250 pounds on an average, and in July and August, 1894, they were under 30 pounds a day.

An examination of the books of the San Francisco dealers by the California fish commission and the writer showed that in 1893 the aggregate receipts of catfish were 43,974 pounds, and in 1894 were 31,055 pounds. The decrease in 1894 was due to a marked diminution in the receipts during the last six months of the year, as will appear from the following statement. In 1893 the largest quantities were handled in September, and in 1894 in April.

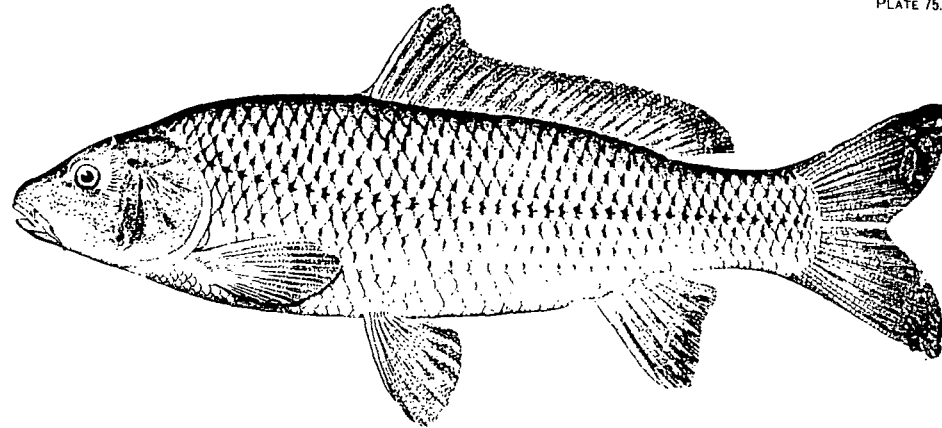
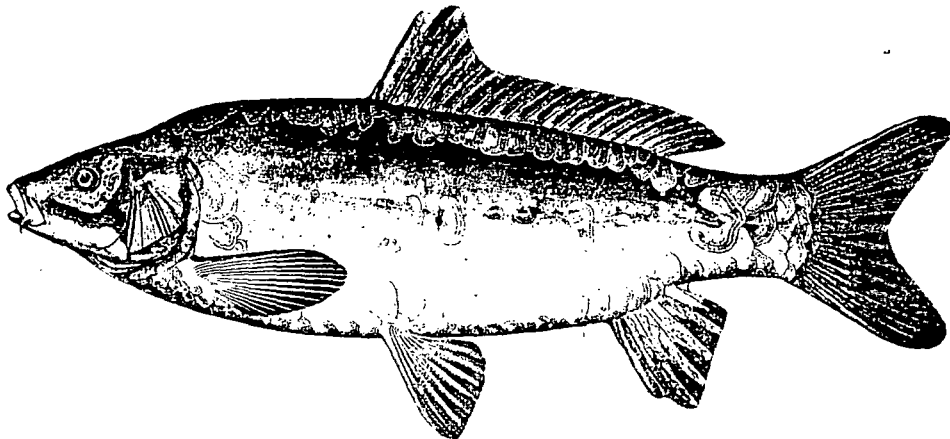
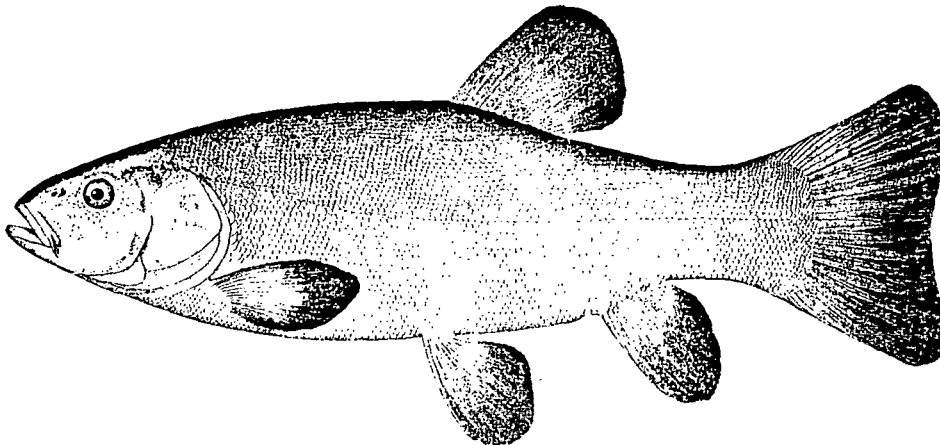


ACCLIMATIZATION OF FISH IN THE PACIFIC STATES.

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Statement by months of the number of pounds of dressed catfish handled by San Francisco dealers in 1893 and 1894.

Months.	1893.	1894.
January	1,515	4,117
February	2,570	1,696
March	5,408	4,706
April	4,115	5,390
May	3,565	2,078
June	3,035	2,630
July	2,819	695
August	950	357
September	8,400	2,473
October	6,347	2,795
November	4,082	1,526
December	3,362	1,732
Total	43,974	31,055

ASIATIC CARP, SCALE CARP (*Cyprinus carpio*).GERMAN CARP, LEATHER CARP (*Cyprinus carpio coriatus*).TENCH (*Tinca tinca*).

There is little or no sale for round catfish in San Francisco, and those which reach the dealers in such condition are dressed by them before being exposed for sale. The fish shown in the foregoing table were dressed weights, which represent about two-thirds the original weights. The dressing consists in skinning, eviscerating, and removal of the head.

The price commanded by catfish in the San Francisco market has greatly decreased in the past few years. In 1888 the average price to consumers was 17 cents a pound; in 1889 it was 10 cents; in 1891, 7 cents; in 1892, 6 cents, and in 1893, 4 cents.

There is very little reshipping of catfish by the wholesale fish-dealers. Fully three-fourths of the receipts of catfish in San Francisco are consumed locally, and but few are sent beyond the limits of the State.

The catfish trade of Portland is comparatively large. The quantity of fish handled in 1893 was 75,000 pounds of dressed fish, with a retail value of \$3,750 and a cost price of \$2,250.

As elsewhere stated, the quantity of catfish handled at Sacramento and Stockton in 1893 was 59,025 pounds and 36,000 pounds, respectively, having about the same retail value per pound as in San Francisco.

THE CARP.

HISTORY OF INTRODUCTION.

The carp (*Cyprinus carpio*) has been planted in all the States of the Pacific and Rocky Mountain regions, and is now one of the most widely distributed fishes. At a comparatively early date the local fish commissioners became impressed with the desirability of planting the carp in the sloughs, bayous, and shallow waters generally, which were either destitute of fish or, to quote the California commissioners, contained only "the worthless and unpalatable fish of the warm waters of the great valleys in the interior of the State." From the outset a very active interest in the cultivation of the carp sprang up in most of the States, and numerous demands for fish for stocking local waters came from farmers and others.

The carp was first imported into California in 1872, when Mr. J. A. Poppe, of Sonoma County, brought five fish from Holstein, Germany, and put them in private

waters. These fish appear to have multiplied rapidly, and it is recorded * that Mr. Poppe did a thriving business in selling their progeny for stocking purposes.

In 1877, in exchange for eggs of the California trout, the California fish commissioners received 88 young carp from Japan; these were retained for breeding purposes.

The United States Fish Commission, in May, 1877, imported carp from Germany, and in 1879 supplied 298 fish to the California commission; 60 of these were placed in Sutterville Lake, near Sacramento, and the remainder in a private pond in Alameda County, where they were at the disposal of the State authorities.

The foregoing lots, aggregating only 394, represent all the carp from outside the State planted in California up to the time the consignment to private applicants was begun by the United States Fish Commission in 1882.

The United States Fish Commission began the distribution of carp to applicants in Idaho, Oregon, and Washington in 1882, and has continued to supply them as requested up to the present time, comparatively large consignments being made in recent years. Most of the original plants were made in private waters, but by the breaking of dams, the overflowing of ponds, and other accidents, the fish have in some localities reached rivers and other public waters.

The carp was introduced in Nevada in 1881, when the State commissioner distributed to applicants some that had been supplied by the United States Fish Commission. In the two subsequent years numerous assignments were made by the national commission, 190 fish being sent to nine applicants in 1882 and 2,285 to more than 100 applicants in 1883. Since that time there have been calls for but few fish for stocking purposes.

GENERAL RESULTS OF CARP PLANTING.

A detailed account of the early results of carp introduction in the Pacific States, based on the testimony of the recipients of fish, is given in an article entitled "Some results of carp culture in the United States," compiled by Charles W. Smiley, and published in the Report of the United States Fish Commission for 1884.

