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# The Striped Bass in California

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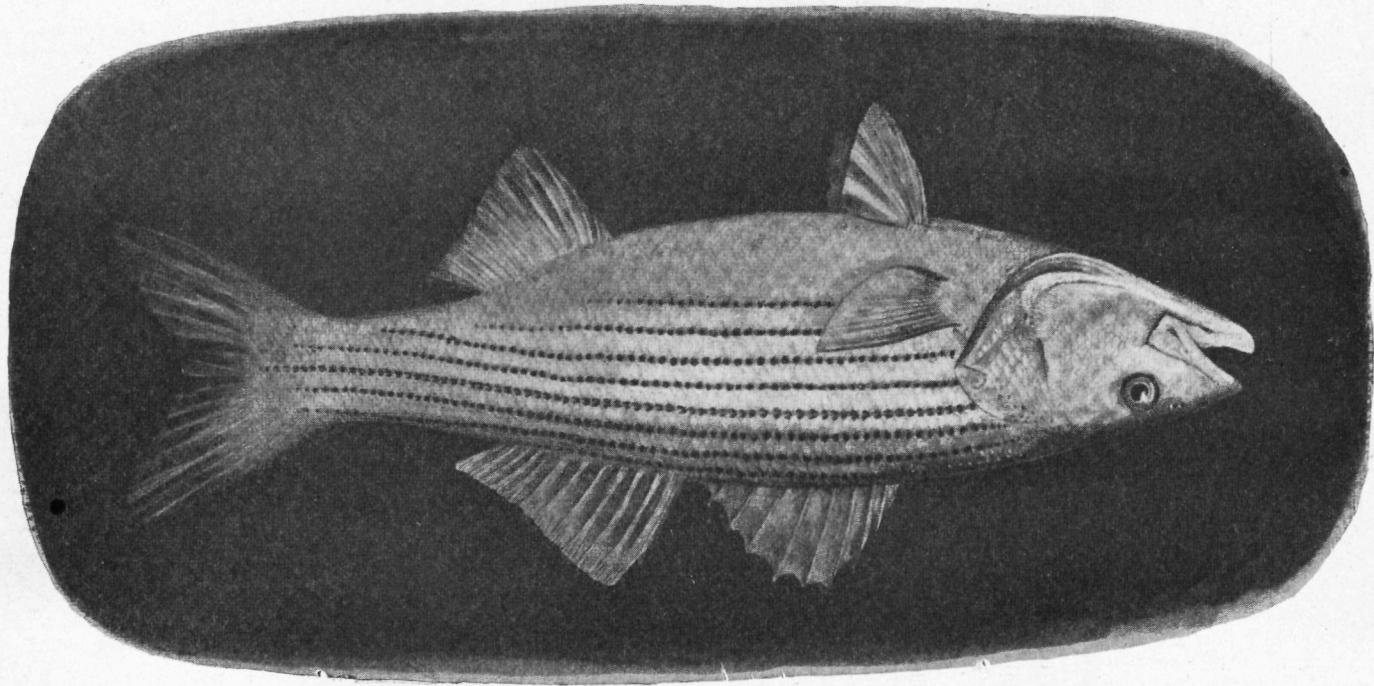
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Fig. 13. Striped bass (*Morone saxatilis*) introduced into California in 1879 and now a notable food and game fish.



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"CONSERVATION OF WILD LIFE THROUGH EDUCATION"

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## THE STRIPED BASS IN CALIFORNIA.

By N. B. SCOFIELD and H. C. BRYANT.

To develop a fishery which has been known to yield over 1,750,000 pounds valued at a half million dollars annually, with an original outlay of less than a thousand dollars, to say nothing of continuous, superb sport and valuable food furnished the anglers of the state, is an accomplishment that merits review. The striped bass, originally native to the Atlantic seaboard, is now a common food and game fish of California, the basis of a great fishery, and so highly prized by anglers that numerous bass clubs find existence in the cities and bass fishing enthusiasts line the banks of sloughs whenever this fish is pro-

curable. Unquestionably, next to trout, the striped bass is the most popular game fish of northern California.

*Roccus linneatus*, although known commonly as striped bass, is in reality not a true bass, nor is it a true perch, though possibly related to both. Most ichthyologists consider it a transitional type between the perch and the sea bass. Among fishermen, especially in the south, the fish has long been dubbed "rock fish."

**Geographical Distribution.** The original distribution of the striped bass or "rock fish" included the Atlantic coast from the Gulf of St. Lawrence to northern Florida, with a few more or less authentic records of its occurrence in the Gulf of Mexico.

As indicated by the fisheries, its present centers of abundance lie between Cape Cod and North Carolina, where it ascends all suitable rivers to spawn and in the pursuit of food. According to tradition, many years ago it was very abundant on the New England coast, north of Cape Cod, in the Bay of Fundy, on the Coast of Nova Scotia and gulf coast of New Brunswick. In the United States north of Cape Cod, it is now comparatively rare. Although formerly known to ascend the St. Lawrence in large numbers, some of them as far as Quebec, this fish is now very scarce in that river. In the early nineties, the striped bass was most abundant in the Chesapeake and Delaware Bay region and in the waters of New York and southern New England.

*Plantings of Striped Bass in California.*

- 1879—135 from New Jersey, near Martinez.
- 1882—300 from New Jersey, Suisun Bay near Army Point.
- 1899—Less than dozen, Humboldt Bay.
- 1903—75 (size, 2 to 3½ lbs.), Brackish lagoons of Orange County, mouth of Santa Ana River.
- 1905—80 (5 to 8-inch fish), Brackish lake at Crescent City, Del Norte County.
- 1909—Car load (6 in. to 4 lbs.), North Santa Ana River, Orange County.
- 1916—1800, North San Diego River, San Diego County.
- 1916—2000, Morro Bay, San Luis Obispo County.
- 1919—1500, Bolsa Chica, Orange County.
- 1919—1500, Morro Bay, San Luis Obispo County.

**Introduction Into California.** "The striped bass was first introduced into the waters of the Pacific slope in 1879, at the same time that a consignment of eastern lobsters was taken across the continent. The acclimatization of this species was undertaken at the suggestion of Mr. S. R. Throckmorton, then chairman of the California Fish Commission \* \* \*.

"In July, 1879, Mr. Livingston Stone, of the United States Fish Commission, made a collection of living striped bass in the Naveesink River, New Jersey, for transportation to California. He obtained 132 fish from 1½ to 3 inches long and 30 medium-sized specimens. Twenty-five of these died during transportation and several were thrown away, but the remainder, about 135, reached California in good condition and were deposited in Carquinez Strait at Martinez.

"The second and only other plant of striped bass in California waters was made in 1882, when Mr. J. G. Woodbury of the California Fish Commission carried about 300 fish, 5 to 9 inches long, from the Shrewsbury River, New Jersey to Suisun Bay, where they were deposited at Army Point, about 3 miles from the preceding plant." (Smith, 1896.)

Increase in size was noticeable in the catches of succeeding years. In September, 1883, a 17-pound striped bass was taken at Monterey Bay. The following month a 16-pound fish was caught in the Sacramento River. On March 11, 1884, an 18½-pounder was offered for sale in the San Francisco market. Ten years after planting, on June 16, 1889, a 45-pound striped bass was sold on the San Francisco market. (Smith, 1896.)

In 1889, hundreds of them weighing from one-half to a pound each, were being caught and sold in the San Francisco markets. From 1889 to 1892, the number caught had increased 250 per cent. After 1900 they were occasionally taken in tributary streams. Previous to 1903 striped bass weighing twelve pounds were taken in the Feather River near Oroville and were numerous in the Tuolumne River above Modesto in the Stanislaus and in the Merced and San Joaquin rivers. In the Sacramento River striped bass have been taken as far north as Kennett.

For many years there was no great extension of range along the coast. Striped bass were limited largely to the Sacramento and San Joaquin rivers, with occasional specimens being taken from Monterey Bay northward as far as the mouth of Russian River in Sonoma County. By 1896 it was fairly abundant in the mouth of Salinas River; a few years later it was taken in the coastal streams of Oregon, and in the fall of 1906, a half dozen specimens were secured by the U. S. Bureau of Fisheries in traps at the mouth of the Columbia River. (Smith, 1910.)

In 1925 striped bass were being caught in commercial quantities in the Coos Bay region, Oregon, and dealers at Big Bend, Oregon, were looking for a market for these fish in California.

Considering the small number of fish introduced and their remarkable increase in a few years, the result obtained from the introduction of the striped bass into California is one of the greatest feats of acclimatization of new species of fish in the history of fishculture.

Desirous of furnishing the northern coast countries with this most desirable food fish an attempt was made in 1899 to introduce the striped bass into the streams entering Humboldt Bay. Most of the shipment died en route and less than a dozen were actually planted. Whether or not this plant was successful is not known, but three or four specimens were secured in the Eel River ranging as high as twenty pounds in weight in 1907, and an occasional bass is taken in Klamath River to the north.

In 1903 seventy-five bass six inches to three and one-half pounds in weight were planted in brackish lagoons at the mouth of the Santa Ana River in Orange County. Another plant was made the following year. Finally a carload of striped bass ranging in size from six inches to four pounds in weight was collected in 1909 in the Straits of Carquinez, at Port Costa, within two miles of where the original plant of bass was made twenty-seven years ago and transported without loss of a single fish to southern California, where they were distributed in suitable waters of limited area in Orange County. This third shipment made into these waters within eight years was expected to determine beyond all question their adaptability to the conditions found there.

On October 26, 1916, eighteen hundred small striped bass were planted near the mouth of San Diego River by the Fish and Game Commission,

and since that time small striped bass have on several occasions been observed near the place of planting.

Mr. A. G. Pearson of San Diego reported that on or about June 20, 1919, he took several small striped bass ranging from five to eight inches in length in San Diego River near its outlet into Mission Bay.

The fry at the time of planting were between two and three inches long, being fish of the year, spawned in April or May, 1916. If these fry had grown at the rate they do in San Francisco Bay they would have reached the size of five to eight inches in 1917, during their second year. If the fry reported by Mr. Pearson were some of the fry liberated in 1916 they were in their fourth year and their rate of growth had been remarkably slow. It was suggested that these five to eight-inch fish were the progeny of the fish planted in 1916, but that can



FIG.14. Catch of striped bass on Salinas River June 9, 1921. Five of these fish weighed 15 pounds or over. The fishermen are G. O. Clark, E. W. Smutz, and Douglas Hollingworth of Watsonville. Photograph by G. A. Clark.

hardly be, as a sufficient length of time had not elapsed. It is pretty certain that striped bass do not spawn earlier than their fourth year, and the fish planted in 1916 would not have completed their fourth year until the spring of 1920. It would seem more probable that other striped bass plants have been made of which we have no record, or else that striped bass have strayed to the south and occasionally spawn as far south as San Diego.

In the same year a plant was made in Morro Bay. Again in 1919 5000 small striped bass were secured in the Sacramento River and 2500 shipped in the fish car of the Fish and Game Commission to Morro Bay, San Luis Obispo County, and 2500 to Bolsa Chica, Orange County.

On Saturday, November 15, 1919, the California Fish and Game Commission shipped about 2500 striped bass from two and one-half to five inches in length to the Fish and Game Commission of the Territory

of Hawaii to be planted in streams in the vicinity of Honolulu. The fish were caught in a seine on the Benicia flats, held in live cars until sufficient were collected to make the shipment, and then were put aboard the Matson Navigation Company's steamer *Mauui*. Here the fish were distributed in six large salmon tierces that had been arranged on the main upper deck in from the office of the chief engineer, who took personal charge of them.

**Life History  
and Habits.**

Although known to be an anadromous fish, the striped bass is to be found in the San Francisco Bay region or in the lower Sacramento or San Joaquin rivers in varying numbers in any month of the year. In the lower rivers, however, more of them are caught in the spring and autumn.

Two distinct migrations take place. In the spring of the year, beginning during March and extending through April, May and part of June, the spawning migration of striped bass takes place. They come from the deeper holes in the lower rivers and bays, also from the ocean, and run well up the Sacramento and San Joaquin rivers and some of the smaller tributaries like Napa River. This run consists mainly of large bass. The average weight of these fish was formerly between twelve and fifteen pounds. Thirty-pound fish were common, and occasionally fifty and sixty-pound fish were caught. At present fewer large fish are taken and the average weight is less.