As early as 1879 the carp had become extensively acclimatized in private waters in California and furnished a large amount of food to people living in the interior of the State; this outcome was chiefly due to the distribution from Mr. Poppe's private ponds. In 1880 the commissioners reported that wherever introduced the carp had grown rapidly in size and numbers, and by 1884 they had become so generally and successfully planted in the waters of the State that few calls were made for them, and the commissioners reported that the supply was enormous, the market price at times being only 1½ cents a pound.

The history of the introduction of carp in the open waters of the Columbia basin is not known. It is probable that the fish accidentally gained access to the river by the breaking of dams or the flooding of ponds. It has become exceedingly abundant in the lower Columbia and its tributaries, especially the Willamette River. At The Dalles and Celilo the fish are also very numerous. Recent investigations by the Fish Commission have shown that the fish also inhabits the Snake River as high up as Glenn Ferry. Mr. Barnum reported the fish as abundant at Weiser, and cited its occurrence at Huntington, Ontario, Payette, and other points on the river.

*The introduction and culture of the carp in California. By Robert A. Poppe. Report U. S. Fish Comm. 1878, pp. 661-666. Also Reports California Fish Commission, 1874-75 (p. 12), 1880 (p. 10), and 1893-94 (p. 74).

Carp have become numerous in Clear and Silver lakes, near Spokane, Wash., and are held in considerable esteem.

Marked and immediate results attended the planting of carp in Nevada. In 1884 Mr. Thomas Oliver, who had carp ponds near Carson City, was reported to have thousands of young carp for sale, the progeny of eleven small fish received two years before. The report of the Nevada fish commission for 1889-90 stated that Mr. Oliver's fish had multiplied so rapidly that he produced more than enough to supply his neighbors and the State commission with plants. An earthquake in June, 1887, however, destroyed these flourishing ponds.

Mr. Taft, of Diamond Valley, in 1890, produced fish for the Eureka market and local consumption. The Humboldt River near Winnemucca was said to have an abundance of carp in 1890, some of the fish weighing 5 pounds and upward; they were sold in the Winnemucca markets, and were rather highly esteemed.

In 1881 Hon. Thomas B. Riekey planted some carp in reservoirs and ditches connected with Alkali Lake, in Douglas County. The Nevada fish commission report for 1889-90 stated that the fish had increased beyond all expectations in Alkali Lake, from which many fish had been taken and salted for home use.

ECONOMIC IMPORTANCE, FOOD VALUE, AND INJURIOUS QUALITIES OF CARP.

In the Pacific States, as elsewhere, opinions differ widely as to the edible qualities of the carp, and as to whether the fish is not more injurious than useful. The various views entertained depend to a considerable extent on local conditions and are often based on limited observation and experience. Prejudice and preconceived ideas have also led to the formation of opinions favorable and unfavorable to the fish.

The present feeling toward the carp in California, Oregon, Washington, and Idaho is generally adverse, and seems to represent a reaction from the favorable attitude which prevailed for a number of years after the acclimatization of the carp. The most extravagant statements regarding the food value of the fish were then entertained. We find in some State reports such superlative expressions as "carp are the most delicious fish that swim"; "carp as food-fish have no superior," etc.—which excellence has hardly been claimed even by many who are thoroughly acquainted with and most favorably impressed with the edible qualities of the carp. With this high ideal in mind, it is not surprising that disappointment overtook those who stocked their ponds with these fish.

Outside of the question of its food value, the carp is, in the Pacific States, condemned on a number of other grounds, which will be mentioned.

In reservoirs and lakes, its habit of stirring up the mud and sediment makes the water roily. Reference is elsewhere made to the planting of fry of the predaceous muskellunge in Lake Merced, near San Francisco, in order to secure the destruction of the carp, which were very abundant and constantly kept the water muddy. As this lake was one of the reservoirs for the water supply of San Francisco, the matter had considerable importance. Sea lions were previously placed in this lake for the same purpose. Mr. Babcock writes as follows on this subject:

Carp have entered the Blue Lakes in Lake County. The Blue Lakes, three in number, were formerly very striking and beautiful bodies of water. A. V. La Mott now tells me that lower Blue Lake is so muddy that its beauty is gone, the carp keeping the water rolled all the time. Lake Merced, property of the Spring Valley Water Company, in the city and county of San Francisco, was so damaged by

carp as to be almost useless to the company. The company employed 1 fisherman by the month to seine the lake, and during that time—some four months—bought 19 good-sized seals (i. e., sea lions) taken near Cliff House. These seals were placed in Lake Merced in 1891, and for a time the company employed men to go over the lake to pick up the pieces of dead carp that were so numerous as to be dangerous to the purity of the water. In the summer of 1895, at the request and expense of the water company, I engaged several Italian fishermen to go to the lake, and under our supervision they used all kinds of drag nets and seines in the lake and were unable to take any carp or any other fish than sticklebacks. The seals have grown very thin. Another effort was made in same manner with like result in fall of 1895. I am of the opinion that there are no carp, big or little, in the lake at this time. The coming season the company will try again for carp, and if none is found the seals will be killed off and large-mouth black bass placed in the lake.

A rather wide-spread opinion prevails that the carp consumes or uproots the wild celery on which wild ducks feed, and "it is reported that these game birds have diminished in numbers of late wherever in this State their feeding-grounds have been invaded by the carp."

Carp are credited with eating other and better food-fishes, but the charge seems almost too trivial to notice. The ingestion of live fish must be very rarely if ever undertaken, and is inconsistent with the anatomy and known habits of the carp.

The habit of eating the spawn of other fish is ascribed to the carp in the Pacific States, as in other parts of the country. From a statement hereafter quoted, it will be seen that by some the scarcity of Sacramento perch in California is attributed to this cause.

The *Sau Francisco Evening Bulletin* of May 29, 1894, contained the following editorial notice of the carp and catfish under the caption "Where the fish commission went astray." The article may be quoted to illustrate the sentiment entertained by many persons against the carp, and to show the general grounds for that sentiment.

When the fish commission a few years ago undertook to stock the rivers and sloughs of California with catfish and carp, the *Bulletin* deprecated that sort of enterprise. Pains were taken to acquire information from various sources about the value of these species as food-fish, in addition to what was personally known from observation on western rivers. It was found that these fish were relatively of small value, and that this was overbalanced by the injury they would do in decreasing the number of better fish.

The German carp had already been tried in ponds and lakes on private estates. Not a single favorable report could be obtained. The tenor of the reports were that the fish were a nuisance, and that efforts were being made to exterminate them. Ponds and small lakes were drained off, but the fish went into the mud and lived for weeks. When the water was turned on, the fish were as active as ever. They multiplied with amazing rapidity. But nobody seemed to want them, except the few who were still bent on making experiments. These fish have multiplied in the rivers and sloughs until in many places they have become a nuisance. Like the English sparrow on the land, they are beyond extermination, and are everywhere execrated.

Now comes the *Oregonian* and reports that carp have become so plentiful in the sloughs and bays along the Columbia that fishermen have offered to supply farmers with any desired quantity for manure at \$5 a ton. The carp are gross feeders, consuming better food-fishes and wild celery and grasses on which wild ducks feed and fatten. It is reported that these game birds have diminished in numbers of late wherever in this State their feeding-grounds have been invaded by carp.

Then the fish commissioners made another unfortunate experiment, against the strongest protests that could be put forth. They introduced the hated and almost worthless catfish to the waters of California. These fish, like the carp, have multiplied rapidly. It was reported, in answer to the protests made at the time, that only a superior kind of catfish would be introduced, against which there could be no valid objection. But they turned out to be the same old toughs that have occupied western rivers and bayous to the exclusion of better fish. These catfish are voracious feeders on young trout and salmon. Their value is so low that very few seek them. The Chinese sell them occasionally, as they do carp, if they can find a customer. But most consumers turn away from these fish in disgust.

The fish commissioners introduced to the waters of California, among some of good quality, two species of what were called edible fish that now have come into the category of nuisances. If every one of these fish could be removed from the water to the land, and there employed as fertilizers, a substantial gain would be made.

Drs. Jordan and Gilbert, in a paper* on the fishes of Clear Lake, California, condemn the carp in severe terms. They say of this fish:

Everywhere very common; burrowing into the mud among the tules or in shallow waters, thus keeping the shoal waters roily all the time. This species is regarded as worthless for food. It destroys the eggs of the Sacramento perch and also devours the *Callinectes* or water celery, on which the canvas-back and other ducks feed. In California this species is a nuisance, without redeeming qualities.