In the fall of the year the run of what is known as "winter bass" takes place. These fish average much smaller. They come into the bays, run into the sloughs and for some distance up the rivers for the purpose of feeding. Some of these bass may be with spawn, but the eggs probably are not deposited until after March when the water temperature gets above sixty degrees. This fall run commences usually in September, the time being somewhat variable, and lasts from two weeks to two months. The fish of this run are often immature bass, not often over five or six pounds, and according to the fishermen, are bright and fresh from the sea. The small sized bass are more apt to be found in schools than the large fish, and the large catches in gill nets are usually of this size. This is particularly true of catches in gill nets in the lower bays. In the lower bays they are often found on the flats voraciously feeding on schools of small fish, making a sucking noise similar to that of the carp when feeding at the surface of the water. Often a school of these bass will run into one of the numerous tule-lined sloughs of the Sacramento and San Joaquin deltas, evidently attracted by the small river fish which they drive before them, feeding as they go. Such schools are often indicated by a large number of shags, gulls and fishing birds which take this advantage to feed upon the maimed and frightened fish. Several years ago commercial fishermen would look for these bass schools in the sloughs and would occasionally make catches so large they could not take all in their boat and would have to put some on the bank and come back later for them. But these catches are no longer made, for in 1915 the legislature passed laws which closed the sloughs to commercial fishing.

Striped bass during these two runs or at any other time seem to be quite notional. They will suddenly appear on the river fishing drifts and as suddenly disappear again, and no trace of them can be found. Commercial fishermen who have had fifteen or twenty years' experience

fishing for them in these waters still trust mostly to chance in locating them, not being able to figure out their movements other than that rough water spoils the fishing, the theory being that they leave the flats and sloughs in rough weather and take to the deeper parts of the river where the nets do not reach them.

Nearly twenty years ago when an attempt was made in California to artificially propagate striped bass, most of the large "spawn" bass were being caught on the San Joaquin River near Bouldin Island. But this is now changed, and although there is a spawning migration of bass in the lower San Joaquin River, the larger run is now in the Sacramento River and were caught in nets as far up as the mouth of Feather River until netting was prohibited above the bridge at Sacramento by the legislature in 1925. After spawning they ascend the rivers for long distances, or enter the sloughs or flooded lands in search of food, for after spawning they again become voracious feeders.

In the years 1903, 1904 and 1905 spawn bass were so plentiful about Bouldin Island that the fishermen, in order not to glut the market, agreed among themselves to catch no more than 600 pounds to the boat each twenty-four hours. They frequently got more than double this amount at one drift of a gill net.

Many of these fish were with mature eggs and the fishermen all testify that the bottoms of their fish lockers were covered with eggs. The main spawning season is between the middle of April and the middle of June. The spawning migration commences in the bay and lower river a month earlier than this.

#### SPAWNING.

"The striped bass spawns in the late spring and early summer, ascending rivers and their tributaries for the purpose. The principal streams on the Atlantic coast of the United States are those flowing into Albermarle Sound, Chesapeake Bay and New York Bay. From North Carolina to New Jersey the spawning time appears to be in late April and early May; farther north, in late May and June.

\* \* \*

"An observer described some of the breeding habits of the fish to the effect that when a female was in spawning condition the males gathered about her in great numbers. A single female which might weigh from five to fifty pounds would have around her twenty, thirty or fifty small male fish, all of which weighed less than two pounds each, and they seemed to be the only males present. The water was stated to be discolored with blood from the fish 'finning' one another while contending for the female." (U. S. Bur. of Fisheries Memorandum.)

The eggs of the striped bass are about one-twentieth of an inch in diameter, produced in large numbers. In spawning operations at Bouldin Island, California, 20,000 to 500,000 eggs were secured from ripe females. Two females spawned produced 1,000,000 eggs each. According to a report a twenty-pound female in the east has produced 1,500,000 eggs estimated on the basis of 25,000 to a quart.

Convinced of the advisability of attempting to increase the supply by artificial propagation, an investigation of hatchery sites was begun by the California Fish and Game Commission in 1907. The funds at that time being insufficient to bear the expense unaided, the subject was

taken up with the United States Bureau of Fisheries at Washington, with the result that Capt. G. H. Lambson, in charge of the salmon hatching work of the Federal Bureau of Fisheries in California, was instructed to cooperate. Accordingly, in the month of May, 1907, operations were commenced at Bouldin Island, on the San Joaquin River, at which point a small hatchery building was constructed at the expense of the commission. A small pumping plant for the purpose of raising water into two tanks of 2000 gallons each to furnish the necessary amount of water for hatching operations was also in-

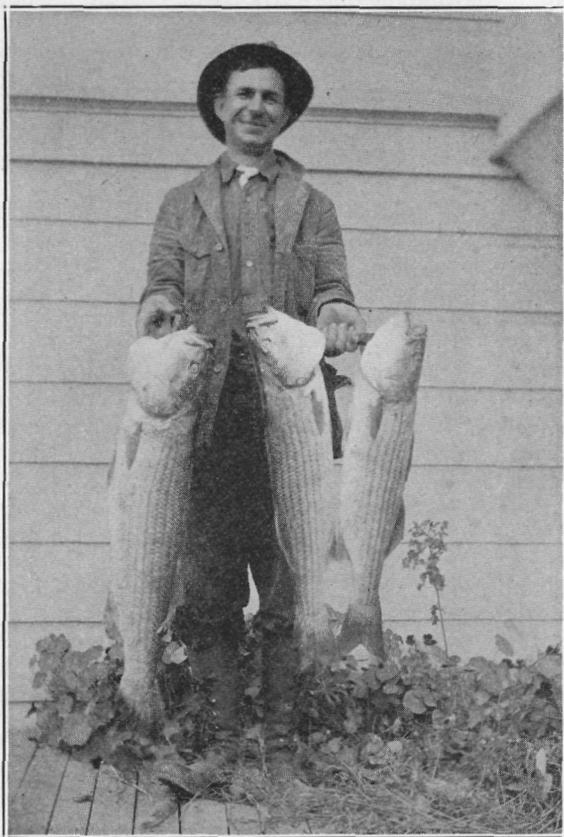


FIG. 15. Three striped bass caught by trolling in Salinas River July 9, 1921, by Douglas Hollingworth of Watsonville. The fish weighed 12, 14 and 17 pounds respectively. Photograph by G. A. Clark.

stalled. The equipment of the hatchery, McDonald hatching jars, was furnished by the United States Bureau of Fisheries. The hatchery depended on the commercial fishermen for any ripe eggs they might take.

Although fishermen took a lively interest and assisted in every way, yet the results were unsatisfactory. It was found that by the same methods followed in "stripping" trout and salmon, the eggs and milt

could be taken from striped bass, and yet neither the eggs nor milt be sufficiently matured to insure fertilization. The result was many eggs were taken that were apparently ripe, but whose fertility could not be definitely determined until after the eggs were placed in the hatchery. The total take of eggs for the first year's operations was about eighteen million, about three times the amount taken up to that time on the Atlantic coast in a single season of which there is any record. The percentage fertilized and hatched, however, was small. From many lots of eggs no fish hatched. Other lots hatched 5 per cent only, and from that up to 50 and 60 per cent. One lot hatched a very high percentage of the eggs.

Nevertheless, the results of the season's work were encouraging, for hatching striped bass was still in the experimental stage, and the results in number of eggs hatched during the season of 1907 were much better than had been obtained on the Atlantic coast. It was not determined just why so many eggs failed to hatch, but it was laid to unsuitable water or some defect in hatchery method.

The season of 1908 found the hatchery better prepared for work and equipped with microscopes and apparatus for determining the cause of the failure of so many eggs to hatch. This season the run of bass was almost a failure, and the take of eggs so small that many of the experiments came to nothing for lack of eggs with which to experiment.

It was soon found that the first cleavage of the germinal disc in the developing egg takes place about two hours after fertilization. So with the microscope it was possible to tell within two hours after the eggs were taken just what per cent was fertilized and developing. It was found also that the loss of eggs was not due to bad water or any defective method of handling the eggs in the hatchery, but due to the nonfertilization of the eggs. That fungus could be established through the use of copper sulphate 1-500,000 parts was demonstrated.

Hatching takes place about three days after impregnation. The yolk-sac is not entirely absorbed until after the seventh day, and the stomach is not well developed until about the thirteenth day.

Young fry were kept for two weeks in McDonald hatching jars by removing the siphon tubes and replacing the top with silk bolting cloth, allowing a small stream of water to flow on the cloth.

Artificial propagation was finally abandoned after further discouraging work in the seasons of 1909 and 1910, when few ripe females were obtainable.

#### RATE OF GROWTH.

"The rate of growth is very rapid. Young fish an inch long found in the Delaware River in the second week of June, about the middle of October were observed to have grown to the length of four and one-half inches. Young fish five to nine inches in length, which are taken in quantities in the Potomac in February and March, are supposed to be the young of the previous year.

"The striped bass has been kept in a small pond of fresh water and fed upon crabs and oysters, increasing in about eleven months from six to twenty inches in length. It is stated that in a Rhode Island pond a bass weighing one-half to one pound in June increased to a weight of

six pounds in the following October." (U. S. Bur. Fisheries Memorandum.)

## SIZE ATTAINED.

According to the U. S. Bureau of Fisheries, the largest striped bass records are of several taken at Edenton, North Carolina, each of which weighed 125 pounds. One taken at Orleans, Massachusetts, weighed 112 pounds. Such a fish would measure at least six feet in length.

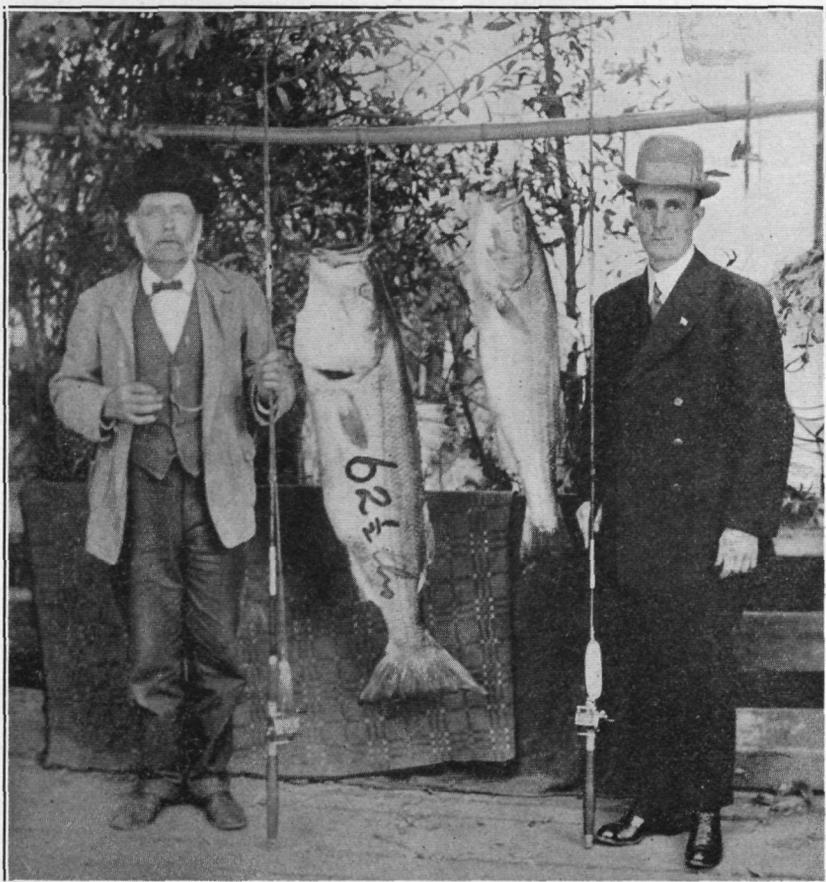


FIG. 16. A striped bass weighing  $62\frac{1}{2}$  pounds caught in the Napa River by William West September 11, 1911. This is the largest fish recorded for the Napa River. Photograph by William West.

Individuals of 60 and 70 pounds are not uncommon, although the average is probably not over four or five pounds.

Mr. George Neale, former executive officer of the Fish and Game Commission, saw and weighed a striped bass in a San Francisco market that tipped the scales at 78 pounds. The dealer told him that two days before he had one weighing 82 pounds. This was about 1910.

The fish shown in the accompanying photograph, the largest bass ever caught in Napa River by hook and line, was taken by William

West September 11, 1911. This fish weighed 62½ pounds and was taken on a 7B Wilson spoon, all copper.

Another bass caught in Napa River February 27, 1925, by A. C. Doble weighed 44 pounds and measured 49 inches by 29 inches in girth.