The remarks of these writers on the Sacramento perch and the catfish in this lake are also applicable to the question of the destructiveness of the carp:

Archoplites interruptus (Perch). Formerly very common, but now becoming scarcer, as its spawning-grounds are devastated by the carp. The destruction of this valuable fish is one of the most unfortunate results of the ill-advised introduction of the carp into California waters.

Ameiurus nebulosus (Catfish). Extremely abundant and destructive to the spawn of other species. It is, however, a fair food-fish and much less objectionable than the carp.

The following statements concerning the destruction of vegetation by carp in California are from a letter from the late Mr. Ramon E. Wilson, secretary of the California fish commission, dated November 12, 1891:

I took advantage of the first opportunity presented, November 3, to visit the duck-shooting preserve of the Tule Shooting Club, located in the heart of what is known as the "Suisun Marshes," lying midway between Benicia and Suisun. These marshes for twenty years have been famous for duck shooting, and for the past ten years have been preserved by five clubs. Each of these clubs has, from year to year, supplemented the natural and indigenous growth of vegetation by planting non-indigenous seeds and grasses, until about two years ago the ponds, ditches, and sloughs had so grown up with vegetable matter that upon the opening of the season it was almost impossible to push a boat through the dense growth. Last year, the season of 1890, it was discovered that a marked change had taken place. The cause was attributed to the winter, which was a rather severe one, in that there were many overflows and freshets occasioned by heavy storms. This year the change in the respect mentioned was much greater. It was early reported in the spring that there was very little sign of vegetable growth in any of the ponds. Investigation followed, and it was found that fish in large numbers, ranging from a few inches in length to 15 pounds in weight, had invaded the grounds and taken entire possession of all the waters. These fish came, say, in May and remained until about the latter part of July—that is, the bulk, but many remained later. We are convinced that these great numbers came to spawn. About August, this great school, if you can so call it, suddenly disappeared—that is, the larger ones and the majority of the whole. Their going was not unlike the grasshopper in effect on vegetation—not a sign or remnant left. The result is that to-day, where these same ponds have heretofore afforded unlimited food supply for surface-feeding ducks in the early part of the season and a like supply of celery bulbs for the canvasbacks and redheads for the balance of the season, there is absolutely not a single sign of vegetation. At the time mentioned I carefully examined the beds of the ponds and found them positively barren of vegetable matter. Notwithstanding the emigration, if it can be so called, of the larger fish, the waters are still alive with the same fish, ranging from 2 to 8 inches in length. These ponds, heretofore quite clear, are now nothing more than mud holes. That this fish burrows in the mud there is no question. The beds of the waters are not unlike a sieve in appearance, with holes, round in form, ranging from one-half inch to 3 inches in diameter. The banks of the ponds and sloughs are quite like the bottoms. The fish have burrowed to the depth of a foot in many places, and it can be readily seen that it has been done for the purpose of getting at the roots of the vegetable growth.

Following out your suggestion, I secured three of the largest specimens of the fish. I caught

* Bulletin U. S. Fish Commission, 1894, p. 141.

them myself in one of the ponds. I should say each weighed three-fourths of a pound. I sent them to Dr. Jordan, wrote to him my experience, and am now in receipt of his reply. I quote:

"The three specimens mentioned in your letter have been received. They are, of course, the ordinary carp (*Cyprinus carpio*). I will have them opened to see if, perchance, the contents of their stomachs may throw any light on the question at issue. I should think there would be little doubt that the carp might destroy the water celery and so interfere with the food of ducks."

What I have said, as the result of my own observation, is true from evidence, by way of correspondence, which has accumulated in my office, and applies to all the marshes on the Sacramento and San Joaquin rivers for a distance of quite 100 miles. The irrigating ditches throughout the San Joaquin Valley are full of these fish, and it is no "fish story" to say that they burrow into the banks and make breaks in the levees.

The carp is very unpopular in the upper Columbia, at The Dalles and Celilo, on account of its supposed destructiveness to salmon spawn. It is used to some extent by the German families of that section and also in the fishing-camps, but the consumption is light. At Umatilla and Arlington complaints are also made of the carp.

At Huntington, on the Snake River, Oregon, some carp are caught which find a sale among the farmers of the neighborhood. Along the same river, at Payette and Ontario, some favorable mention of the carp as a food-fish is made, but the sentiment of the people is generally against it and the fish has no economic value.

At Spokane, carp are sold in limited quantities to German families at 3 to 3½ cents a pound.

Mr. Wilcox reports that carp are found constantly in the Portland market, although the abundance of the fish is such that at times it can not be sold at any price.

Mr. James Crawford, fish commissioner of Washington, reports that carp and catfish have recently begun to be recognized as of some importance as food-fishes in that State, and that in 1892 at least \$2,000 worth of these fish were disposed of in local markets and in inland towns along the Union Pacific and Northern Pacific railroads.

Without desiring to ignore any injurious qualities the carp may possess, the opinion may be ventured that the fish is credited with doing much harm that it may not be responsible for, and that the evidence on which the carp is so severely condemned is, in the Western States, as elsewhere, wholly insufficient at present, whatever may be the result of an impartial investigation of the matter.

In the November 5, 1891, issue of *Forest and Stream* is the following editorial reference to carp in California:

Nearly two decades ago, and five years before the United States imported the fish from Germany, Mr. J. A. Poppe placed five small carp in one of his ponds at Sonoma, Cal. Nine months later (May, 1873) his stock had grown to 16 inches in length, and 3,000 young fish were obtained from the first breeding. The fish were sold to farmers throughout the State, and some were shipped to Central America and the Sandwich Islands. The increase of the species, especially in the marsh or "tule" lands, was remarkable, and the demand continued steady. Now a reaction appears to have set in, and a most unjustifiable style and amount of abuse is being heaped upon a really valuable food-fish, which has also long held a worthy place among the anglers' favorites in countries wherein it was best known. The qualities which led to the action of the Government in behalf of carp acclimation were the following:

- (1) Fecundity and adaptability to the processes of artificial propagation.
- (2) Living largely on a vegetable diet.
- (3) Hardiness in all stages of growth.
- (4) Adaptability to conditions unfavorable to any equally palatable American fish and to very varied climates.
- (5) Rapid growth.
- (6) Harmlessness in its relations to other fishes.

- (7) Ability to populate waters to their greatest extent.
- (8) Good table qualities.

These properties still exist and no amount of unreasoning prejudice can alter or reduce them. When we are told that the carp is a kind of sucker and "sucks the roots out of the banks of the ditches, causing the banks to wash out," we are bound to reply that California is noted for the variety and size of its suckers, but the carp is not one of them. The habit referred to is not observed in the carp, and the real culprit must be sought in some other direction. It is gravely asserted also that the food of the ducks and other wild fowl is consumed by the carp and the game birds are deserting the marshes in consequence. Again, it is charged that the salmon and trout waters are being invaded and the eggs devoured on the spawning beds. Carp in water having a summer temperature of 54° would be about as untimely as oranges on the tundra at Point Barrow. We shall next hear that the carp has utterly destroyed the salmon industry of Alaska and driven the seals out of Bering Sea. As a matter of fact, California has many native fishes of the carp or minnow family, some of which swarm in the irrigating ditches, while others inhabit trout waters, and certain of these are known to be very destructive of eggs. In the Pit and McCloud, for example, may be found a large species of *Ptychocheilus*, known as the Sacramento "pike," which is really a giant minnow, growing to a length of 5 feet. This, or something like it, is probably the fish for whose sins the carp is now suffering in the estimation of many good people of California. Before passing final judgment on the subject, send some of the cold-water carp and the burrowing nuisance to some one who knows the fishes of the State for identification. Dr. Jordan, at the Leland Stanford Junior University, will settle all doubts for you, and *Forest and Stream* will take pleasure in aiding investigations of any sort into the habits of fishes.

In a letter dated September 25, 1891, Mr. Ramon E. Wilson, at that time secretary of the California fish commission, called the attention of the United States Fish Commissioner to the fact that carp had been taken at the McCloud River station of the United States Fish Commission, and that Pitt River and Squaw Creek, in the vicinity, were swarming with the fish. Mr. Wilson expressed the fear that this raid of carp in the upper waters of the most important salmon river of the State, the Sacramento, was a serious matter. In reply, the United States Fish Commissioner stated that it did not seem possible that the carp could injure the salmon, whose spawning beds are located in the cold upper portions of the streams, and that it would be contrary to all experience to find carp thriving in such situations. The Commissioner suggested that the fish reported in such numbers in the Pitt River might not all be carp, but some other members of the carp family, such as *Orthodon*, *Lavinia*, *Pogonichthys*, *Mylocheilus*, *Ptychocheilus*, etc.