In November, 1924, Messrs. Johnson and Kelly, using live suckers as bait, caught two bass weighing 32 and 54 pounds each, respectively, in the Russian River near Monte Rio. Mr. Jim Cahill of Sebastopol secured a 57-pound striped bass in Forest Pool on the Russian River in October, 1924. Several 40 and 45-pound bass were taken in the same river during the season of 1925.

There are many unverified statements as to the size of striped bass caught years ago when larger ones were taken more often.

Fish weighing less than three pounds (now size limit of 20 inches) are protected the year round in California, and fish of more than ten pounds in weight can not be taken during the spawning season.

#### HABITS.

"The striped bass, although migratory and anadromous, does not cover great distances nor spend much of its life in the ocean as does the salmon, for it may be found in the range throughout the year. It may be taken in salt, brackish or fresh water, even being kept in artificial ponds of fresh water for considerable lengths of time without detriment." (U. S. Bur. Fisheries Memorandum.)

Young fish apparently feed in shallow water, for they are often found in overflow areas and must be rescued when these areas dry up in the fall. Many young fish also feed in San Francisco Bay, for a bay with rivers entering it is always a nursery for young fish. Where there is an intermingling of fresh and salt water, as in the upper San Francisco Bay, there is a prodigal growth of small animal life, including shrimps and other species of small crustaceans. Upon this small life the young fishes feed.

When Chinese shrimp fishing was allowed in upper San Francisco Bay, large numbers of small striped bass were killed in the nets during winter months. The boats which fished below San Pablo Bay in the deeper water near Red Rock and the stone quarry on the opposite side caught smaller quantities of young fish than those above in San Pablo Bay, but they caught more of the young striped bass than any others.

There is evidence to believe that in the late fall and winter the young bass of the year which have reached a length of from three to five inches abandon the shallow water of the "flats" and move into the deeper water of the channels and thence pass out into the ocean where they spread up and down the coast for a short distance. During the spring young bass of this size appear in numbers in the shallow waters of the inner lagoon of Drakes Bay and in the shallows at the head of Tomales Bay. To the south they appear in Elkhorn Slough, but these may be the result of bass spawning in Salinas River. We know of no proof that striped bass spawn in Salinas River. It is believed that no spawning takes place in either Drakes Bay or Tomales Bay or the fresh water tributaries and that the young bass appearing there come from San Francisco Bay. It is known that the young bass of the year are plentiful in San Francisco and upper bays until the cold of winter comes on. In collecting the young bass for transplanting small meshed

seines are used, and experience in getting these fish for shipment has taught us that the best time to get them in numbers is in the fall before cold weather sets in, and that after cold weather sets in it is about impossible to find enough to make a shipment. The fact that the shrimp nets formerly set on either side of the straits between San Pablo and San Francisco bays in about 30 feet of water caught considerable numbers of young striped bass of the year while they were drifting out on the ebb tide is the best of evidence that there is a seaward migration of the young bass in the fall and winter. It is not likely that these young bass which pass out to sea return for at least a year. Investigations on the age and rate of growth of striped bass in the San Francisco Bay region now being carried on by the commission is likely to throw much light on these questions. Already it is fairly well shown from a study of the scale growth to determine age, that a large proportion of the bass studied passed out of fresh water in the fall and made a large sea growth during their second year. A smaller number remain until the second winter before migrating to the sea and these make their large sea growth in their third year.

Many of these fish were with mature eggs, and the fishermen all testify that the bottoms of their fish lockers were covered with eggs. The main spawning season is between the middle of April and the middle of June. The spawning migration commences in the bay and lower rivers a month earlier than this.

Striped bass occasionally reach fresh water at the headwaters of streams in their spawning migration. Two fish weighing five and six pounds, respectively, were taken in Dry Creek, a tributary of the Napa River, during the spring of 1925. This species is known as far up the Sacramento River as Redding and up the San Joaquin as far as Mendota dam.

In 1914, according to W. P. West of Napa, a bass was speared near Calistoga, 27 miles from tidewater. Fish have frequently been seen above the Trancas dam just above tidewater, but in distinctly fresh water pools. They appeared to be in a very excited state of mind, moving swiftly around as if looking for a way out. This dam consists of six fish ladders with a rise of at least 12 feet, the water in the ladders being very swift. The fish must necessarily jump to get up. When the fish are found above this dam they will not touch any bait no matter what is offered.

Every fisherman knows that striped bass are very sporadic in their occurrence and that in a place where large catches have been made one day the fish are not to be found the next day. Supposedly the same school of fish remain in the same pools to feed each day, even though there may be a daily migration with the tides. Inability to catch fish with hook and line is not always an indication of "no fish," but may be only an indication that they are not feeding. The movements of striped bass in a stream are not definitely known and much is still to be learned regarding feeding preferences.

#### FOOD.

The striped bass is reputed to be a voracious fish preying largely upon smaller fishes, and is particularly abundant at the time of the spring runs of shad and alewives or river herring. At this season

it is well fed and plump. To some extent it frequents the rocky shores and beaches of bays and sounds at high tide in search of crabs, shrimp and other food, and, at the mouths of creeks, smaller individuals lie in wait for the schools of small fishes and crustaceans which supply them with food. It also subsists upon mollusks, sea worms, etc. (U. S. Bur. Fisheries Memorandum.)



Fig. 17. A striped bass caught February 27, 1925, in the Napa River by A. C. Dobbs. The fish weighed 44 pounds, had a length of 49 inches and a girth of 29 inches. Photograph by Ed Bowen.

#### FOOD OF ADULT STRIPED BASS IN CALIFORNIA.

The food of the adult striped bass in the rivers is principally carp, hardheads and split-tails. Nearly all the fishermen claim that when the carp is plentiful it is their principal food. They even advance the theory that the bass are not so numerous in the San Joaquin because the carp are not so plentiful on the lower river as they were, and they run up the Sacramento because of their great abundance in those waters.

An investigator for the United States Bureau of Fisheries in 1894 reported that seven out of every ten striped bass examined in California contained carp. Carp even as large as two pounds have been found in stomachs. In spite of this evidence there are many who believe that live carp are not taken if other small scaled fishes are obtainable.

In the stomachs of bass W. P. West of Napa has found crabs, minnows 6 inches long, clams, duck entrails and sardines. Crabs and small fish appear to be the favorite food of bass in the Napa River.

Fishermen have occasionally found a dead striped bass with a catfish caught in its throat by the spines. Catfish weighing up to two pounds appear to be a common item in the diet in the sloughs.

#### FOOD OF YOUNG STRIPED BASS IN CALIFORNIA.

An examination of the stomachs of fifty young bass averaging three inches in length which were taken at "Morrison's Bight" in Napa Creek on September 10, 1908, showed the following contents: Crustaceans, a species of *Mysis*, 30 per cent; of young shrimp, 15 per cent; of a species of *Gammarus*, 1 per cent; of an isopod, 1 per cent, and 1 small crab; marine worms or annelids, a species of *Nereis*, 45 per cent; of species not recognizable, 5 per cent; small fish, species not recognizable, 2 per cent.

It will, therefore, be seen that on this feeding ground at least, marine worms comprise 50 per cent of the food, crustaceans of marine species 48 per cent, and small fish only 2 per cent. The young shrimp and young fish were taken from the stomachs of young bass of three to four inches in length and the other small crustaceans from the stomachs of specimens three inches and under in length, showing that the young bass begin feeding on the small species of crustaceans and worms, and as they grow in size are able to take the shrimp and young fish.

#### COMMERCIAL VALUE.

While the striped bass in California has come to be best known by the general public for its value as a game fish it is at the same time a very valuable commercial food fish and in the markets is prized next to salmon. The annual commercial catch of striped bass in California is near one million pounds and this amount is conserved in the state for under our state laws it can not be exported from the state. The amount of bass caught by anglers and used for food each year is hard to estimate but it probably would raise the total bass catch in the state to one million pounds.

"According to the Census Report of 1908, the striped bass fishery of the United States then amounted to 3,657,000 pounds, valued at \$314,000, the Atlantic coast fishery exceeding that of the Pacific coast by only 105,000 pounds with a value of \$45,000.

"On the Atlantic coast, Maryland, Virginia and North Carolina are paramount striped bass states, of which, according to the 1908 census, in order of pounds of fish caught, Maryland was first with 640,000 pounds, valued at \$65,000; North Carolina second, with 510,000 pounds, valued at \$36,000; Virginia third, with 502,000 pounds, valued at \$46,000. Of the remaining Middle Atlantic states, New Jersey and Delaware show the largest quantity—53,000 pounds each—valued at \$7,400 and \$7,300, respectively, followed by New York with 32,000

pounds, valued at \$5,300, and Pennsylvania with only 7,200 pounds, valued at \$800." (U. S. Bur. Fisheries Memorandum.)

On the Pacific coast, California is the only state with a striped bass fishery. During the eighties it commanded a high price even selling for \$1 a pound. However, by 1890, the striped bass was so well acclimated that it had become a well known market fish and sold for a less price than those marketed within its natural habitat in the east. In 1893 the San Francisco markets received only 79,738 pounds, but three years later this amount was increased to 363,747 pounds. In 1895 the price dropped to as low as six cents per pound. By 1899 this market was receiving nearly a million and a quarter pounds which brought the fishermen \$61,814. In 1904 1,570,404 pounds were landed at San Francisco for which the fishermen received \$92,116.

The 1908 census gave California 1,776,000 pounds, valued at \$135,000, and the 1915 statistical bulletin of the Bureau of Fisheries shows 1,784,448 pounds, valued at \$146,928.

With rigid restrictions relative to season and size limit in recent years (1916-1923), the fishery continues to yield from 600,000 to 1,500,000 pounds annually. At retail this fish sells for about 35 cents a pound.

The principal market catch is secured by gill net fishermen mainly from upper San Francisco bays and the lower Sacramento and San Joaquin rivers. A few are caught commercially with hook and line.

#### PROTECTIVE LEGISLATION.

Doubtless protective measures are largely responsible for the continued supply of this splendid food and game fish. As early as 1889 it was feared that the recently introduced striped bass were being exterminated before they had come to maturity and had a chance to reproduce. A county ordinance in San Francisco was accordingly passed prohibiting the sale of striped bass under eight pounds in weight. Later it was made unlawful to take bass under one pound, this limit being raised to three pounds in succeeding years.

By 1909 it was believed that additional protection was necessary as the intensity of the fishing was increasing owing to a large export trade and high prices. Accordingly, a nonexport law was enacted. This law was deemed advisable in spite of the fact that a closed season for commercial fishing had been declared during the spawning season in May or June.

The closed season did very little good for the reason that the season for salmon and shad was open at the same time and as each of those fish are running at that time large numbers of bass were killed in the nets and thrown away.

The striped bass conservation problem is a complicated one. During the spring spawning migration of striped bass we also have in the Sacramento and San Joaquin rivers shad and salmon which are also running up for the purpose of spawning. The shad are running during the latter part of March, through April, May, and into June. Salmon are running during this time and until October. The only time during which shad may be taken in commercial quantities is during this migration, and the main fishing grounds are in Suisun Bay and the lower rivers. Shad can not be caught without catching bass at the same time and it is extremely difficult to so regulate salmon fishing that striped

bass will not be caught at the same time. If nets are used for salmon or shad while striped bass are running, striped bass will surely be caught. If gill nets with meshes less than eight and one-half inches be prohibited so as to permit salmon fishing, the catch of bass is light, but the fishermen are not able to take shad as they are taken with meshes measuring from five and one-half inches to six and one-half inches. To prohibit nets with meshes less than eight and one-half inches during the entire shad run would be entirely too severe.

#### LEGAL PROTECTION.

Laws now provide against the shipment of striped bass out of the state; prohibit the sale or shipment of striped bass formerly less than three pounds in weight, now a size limit of twenty inches; the sale of striped bass of ten pounds or over in weight between March 1st and May 31st; the sale of striped bass of any size between May 16th and July 31st, or between September 17th and November 14th; the taking or having in possession at any time of any striped bass of less than twelve inches in length; the taking within Districts 1, 2 and 3 of more than five striped bass per day; with provision against sale; the taking of striped bass between one hour after sunset or one hour before sunrise, or in nets on Saturday and Sunday; and the use of nets with a mesh smaller than five and one-half inches.

A law prohibits the use of nets with meshes measuring between five and five-eighths inches and seven and one-half inches in San Francisco and San Pablo bays, between March 1st and July 31st. This measure adopted to prevent shad fishing in these waters is a splendid protection to the striped bass spawning run through those bays. Besides this, fully 1000 miles of sloughs in the San Francisco Bay region have been closed to commercial striped bass fishing. The Sacramento River has been closed to commercial fishing above the city of Sacramento and the San Joaquin River has been closed above the Santa Fe railroad bridge in San Joaquin County. As a concession to the angler, a person may have in his possession in any one calendar day, not to exceed five striped bass between twelve and twenty-one inches in length, but such striped bass must be caught only with hook and line and must not be bought, sold or offered for sale.