In attributing to the carp the scarcity of canvasback and other ducks in a given region, there should be proof that the carp does and other fish do not eat and uproot large quantities of *Vallisneria*; and the influence of market hunters and indiscriminate killing by sportsmen must not be overlooked. The scarcity of canvasback ducks in most streams probably antedates the advent of the carp in noteworthy numbers, and, as in the Potomac, was coincident with spring shooting and with the activity of pot-hunters using swivel guns. Mr. John P. Babcock, chief deputy of the California fish commission, states that he thinks ducks in that State have changed their feeding-grounds; miles of lands in the San Joaquin Valley are now covered with ditches and miles of alfalfa now grow where a few years ago there was a desert; and the main market supply of ducks comes from that region instead of the Suisun Marshes. He thinks, however, that the carp have proved very objectionable in this region, and in a letter communicates his observations, as follows:

The carp have destroyed almost all the wild celery of the lower Sacramento and Suisun Marshes. They reach all the ponds during high water, and, as soon as celery comes up, they eat the shoots, and, in many of the best ponds on the shooting preserves, have taken roots and all of the celery. They have not destroyed the tule grass to any noticeable extent, if at all. The damage has been to the

better grasses. Many of the clubs planted wild celery in 1891, 1892, and 1893, but the carp destroyed it all, and it is claimed by observing men that the celery is entirely destroyed. The clubs resort every season to baiting their ponds with grain, and in these ponds the carp move in droves that W. P. Whittier tells me look like a tidal wave, as they move from one side to the other.

The following observations on the food and the feeding-habits of the carp have been furnished by Dr. Rudolph Hessel, who superintended the first importation of German carp by the Government in 1877, and the foremost authority in the United States on carp-culture. Dr. Hessel's remarks were prompted by the letter of Mr. Wilson previously quoted, an extract from which was submitted for an expression of opinion.

In connection with an extract from a letter of Mr. Ramon E. Wilson, California fish commission, relating to the suspected destruction of wild celery and other vegetation in the Suisun Marshes in the vicinity of San Francisco, Cal., by the carp, I will give you my observations, extending over a period of many years, regarding the habits of the carp (if I may be allowed to so term its mode of living, and the likes and dislikes of that fish), cautioning you, however, not to regard such observations as authority.

It is true that I have paid a great deal of attention to the habits of the carp in Europe and in our eastern waters, but I am not familiar with the waters of the Pacific Coast, and, for this reason, my conclusions should not be taken as final.

It is well known that the carp is not very particular as to its food. It feasts upon animal as well as upon vegetable food. It seems to be an established fact, however, that animal food is preferred, hence their persistent hunt in the mud and about the roots of water plants for worms, crustacea, and larvae. At the earliest stages of its existence, from a few weeks to a few months old, the young carp can be seen scrutinizing water grasses and the under parts of floating leaves, etc., for diminutive and almost microscopic animals for feeding purposes. Later on they do not despise larger animal substances in the rivers; but where there is a perceptible scarcity of that kind of food in rivers and stagnant waters, they ascend into tributaries, creeks, and bayous, ostensibly going for vegetable food, in reality, however, delving, digging, burrowing, and hunting in the mud and about the roots of the water vegetation for animal food, as indicated above. No one need, therefore, be surprised if at such vigorous exertions of the carp the growth of vegetation generally will not be promoted and the water will not become any clearer. Many a plant will thus be uprooted, rise to the surface, and perish, and this may have been the case with the celery plants in the Suisun Marshes, too, to a certain extent.

The carp is very numerous and prolific in the Potomac River. There are specimens from 20 to 30 pounds, but that they go for the water celery has not been noticed here as yet. Water celery grows in abundance in places where the river flows slowly, especially about the so-called flats, but any injury to its growth, or a reduction of its density, not to speak of its total destruction, has not been heard of, as far as I know, with two exceptions only, not attributable, however, to the carp, but to high water in the spring of 1882 and 1889, when every kind of vegetation was swept away by the floods, and consequently water celery disappeared from the river during the two years subsequent to those freshets.

I must not forget to call your attention to the fact that turtles, too, are not averse to a meal of water celery. Frequently I have seen "red-bellies" and "yellow-bellies" feasting in the dense growth of Potomac celery upon that plant. Another point: For years I have kept quite a number of these species of turtles for ornamental purposes in a small pond about this station and fed them with water celery taken fresh from two ponds stocked with a great number of old and young carp, which never touched the celery, though it must be admitted that they did loosen the roots in their hunt for animal food.

In conclusion, I reiterate that I am not familiar with the fauna of the Suisun Marshes, but my impression is that, upon closer investigation, there may perhaps be found additional causes for the disappearance of the water celery and other vegetation therein, besides the undeservedly much-abused carp.

The carp may be very destructive to the spawn of certain fishes; this is probably the most serious charge that can be lodged against it. At the same time, no examinations, by competent persons, of the stomach contents of carp appear to have been made in the Pacific States or elsewhere. Even if it should be demonstrated that the carp consumes large quantities of fish spawn, it would not differ in this respect from a host of native species whose shortcomings in this respect are usually overlooked. If

we condemn the carp for this pernicious propensity, without conclusive evidence, what are we to do with the basses, trouts, salmon, sturgeons, and the entire sucker and catfish tribes, with known spawn-eating tendencies? There can be no question that in the waters of the Pacific States the large indigenous representatives of the carp family—the Sacramento pike (*Ptychocheilus*) and the squawfish or Columbia River chub (*Alylocheilus*)—are immeasurably more destructive to spawn than the carp. They are notorious spawn-eaters; the most attractive bait with which to catch them is fish spawn; and on the spawning-grounds of salmon and trout, where the character of the water is not adapted to the carp and where it is either entirely absent or quite uncommon, these fish are almost always present in large numbers and are known to subsist largely on the ova of salmonoid fishes.

Considering the question of the relation between the carp and the scarcity of the perch in California, attention is directed to the report of the board of State fish commissioners for 1883-84, in which the decrease in the abundance of the perch is commented on and other factors than the carp assigned as the cause of the scarcity. The beginning of the scarcity of Sacramento perch dates from 1881 or 1882, and was probably antecedent to the general abundance of carp in public waters. The remarks of the fish commissioners in the report cited are as follows:

In former years this fish was very plentiful, but has become very scarce in the last few years, owing to several causes, viz:

(1) We believe the greatest cause of disappearance is due to the reclamation of our tule lands by closing the sloughs, whereby ingress and egress are stopped, causing them to deposit their spawn in the rivers, and the spawn is lost by being covered with sediment.

(2) By a continual drain upon the supply by Chinese and other fishermen, who are ever on the alert to find their hiding-places.

Many people in California think catfish are to blame for the scarcity of Sacramento perch. Reference to this matter is made in the remarks on the catfish.

The fact that carp uniformly command a higher price in the principal markets of the country than do many fish with well-established reputations as good food-fishes should prevent the reiteration of the statement that the carp is of no value as food. The additional facts that in the United States the carp has greater money value and is consumed in larger quantities than any other fish taken from private waters should be conclusive evidence of its food value and economic status.

A great deal more has been expected of the carp than has ever been claimed by those whose experience entitle them to speak on the subject. In the United States, which is so bountifully provided with salt-water and fresh-water food-fishes, the chief utility of the carp lies in its adaptability to cultivation in natural and artificial waters in the lowlands and plains which are either destitute of food-fish or contain species inferior to the carp in size or edible qualities. Throughout the Western States there are closed waters, containing few or no desirable fish, in which the carp is susceptible of successful cultivation and is the equal in food value of any of the fish which are found in the same situations. It is to the stocking of such waters that the carp is eminently adapted, and it is thus being utilized by thousands of families in which it is the chief if not the only available food-fish.

The carp is preeminently a pond fish, and when reared in ponds or similarly closed waters it will have food qualities, the degree of excellence of which will depend on the character of the water. Discrimination in the planting of carp should entirely obviate any necessity for considering the injurious qualities of the fish, except as a precautionary measure.