It can be seen, therefore, that careful protection has been given striped bass in California, in fact, much greater protection than has been afforded in eastern states. Protection of spawning fish, closed seasons, size limit and limited sale, all contribute to the safeguarding of this valuable fish.

#### STRIPED BASS DECREASING.

For many years depletion has been evident in eastern states. For instance the 1920 season's catch of striped bass for the state of New York was only 24,437 pounds. The catch in California during the same period amounted to 671,731 pounds. In California there is also a decrease in catch. The annual commercial catch of striped bass shows a decrease of about 50 per cent since 1915.

If we are to use the commercial catch as an index of the abundance of bass we should be sure that we take account of all factors affecting the catch. If the fishing area, the seasons, netting restrictions and

fishing methods remain the same and still the catch falls off, then we can be quite sure that the bass are becoming less abundant, although we can not be sure whether it is the commercial fishing, water pollution, loss of too many spawners or unfavorable spawning conditions that are causing the decrease. But to be on the safe side we should consider commercial fishing the main cause.

On the other hand if fishing areas have been reduced, closed seasons established or restriction placed upon nets, it can not be rightly argued that the decreased catch means decreased abundance of bass. In the case of our striped bass the fishing area was greatly reduced in 1915, and several sloughs and rivers were closed before that. Closed seasons have been established and netting restrictions have been adopted which have made it unprofitable for fishermen to operate in San Pablo Bay during the spring spawning migration. It was to be expected that the catch would fall off. The fishing restrictions were enacted for the purpose of reducing the catch and if the reduced catch shows anything it shows that the restrictions were effective and that the bass are getting the protection they need and it is totally unfair to use the reduced catch as an argument that the bass are being exterminated.

If the fishing restrictions adopted are sufficient, the catch should, after a time, remain the same or even increase. The length of time it would take to show the benefit of the protection would depend upon the age at which the protected fish matured and spawned. Along this line it is interesting to note that, in spite of added protection given by our legislature in 1921 and 1923, the commercial striped bass catch in 1922 showed an increase of 84,000 pounds over the preceding year, and each year since has shown an increase in the catch.

However, along with this decrease in the commercial catch prior to 1922 was a decided scarcity of bass in many of the haunts where both anglers and commercial fishermen formerly found them abundant. The present scarcity is most noticeable in most parts of San Pablo Bay and in the mouths of sloughs tributary to it. On the other hand, striped bass are apparently more plentiful in some other places, and good angling has been enjoyed in places where they had been caught only in very limited numbers before. There are some ardent striped bass anglers who believe that these fish are just as plentiful as they ever were. They believe that some of the sloughs have been fished out by anglers, but that in some cases the bass have moved from their old haunts and have to be sought in other places. Some of the commercial fishermen say that the bass are about as numerous as ever but that they have moved, and that the best net fishing is to be found in places where the bass were formerly not so abundant.

Some commercial fishermen believe that striped bass are not so abundant as formerly.

Most bass anglers are firmly of the opinion that the bass are not only less plentiful but that they are on the road to extermination. Typical of the arguments advanced is the following:

"Great spawning grounds of the striped bass are located in the middle channel of the San Joaquin River. Large fish with a great accumulation of eggs are found there. Formerly as high as 1000 to 2000 pounds of large spawning striped bass would be taken there with nets at one time. In 1907 one angler took 39 fish weighing from 12 to

36 pounds. Now from 75 to 80 per cent of those taken run from two to five pounds in weight."

In spite of discouraging reports good seasons come. The year 1924 was an especially fine season for the angler of striped bass. The average price in the market continues to be 35 cents per pound.

It is our belief after reviewing all the evidence that striped bass are not so plentiful as they were. Large sized "spawn" bass are less abundant than they were, which is a pretty sure sign of over-fishing. But the increase in the catch of bass beginning with the year 1922 in spite of added fishing restrictions of 1921 and 1923 is the best of evidence that the bass are becoming more plentiful and that the effect of the fishing restrictions adopted began to show first in 1922 and that there is now a steady increase in the number of striped bass. It should not be argued that the falling off of the commercial catch prior to 1922 shows that the bass were being fished out by the nets and that there were less than half as many bass as in 1915. It is very much more likely that the 50 per cent decrease in the commercial catch was almost entirely due to the very good restrictive legislation which has been obtained through the efforts of the Fish and Game Commission's efficient enforcement of the protective laws.

The usual method of protecting fish against overfishing is to restrict the catch, and when efficient protective measures are adopted and enforced the resulting decrease in the catch should not be used as evidence that the fish are being exterminated. The scarcity of bass in some of their old haunts about San Pablo Bay we believe is largely due to the bass moving to other regions. This movement is caused mainly by the pollution of San Pablo Bay waters by the government's dredging operations about Mare Island and in dredging the channel from Mare Island to Pinole Point. Much dredging has also been done about the mouths of the more important sloughs. The continued stirring of the mud by dredging operations has caused the tides to carry great quantities of silt over the bay and into the mouths of the sloughs, where it has settled to the bottom like a blanket, and almost entirely killed the diatoms and other plant life which form the basis of the food supply of fishes.

This condition was called to our attention by Dr. Albert Mann of the Carnegie Institution after he had made a diatom survey of San Francisco and San Pablo Bay waters. Dr. Mann was alarmed by the conditions he found in San Pablo Bay and stated that if we are to preserve our fisheries we will have to guard against the blotting out of diatom life by silt from dredging operations such as are taking place in our bays and rivers. There can be no doubt that the pollution of the waters by sediment from the dredgers has caused the bass to largely abandon their old haunts about San Pablo Bay. Oil pollution may also be a contributing factor.

#### AS A GAME FISH.

The striped bass is a very popular game fish in the east, principally secured by surf-casting along the coast of southern New England and Long Island. In various rivers, such as the Potomac, small fish are caught by ordinary bait fishing. The baits employed may be squid, strips of some shiny fish such as menhaden, small silvery fishes, pieces

of crab, preferably "shedders," fiddler crabs, "bloodworms," clams, mussels, etc. Sometimes artificial lures, such as "squid," spoons and even flies are effective. (U. S. Bur. Fisheries Memorandum.)