The "Abstract of the Eleventh Census," in a table showing the extent of carp-culture in the United States in the decade ending in 1890, gives the following data for the States of California, Oregon, Washington, Nevada, Idaho, and Utah:

Number of carp-culturists	1,006
Number of ponds and other bodies of water in which carp were planted..	1,241
Number of carp planted	101,617
Value of carp sold or used from private waters	\$15,324

The field inquiries conducted by the Fish Commission through Mr. W. A. Wilcox showed that the sales of carp by the fishermen increased annually from 1889 to 1892. Figures drawn from the books of the San Francisco dealers for the years 1893 and 1894 indicate a continuation of the increase, the aggregate receipts in the latter year being about 20 per cent larger than in 1893. Following is a statement of the quantity and value of the carp taken for market in the Sacramento and San Joaquin rivers during a series of four years, as determined by Mr. Wilcox:

Years.	Pounds.	Value.
1889	51,214	\$1,734
1890	56,113	1,974
1891	59,618	2,016
1892	65,602	2,191
Total	234,607	7,915

The foregoing fish were taken with seines and fyke nets. The average gross price received by the fishermen was a little over 3 cents a pound each year. In addition to these fish, large quantities are known to be taken for local sale and home consumption in counties remote from the coast, for which no statistics are available.

San Francisco is naturally the principal market for carp on the Pacific Coast. An examination of the records of the wholesale fish-dealers of that city by the writer and the California fish commission showed the receipts to have been 35,653 pounds in 1893 and 42,580 pounds in 1894. The largest quantity handled in any one month was 10,142 pounds in January, 1894. The figures for each month in the years named are given in the following table. In addition to these, many thousand pounds of carp are handled by the Chinese dealers, of which no accounts can be obtained. The catch of the Chinese fishermen can not be ascertained, owing to their suspicious disposition and their failure to keep any records. Mr. Babcock states that large quantities of carp are offered for sale in the Chinese markets every morning. It is likely that their aggregate trade in this fish is larger than that of all the other dealers.

Statement by months of the number of pounds of carp handled by San Francisco dealers in 1893 and 1894.

Months.	1893.	1894.
January	784	10,142
February	709	4,755
March	4,936	6,708
April	3,191	2,839
May	660	767
June	1,589	699
July	4,650	729
August	1,725	363
September	1,531	4,396
October	3,082	4,960
November	6,319	4,461
December	5,577	1,612
Total	35,653	42,580

The average retail price received by the San Francisco dealers for carp during the past few years has been about 4 cents a pound. The average weight of those exposed for sale in the city markets is 5 pounds. The largest seen by Mr. Paladini, one of the oldest dealers, weighed 30 pounds, while Mr. Cuneo, of the American Union Fish Company, has handled a fish whose weight was 33 pounds.

In discussing the striped bass, reference is made to the observations of Mr. Alexander, which showed that in the Sacramento and San Joaquin Rivers the carp constitute the principal food of the bass. Further investigation will doubtless indicate that a number of other fishes (black bass, steelhead, and Sacramento perch, for instance) also subsist, in part at least, on carp.

THE TENCH.

The tench (*Tinca tinca*) is a fish of the carp family native to Europe. It has been somewhat extensively planted in the United States by the national fish commission. In foreign countries it reaches a maximum weight of 12 pounds. The fish is covered with very fine scales and is shapely and handsome. Its habits are very much like those of the carp. The flesh is firm and white, and is considered very palatable. In 1895 a number of shipments of yearling tench were made to the Pacific States; 50 fish were placed in Older Springs, Washington County, Oreg.; 400 were put in Fourth of July Lake, Petz Lake, and a pond in Spokane County, Wash., and 758 in Diamond Lake, a lake and a pond in Kootenai County, and a pond in Latah County, Idaho, the first-named lake receiving 500 fish. In February, 1885, 20 tench were sent to a private applicant in Virginia City, Nevada.

THE GOLDFISH.

The goldfish (*Carassius auratus*) is an ornamental fish, without value as food. Numerous plants have been made by the United States Fish Commission in private waters in the Pacific States, and the fish has, in some instances, probably escaped into lakes or larger streams and there become acclimatized. It readily interbreeds with the carp, to which family it belongs.

THE AWA.

In the report of the California fish commission for 1876-77 the following reference is made to the introduction of the Hawaiian awa (*Chanos cyprinella*) in California waters. No further mention is made of the fish in the State reports, and there is no record of their survival or capture:

In exchange for some salmon and trout eggs, sent to the Hawaiian Islands, we received in July last nearly 100 fish called "awa." These we placed in a small stream at Bridgeport, in Solano County, where they could have free access to brackish and salt water. They are said to be the most valuable food-fish of the Hawaiian Islands, of fine flavor, and thrive in fresh, brackish, and salt water. Where they have access to salt water they grow to weigh an average of 5 pounds. We have reason to believe they will find congenial homes and grow and multiply in the waters of this State.

THE SHAD.

HISTORY OF EXPERIMENTS IN CALIFORNIA.

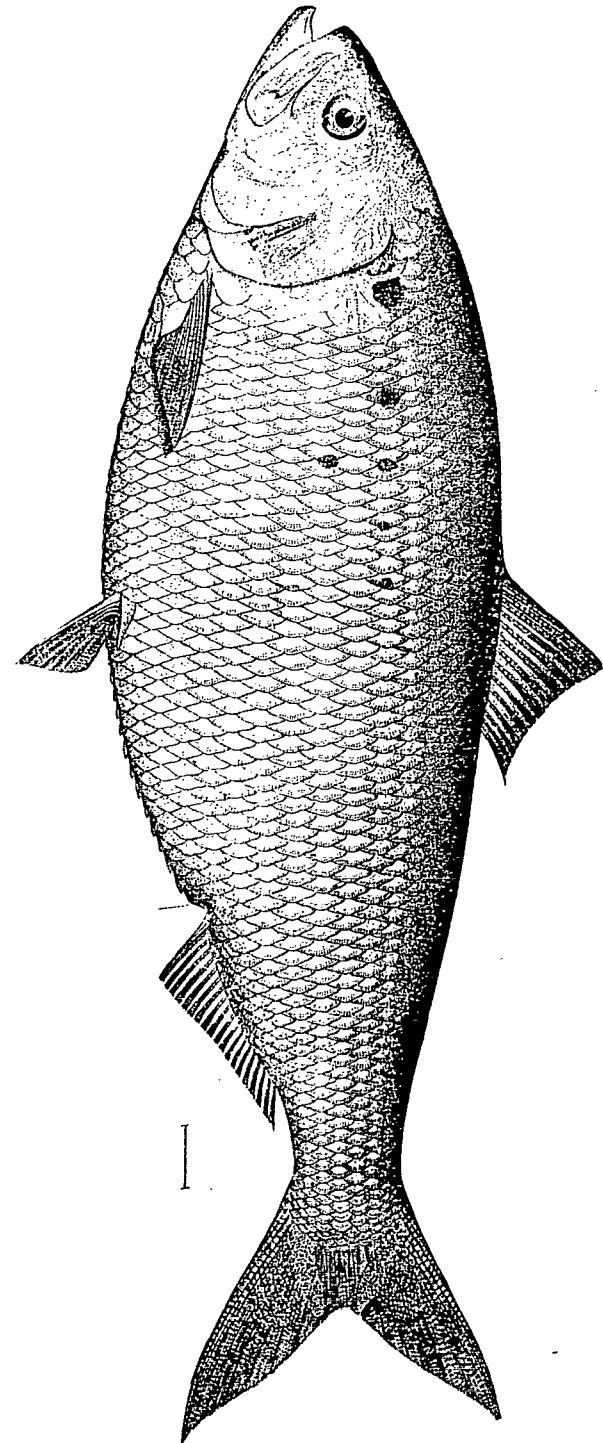
The shad (*Clupea sapidissima*) was first introduced into the waters of the Pacific Coast in 1871. The feat of transporting the fry across the continent was at the time considered so remarkable and has had such a prominent influence on fish transportation that the original accounts of the experiment, as contained in the reports of the California fish commission for 1870-71 and the New York fish commission for 1871, may with propriety be quoted at some length. The possibility and the desirability of introducing the fish into the rivers of the west coast appear to have been first suggested by the California fish commission, as may be seen from the following extract from their report:

Your commissioners made arrangements with Mr. Seth Green, the noted pisciculturist of Rochester, N. Y., for the importation of a lot of young shad to be turned into the Sacramento River. No shad proper (*Alosa prestabilis*) are found in the rivers of the Pacific Coast, while there are found several varieties of the same family, such as herring, anchovies, and sardines. As shad readily enter rivers while muddy from the spring freshets, and spawn in waters of a temperature as high as 65°, there was reason to hope that if the shad could be brought here alive and turned into the river they would find suitable food, and in time go to the ocean and return to propagate their species. As the shad is very prolific, each full-grown female yielding from 50,000 to 80,000 eggs, and as the flesh is esteemed to be nutritious and valuable food, it was deemed proper to make the first experiment of importing new varieties with the young of this fish. The eggs of the shad are hatched in from two to four days after they are spawned; therefore, if there were no other reason, time alone would prevent the importation of the eggs.

Mr. Green felt so much doubt as to the possibility of transporting the young fish for so great a distance that he determined to superintend the experiment in person. He left Rochester, N. Y., with an assistant, on the 20th of June, with 15,000 of the young fish just hatched, contained in eight tin cans holding about 12 gallons of water each. The water had to be changed at every convenient opportunity, as on a part of the journey the weather was quite warm. Constant attention had to be given to prevent the water in the cans from reaching a higher temperature than 80°. At Chicago he lost a few fish from a film of oil from the machinery of the waterworks with which the water attempted to be used was covered. At Omaha the river water killed a few. The cause of this he had not time to investigate. The water of Bear River (discharging into Salt Lake) and the waters of the Humboldt and Truckee rivers were found to agree with them and contained plenty of food.

Mr. Green arrived on the 27th of June. As it was advisable to put the young fish in the river at as high a point as practicable, for the reason that the instinct of the shad is, like that of the salmon, to return to spawn at the same place where it was hatched, they were the same day transferred to the cars of the California and Oregon Railroad and taken to the Sacramento River at Tehama. Here the temperature of the water was found to be 60° F. Upon dipping up the river water in a glass and pouring a lot of the young fish into it they were found to be lively and the water to contain large quantities of some minute substance on which they fed. All the conditions being favorable, they were turned loose in their new home.

It is expected they will remain in this river until about January, by which time they will be 3 or 4 inches long. They will then go to the ocean to return the next year weighing from a pound to a pound and a half, ready to commence the increase of their kind. Thus far the experiment has been a success. The water of the river is adapted to them. It contains the proper kind of food for their young, and the waters of our coast are filled with the sand flea, a small species of the shrimp, on which the fish feed after reaching the salt water. The only thing to be feared is that there may be in the ocean some kind of a fish which may so completely exterminate them that none will be left to come back and spawn. If, after one or two years, even one shad is taken in the river the result will be satisfactory, as it will demonstrate the fact that all the conditions are favorable to their successful

SHAD (*Clupea sapidissima*).

propagation in the waters of our rivers. We could then, at a trifling expense, fill our waters with this valuable fish. When first hatched and in a condition proper to be transported, one freight car would bring over 2,000,000 of them. If, after two years, none should be taken, it would not then be well to abandon the experiment.

Mr. Seth Green's account of his trip across the continent with the young shad, and his opinion of the success of the experiment, are as follows:

On the 19th of June, 1871, I started, at 6 a. m., from Mull's fishery, 10 miles below Albany, on the Hudson River, with 12,000 young shad in four 8-gallon milk cans. They had been hatched the night before at the establishment under charge of the New York commissioners. I arrived at Rochester at 10 p. m. and changed the water, substituting that from the Genesee River without injury to the fish. I arrived at Cleveland at 7.45 next morning, put 200 shad in Lake Erie, and changed the water again. The fish were then fresh and lively, without any signs of sickness. I again changed water at Toledo, and when I arrived at Chicago, at 7 p. m., the fish were still in good order. Here I first tried the water from the city waterworks, but found there was too much oil in it, so I went to the lake. Having tested the water and found that it would answer, I put 200 fish in Lake Michigan, and on June 21 started with cans newly filled, at 10.45 a. m., for California. I carried an extra can of water, for before me was a long stretch of almost arid land. Still I was fortunate enough to find some places between Chicago and Omaha where I could get a few pails of water and make a partial change. The fish were still in good order when we arrived at Omaha, but there I could not find any water in which they would live five minutes. The way I tested the water was by filling a tumbler and putting a few fish in it. It was easy to tell at once, by the behavior of the fry, whether the water agreed with them or not. I did not get a full change until I reached Laramie River. From Omaha I did not find any good water for 400 miles, and the only way I kept my charges alive was by drawing the water out of the cans into pails and pouring it from one pail to another until purified, this process being assisted by my getting a little ice water from the car tanks.

June 22.—Bad water all day, with the thermometer 100° in the shade from 9 a. m. to 4 p. m. I used ice water the entire day, a very little at a time, and had hard work to keep the temperature of the water below 82°. I began to feel blue and doubtful of the result. The fish suffered considerably, but the weather began to get cold toward night, and I got the temperature of the water down to 75° at 9 p. m., the fish recovering somewhat.

June 23.—I arrived at Laramie River at 5 p. m., and got a good change of water, fish doing well, and I began once more to feel hopeful and encouraged. We had a frost that night, and next morning, at 7, I changed water at Green River, where it was in proper condition. At 2 p. m. I got another change from a stream in which there were trout, and again at Ogden, where I put 200 fish in the river.

June 25.—The water was changed at the Humboldt River. The water was good and continued good all the rest of the way.

June 26.—I arrived at Sacramento, and took the fish up the river 275 miles from Sacramento, in company with Messrs. Reidding and Smith, the California fishery commissioners. In their presence I deposited the fish in the Sacramento River the same night at 10 p. m. There were about 10,000, in good order.

On the sixth and seventh days out they began to be very busy, looking for food. Whenever I changed the water, they would clean up all the food there was in five minutes. They did not suffer for food as long as the sac lasted on their bellies—that is, for about five days—then they needed sustenance. If I could get a change of water often enough from running streams, I could carry them a long way, as nearly all streams are filled with small insects. With this view I examined the water of the Sacramento where I put them in, and found plenty of food for the young fry. I then went down to the Pacific Ocean, and ascertained that there were plenty of sand fleas, which are the principal food that the old shad live on in the Atlantic.

And now, in conclusion, I can only say, that if they do not have shad in the Pacific Ocean there will be but one cause—the roily water caused by washing the mountains down for gold. However, I think the fish will get through all right. I examined the river where it looked so roily, and found it quite clear on the surface for a few inches down. The tendency of the roil was to settle to the bottom. The young shad will find the clear water, and if it does not get very much worse than it was when I was there, they will succeed. But if these do not, more must be sent, for any amount of young fish can be taken to California by making the proper preparations beforehand.

THE BLACK BASSES.

HISTORY OF INTRODUCTION.

Plants of both large-mouth black bass (*Micropterus salmoides*) and small-mouth black bass (*M. dolomieu*) have been made in the Pacific States. The small-mouth fish, however, was introduced much earlier and in larger numbers. It appears to have been first taken to California in 1874 by Mr. Livingston Stone in his "aquarium car." The original lot consisted of 75 full-grown spawning bass from Lake Champlain, Vermont, and 24 small fish from St. Joseph River, Michigan. Two of the large fish and 12 of the small ones were lost in transit. The adult fish were placed in Napa Creek and the immature lot in Alameda Creek.

The probable extermination by anglers of the fish put in Napa Creek led the commissioners to renew their attempts to acclimatize the black bass, and in 1879 they had Mr. Stone take out 22 fully matured fish from the East. These were put in the Crystal Spring reservoir of the Spring Valley Water Company, in San Mateo County, with the assurances of the company that the fish would be protected and be at the disposal of the commission should they increase. Shortly before this a small lot of black bass seems to have been imported by a sporting club and placed in Lake Temescal, in Alameda County, near Oakland.*

From 1879 to 1889 no bass appear to have been planted by the California commission, although in the meantime the fish had probably been distributed privately from the waters previously stocked; thus, in 1889, it was reported as being in the Russian River. In 1889 the State authorities began the distribution of black bass from planted waters, chiefly the San Andreas reservoir, and 500 fish from 6 to 9 inches long were deposited in Clear Lake in Lake County, Thermalito Reservoir, in Butte County, and Sweetwater Lake in San Diego County.

In the following year small lots of bass were put in Clear Lake, Blue Lakes, Pajaro River, Laguna de San Luis, reservoirs in Monterey and San Luis Obispo counties, and a lake at El Monte in Monterey County, the aggregate plants being 357. Some bass were taken from the reservoir of the Spring Valley Water Company in 1891 or 1892, but the number was quite small and no details of the distribution are recorded. In 1893, 155 fish were sent out by the State commission. The extent of the work in 1894 eclipsed all previous records. The State authorities sent a deputy to the Russian River, where in May the wild fish were seined. The number caught and distributed was 9,350, which were chiefly consigned to public waters not previously stocked. The

*In a report of Mr. J. G. Woodbury, California superintendent of hatcheries, printed as an appendix to the biennial report of the State fish commission for 1889-90, the following statements are made:

"Seth Green brought the first black bass to California. These were brought out at the expense of a sportsmen's club and placed in Temescal Lake, near Oakland. The second lot of black bass was brought out by B. B. Redding, for the California fish commission, and planted in the Crystal Spring reservoir, near San Mateo, with the permission of the Spring Valley Water Company."