Along the Pacific coast the striped bass is most often caught in the bays near mouths of rivers, in sloughs and slow moving streams.

To the angler the striped bass is "a gallant fish and a bold biter." It is eagerly sought for by a host of anglers because of the excellent sport offered in its capture as well as the delectable white meat so desirable as food.

Night fishing has been much in vogue, but this fish is such an erratic biter that there is no definite proof that fishing is much better during hours of darkness. Legal restrictions have put commercial night fishing under the ban.

Most anglers claim fishing becomes poorer in streams and sloughs during cold or stormy weather. The fish are supposed to seek the deeper pools at the mouths of streams at such times.

Famous old fishing grounds include San Antonio Slough near Petaluma, Oakland Estuary, San Leandro Bay and Petaluma Creek at Schultze's Slough.

Between 1910 and 1915 Cache Slough and tributaries was a notable fishing ground. During this period Mr. George Neale of Sacramento caught many bass weighing from eight to 35 pounds. Reclamation is responsible for the destruction of this area as a fishing ground.

In the clear water of Prospect Slough on the lower Sacramento bass formerly took the spoon readily, and this was a popular fishing ground for those who enjoyed the sport of catching the striped bass with rod and reel. The usual method was to troll behind a gasoline launch. Large numbers were taken in this manner in other sloughs.

Favorite resorts of anglers in the bay region at present are Sausalito, Petaluma, Napa, Rodeo and Crockett. Baker's Beach, San Francisco, is a favorite for surf-casters. Excellent sport is to be found at the mouth of Elkhorn Slough on Monterey Bay near Watsonville. Bait casting from shore brings results in the same locality.

Striped bass take the hook savagely, make runs and sometimes leap from the water, shaking themselves to be rid of the hook. Then they often go to the bottom to sulk. However, the runs of this fish are not so formidable and persistent as those of the steelhead trout and salmon, and the fish is more easily brought to gaff.

In California the same tackle is ordinarily used as is used for salmon. Trolling usually gives the best results in brackish water, but many are taken from the banks of sloughs with hand lines or casting rods. A heavy sinker keeps the hook near the bottom. Bait hooks, plugs and spinners are used. Squid is one of the favorite baits.

In the east the No. 4 or 5 O'Shaughnessy hook appears to be preferred and the white worm or bloodworm is the favorite bait.

Striped bass reach the Napa River and the sloughs in this section from San Pablo Bay by two passages—Mare Island Straits into Shoal Water Bay and Sonoma Creek into the sloughs northwest of Shoal Water Bay. During eight months of the year, September 1st to May 1st, a great many anglers from all sections of the coast states find sport in this region. Many local residents have barks in the sloughs and motor down Saturday afternoons for the week-end fishing. The lower portion of the Napa River is a favorite place, and at Cutting Wharf

several men have boats to hire for this purpose. Cutting Wharf has been taken over by Napa County and put in first-class condition. Ample parking space for autos with gravelled road approaches and comfort stations are provided. On Sundays from 50 to 75 automobiles are frequently parked at this one spot.

"After the heavy rains when the river is washed out, good bass fishing is to be had as far up as the city of Napa. The fishing in 1924 was better in all this section than in any of the past seven or eight years.

"In bait fishing, sardines, clams and bullheads are considered the best. In the sloughs the bass are accustomed to the drawings from wild ducks, hence this makes good bait, as do also breasts of mud hens and skinned small birds such as linnets, sparrows, etc. Bait hooks are usually 5, 6 and 7 sizes. Many artificial lures are used with success—Stewart and Wilson spoons, Nos. 4, 5 and 6; Basseros, Redhead and Lucky 13; Heddon Wiggler, dark or light according to whether the water is clear or turbid at high tide. Trolling is best over the mud flat feeding grounds. From half-tide to low, the channels give best results."—Dr. Robert Crees.

Ed. J. Glos of Napa reports conditions as follows:

"During the late fall and early winter of 1924 the writer had very good success trolling for bass in the main fork of the Napa River above Cutting Wharf. The fish taken were of exceptionally good size, running from 6 to 37 pounds, the majority weighing from 12 to 20 pounds. Most of the females were full of spawn. The lure used was Heddon plug of the silver side variety, scale finish.

"When fishing in deep water, best results were obtained by trolling behind a power boat and using at least 100 yards of No. 9 line with no sinker. It is evident that the fish stay in schools, for once the fisherman gets a strike he will, by continuing to work the spot, get a strike nearly every time his plug passes the same place.

"Many of the fish strike very lightly two or three times before striking hard and many times they get hooked on the outside of the head. They seem to strike more readily on fast tides than on slow tides, and mostly on outgoing tides, although many are caught on incoming tides.

"Anglers using live split-tail and whitefish have good success. Dead bait, such as sardines, clams, etc., are also good. The writer has cleaned bass with almost every variety of food in their stomachs—one time even a chicken foot—showing that they eat almost anything."

Erratic fishing conditions in Napa River are thus described by W. P. West:

"When using a basserino in waters below the town of Napa, the fish are nearly always caught somewhere on the head or under the gills, very seldom in the mouth. It is believed that the fish strike to fight and not for food. It has been observed that one year someone will use a spoon and make a big catch. Immediately everyone uses a spoon and good catches are made by all, while apparently fish can not be caught with anything else at the time. In the season of 1923 a spoon was the best troll, while during 1924 spoons proved of no avail but bass plugs brought results."

Thirty years ago, W. P. West caught a good many bass at the town of Napa, ranging from 10 to 16 inches, using cooked shrimp as bait.

"In later years, pollution from garages and tanneries has ruined fishing of all kinds in the vicinity of Napa except when rains have purified the river; then it is possible to catch fish in town for a few weeks out of the year, whereas formerly they could be taken nearly the year around."

"During the fall of 1924 fish died in Napa River within a radius of six miles from the city of Napa. The stench from the thousands of dead fish floating on the water became so bad that it was necessary to chemicalize the carcasses."

"Years ago bass were so numerous in the lower reaches of Napa's sloughs that a man rowing a boat would strike a fish every few minutes with his oars. In recent years bass fishing in these sloughs has been largely abandoned because almost every slough that formerly afforded good fishing has been levied off. This prevents the bass from reaching well protected spawning and feeding grounds, and, if the practice is continued, it will surely prevent future increase of the species."

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