Mr. Woodbury gives no further particulars, and is certainly in error in claiming that the two lots mentioned by him were the first and second, respectively, taken to California. He has overlooked the bass carried by Mr. Stone in 1874. The fish planted in Temescal Lake probably comprised the second lot transported to the State.

largest plants were made in Fresh-water Lake, Humboldt County (2,000); San Joaquin River, near Herndon, Fresno County (1,000); Lake Yosemite, Merced County (1,000); Stony Lake, Humboldt County (500); Keweenaw River, Tulare County (500); Garvey Lake, San Gabriel, Los Angeles County (500); Irvine Lake, Orange County (500). Small waters in Alameda, Los Angeles, Santa Barbara, San Bernardino, and Tulare counties also received fish.

The distribution of small-mouthed black bass by the California commission was further extended in 1895. Mr. Babcock furnishes the information that from the landlocked overflow ponds of the Russian River 25,600 fry were collected by the commission's agents, and that the fish was given a much wider distribution in the State, applications from almost all counties being filled.

The United States Fish Commission in December, 1891, placed 1,990 yearling large-mouth bass in Lake Cuyamaca near San Diego, and 620 in the Feather River near Gridley. In June, 1895, a carload lot of 2,500 large mouth bass was sent to the California fish commission. The fish were retained in ponds at Sisson. In the same month 50 fish were put in each of the following California waters: Buena Vista Lake near Bakersfield; reservoir near San Diego, and Elsinore Lake near Elsinore.

The plants of black bass in Oregon have not been numerous, although considerable interest has been manifested by anglers in securing the acclimatization of the fish in the State. In October, 1892, 500 yearling large-mouth fish were placed in the upper part of the Willamette River near Salem, and in July, 1895, 75 yearlings were deposited in Doves Lake near Salem; 25 in Mill Creek, a tributary of the Willamette River, and 75 in Big Creek, a branch of the Powder River.

Comparatively numerous plants of yearling large-mouth bass have been made by the United States Fish Commission in Washington during the past few years. In 1890 Washington, Loon, and Colville lakes received 1,220 fish; in 1891, 125 fish were sent to Loon and Liberty lakes; the following year 3,547 fish were planted in Clear, McDonald, Loon, Deer, American, Liberty, and Gravelly lakes. Clear, Padden, and Shepherd lakes, a private lake in Spokane County, and a public lake in Skagit County were supplied with 400 fish in 1893. The shipments in 1895 consisted of 625 fish, deposited in Loon, Cavanaugh, Silver, St. Clair, Welty, and Clear lakes, the aggregate plants in Washington being 5,442.

In the Boise River, near Boise, Idaho, 1,597 yearling large-mouth bass were planted by the United States Fish Commission in November, 1892.

In 1888 the Nevada fish commission exchanged 30,000 young eastern brook trout for small-mouth black bass, the other party to the transaction being the Spring Valley Water Company of San Francisco. The number of bass received is not stated in the official report, but it probably amounted to several thousand. Some were planted in Carson River and Washoe Lake, and about 1,000 were placed in a private reservoir near Carson.

The noteworthy results attending the planting of black bass in Utah warrant reference, although the general discussion of fish acclimatization in that State is not considered in this paper. In September, 1890, the United States Fish Commission delivered 300 yearling large-mouth bass to Mr. A. M. Musser, the State fish commissioner, by whom they were placed in Weber River, near Ogden. At the same time 1,418 yearlings were planted in Utah Lake, at Battle Creek. In 1893 two lots of 25 fish each were supplied to applicants in Salt Lake City.

RANGE AND ABUNDANCE IN PACIFIC STATES.

With very few exceptions, the black bass have survived and multiplied in all the waters in California in which they were planted, so that they have become one of the most widely distributed game fishes of the State. The State fish commissioners have refrained from depositing fry or yearling bass in waters already stocked with salmon or trout, but have restricted the distribution to lakes, reservoirs, ponds, and rivers in which the predaceous bass could do no damage. It seems only a question of time, however, when the bass will naturally find their way into and become abundant in all those rivers in which they have not already been planted.

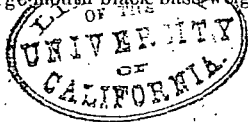
Very prompt results attended the planting in Napa and Alameda creeks in 1874. In their report for 1874-75 the California commissioners stated that during the latter year black bass had been caught in Napa Creek and that large numbers of young had been observed. The fish planted in Alameda Creek were said to have been seen, but none had been taken. The report for 1876-77 stated that the fish had increased, that many had been caught, and that by June, 1878, the young could be taken for stocking other streams. The next biennial report (for 1878-79) records the probable extinction by anglers of the fish put in Napa Creek, none having been caught in the two years named.

The adult bass placed in the reservoir in San Mateo County in 1879 rapidly increased, and in 1880 the State commissioners hoped in another year to take the young for distribution. Fish imported by the Sportsmen's Club of San Francisco about the same time and placed in a lake in Alameda County had also increased and were subsequently utilized in stocking other waters. The San Mateo County reservoir served as the principal source of supply for the State commission until 1894, since which time the young for distribution have been mostly taken from the Russian River.

In the *American Angler* for April 9, 1887, Mr. Charles Kaeding records the arrival at San Francisco on March 2 of the first black bass from the Russian River. The fish was taken at Guerneville and weighed 2½ pounds. By 1889 or 1890 the Russian River had become well supplied, although the California authorities stated that up to that time not many public waters had been stocked. Numerous applications for bass were made to the State commission in 1890, and over 800 yearlings were obtained for planting from waters that had been previously stocked. The abundance of the fish in the Russian River was attested by the large number of yearlings taken for distribution in 1894 and 1895 from the overflow waters of that stream, the aggregate collections being 35,000. Large numbers of young fish were seen in the river itself in 1895. Mr. Babcock believes the stocking of the Russian River was done by private parties, as there is no record of plants made in that stream under State auspices.

In their report for 1893-94, the California commissioners said that they could quote from many letters showing the most remarkable growth of black bass in streams and lakes which had never before been stocked. Besides the numerous closed waters in which the fish are found, the following rivers, in addition to the Russian, are also stocked: Tulac River, headwaters of the American River, headwaters of the San Joaquin River. A few have also been reported from the Sacramento River at Colusa. Jordan and Gilbert record the small-mouth bass from Clear Lake.

Mr. Fletcher, deputy of the California fish commission, reports that black bass are doing very well in Lake Cuyamaca, and that a great many have been taken in the last two years. Mr. J. E. Friend, of San Diego, who passed some weeks on the lake in the latter part of 1895, took 3 large-mouth black bass weighing 2½ to 3½ pounds each.



Regarding the outcome of the plants of bass in Washington waters, Mr. Alexander reports that as far as he has been able to learn nearly all the bass are thriving and are in a fair way to soon become plentiful enough to give the anglers sport and supply many tables with food.

Clear Lake, 14 miles from Spokane, is one of the waters in which the United States Fish Commission has deposited bass, plants being made in 1892 and 1895. In August, 1895, Mr. William Barnum, of the Commission, visited this lake and found the fish abundant. Silver Lake, about 2 miles distant, has also been successfully stocked, and bass were numerous in 1895. Otter Lake, a small lake in the vicinity, was privately stocked with fish from Clear and Silver lakes in 1894. The question of stocking Medical Lake with bass from Clear Lake has been under discussion for some time, and several plants of fish have been made. The peculiar character of the water in Medical Lake, however, is thought by some to militate against the success of the experiment. King Lake, near Medical Lake, has also been planted with bass from one of the neighboring lakes. In 1895 black bass were reported abundant in Loon and Washington lakes.

No information as to the outcome of planting bass in Nevada has been received since 1892. Up to that time the fishermen of Carson River and Washoe Lake had taken no fish, according to the State fish commissioner's report.

Mr. W. H. Ridenbaugh, of Boise, Idaho, has a pond connected with the Boise River, 1½ acres in extent, in which large-mouth bass are abundant. Another pond of 2½ acres was drawn off in 1892, and 2,240 bass, averaging half a pound each, were placed in the Boise River. No fishing has as yet been done in the river, and it is not known how the fish are flourishing. The eventual stocking of the Snake and Columbia rivers from this stream is not improbable. Mr. Ridenbaugh has never heard of any bass being caught by anglers or in any other way in the Boise River. He has watched for them in the irrigation ditches, especially after a break, when the water was low, but has never seen one, and is inclined to believe that the fish have gone down the Boise River into the Snake River. The latter is sluggish and deep in places, and apparently well suited to bass. Mr. Ridenbaugh thinks it will one day be a great bass stream.

Under date of December 21, 1895, Mr. Ridenbaugh informs the Commission that his first stock of black bass was obtained in St. Joseph, Mo., and shipped to Boise by express. The lot consisted of 50 fish about 6 inches long. These were placed in his smaller pond eight years ago, and during the last four years he has caught annually about 60 fish, weighing 1 to 1½ pounds. The larger pond was stocked with small fish from this pond and with bass received from the United States Fish Commission.

Large-mouth black bass are now exceedingly abundant in Utah Lake, Utah, the lake having been stocked by the single plant in 1890. The economic result of this successful introduction is more important than in any other State.

The large-mouth bass reaches a greater weight than the other species; in the Great Lakes, Mississippi Valley and Eastern States, the maximum is about 8 pounds, but in the warm southern waters a weight of 15 or more pounds is attained. The maximum weight of the small-mouth form is about 5 pounds.

As yet there is little occasion on the part of fishermen and anglers in the Western States to know the characters distinguishing the two species of basses, since only one of them has been planted in a given locality; but as the fish receive a wider distribution by natural and artificial means the two kinds will in time be sometimes found in

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same waters, and it will often be a matter of interest to anglers and others to learn which fish has been caught. The color markings and the general appearance of the basses are usually sufficient to distinguish the species, as the accompanying figures will show, but the most satisfactory and conclusive feature by which they may be separated, whatever the age or condition of the specimens, is the number of rows of scales on the side of the head. In the large-mouth bass the scales are relatively large and about 10 transverse rows, while in the small-mouth species these scales are quite minute and in about 17 rows.

FISHING FOR BLACK BASS.

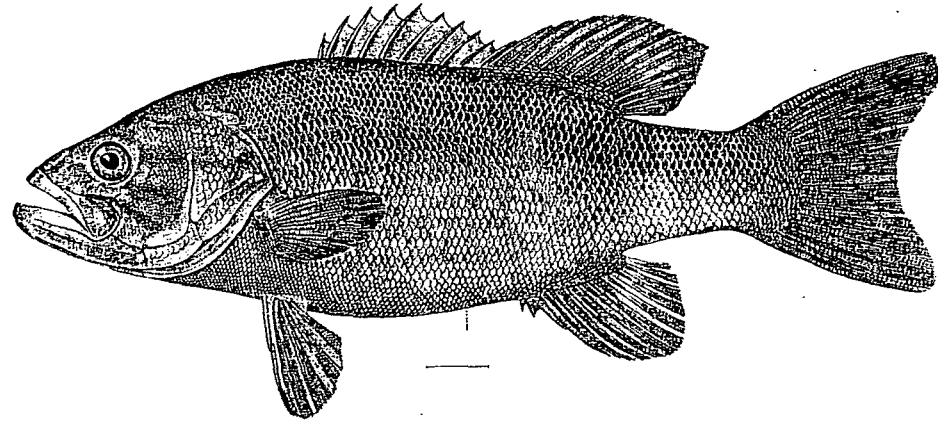
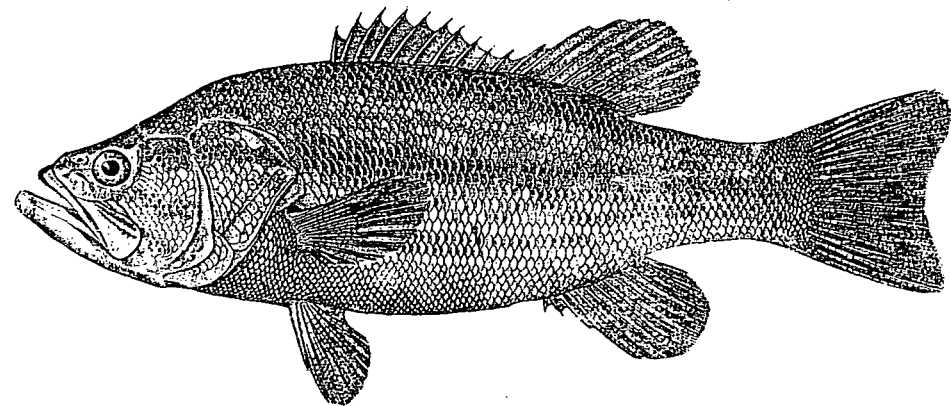
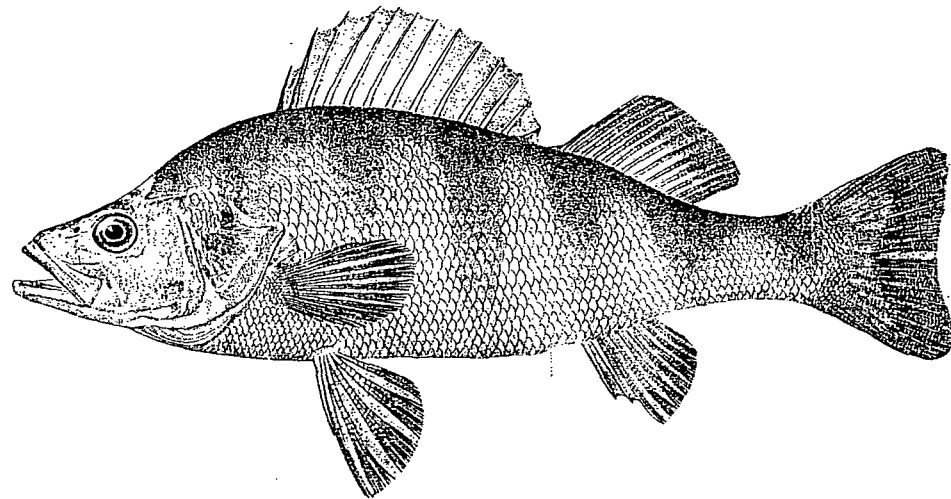
In California the black bass is not a commercial fish. It is seldom, if ever, seen in the markets of San Francisco or other large cities, and when exposed for sale is usually an indication of a violation of law on the part of some fisherman.

The only legal method of taking bass in California is with hook and line. A favorite fishing-ground is the reservoir of the Spring Valley Water Company in San Mateo County, where fishing is by permit, and only 20 bass are allowed to be caught one time by one person. Mr. Alexander reports that the guests at the Hotel del Monte, Monterey, are permitted to fish in the lake and reservoir in the hotel grounds. The catch is limited to 12 fish to a rod. Bass a foot in length have been taken in the lake, and some 18 inches long have been caught in the reservoir at Thermalito.

Some bass angling has been done in the Russian River, where the fish are abundant, but it is said the fishing is not good. Considerable illegal fishing has from time to time been reported in this river. Mr. Alexander states that several fishermen with bag seines made comparatively large hauls in 1894, much to the indignation of the State authorities and the people in the vicinity. In July, 1894, arrests were made and conviction had for using dynamite to kill bass. Several hundred bass were found floating in the river after the explosion of a submerged charge of powder, and dead fish were said to have lined the sides of the river and caused a strong stench for some time.

The bass in Clear Lake and other lakes near Spokane, Wash., afford fine sport to anglers. The fish usually weigh 1 to 1½ pounds. Minnows are used for bait, and even dead or mutilated ones will prove attractive lures. The black bass sold in the Spokane markets are taken in Silver and Clear lakes with hook and line, no netting being permitted. Mr. E. Michael, a fish-dealer of Spokane, reports that he pays the fishermen 12½ cents a pound for bass and retails them at 15 to 17 cents a pound. He handles about 150 pounds a week during a season of about 10 weeks.

In Utah Lake, Utah, the large-mouth black bass has become a fish of considerable commercial value. In 1895 Mr. William Barnum, of the United States Fish Commission, learned at Salt Lake City that one dealer in that place was receiving about 500 pounds a week from Utah Lake. The fish are very highly esteemed, and retail readily at 20 cents a pound. The usual weight of the fish taken for market in Utah Lake is 1 to 1½ pounds, but a few specimens weigh 3 to 4 pounds. A fish weighing 4½ pounds is recorded. The bass is said to be the only high-priced fish used by the Chinese, who are very fond of it. The *Deseret Evening News* of September 26, 1895, reported that 2,000 pounds of bass had already been taken that season from Utah Lake. The report of the Utah commissioner for 1894-95 states that 60,000 pounds of black bass were caught in Utah Lake in those years, most of the fish being shipped to Colorado. Fishing is done with lines.

SMALL-MOUTH BLACK BASS (*Micropterus dolomieu*).LARGE-MOUTH BLACK BASS (*Micropterus salmoides*).YELLOW PERCH OR RINGED PERCH (*Perca flavescens*).