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STATE OF CALIFORNIA
FISH AND GAME COMMISSION
FISH BULLETIN No. 9
Preliminary Investigation of
The Purse Seine Industry of Southern California

By
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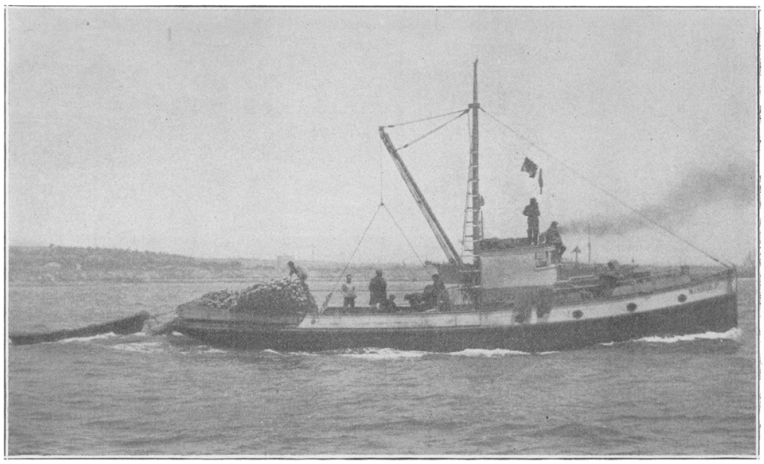

Purse seine boat on its way to the fishing grounds, southern California. Photograph by L. A. Timco, June 12, 1923.

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1. INTRODUCTION

1. STATEMENT OF PROBLEM

In the last few years, the alleged destructive influence of the purse seine industry on the supply of fish in southern California waters has been much discussed among professional fishermen, as well as among other persons interested in our sea fisheries and their future. Articles to the effect that aliens were destroying the natural supply of fish in this region by means of purse seines have been published repeatedly in the newspapers. To quote from one of these articles: "For many of them [the purse seiners] nothing is more pleasing than to enrich themselves at our expense and risk." The most serious complaint against the purse seine fishermen is that, by killing small barracuda in enormous quantities, they are depleting this fish. Another serious complaint is that these men unsettle the market conditions by landing very large individual catches. There is a rather widespread opinion that purse seining for barracuda, white sea bass, and yellowtail should be prohibited in southern California.

Even though it is evident that the complaints are based mainly on hearsay and only to a very little extent on personal and more or less systematic observations, they are too serious to be disregarded. In order to establish the most important facts of the "purse seine problem," the California Fish and Game Commission undertook a preliminary investigation. This was entrusted to me, as a member of the staff of the California State Fisheries Laboratory, and was begun in May, 1922. The present paper is the immediate result of this investigation.

The special problems to be examined were as follows: “1. The present economic condition of the purse seine industry.” “2. The importance of the purse seiners as a source of supply to canneries and fresh fish markets.” “3. The effect of purse seine fishing on the natural supply of fish, with special regard to the barracuda.” “4. The possibilities and results of prohibitive or restrictive legislation against the purse seiners.”

The field to be covered was very extensive and the time at my disposal, for several reasons, very limited. These circumstances, unfortunately, made it necessary to treat several phases of the subject in a very summary way; and others have had to be totally or almost entirely disregarded, for instance, the description of the purse seine boats and of the fishing operations, and problems bearing on the life history of the species involved.

In order to study the fishing operations and the effect of purse seining on the natural supply of fish, I made several trips with different purse seine and gill net boats during six weeks in May and June, 1922. The rest of the time used for the investigation was spent mostly in analyzing the statistical data bearing on the purse seine problem which previously had been collected by the Fish and Game Commission.* The intention

* In California, whenever a fisherman sells fish, the buyer gives him a receipt upon a form issued by the Fish and Game Commission. One copy of this receipt is kept by the buyer, one is returned to the Commission. This system was devised in order to give the Commission actual records, according to boat and day, of all fish caught for profit. These tickets are the basis for the analysis made for this report.

was to analyze data covering a whole year, but lack of time made it necessary to confine the analysis to data extending over a period of six months. The period chosen was January 1 to July 1, 1922.

The term "purse seine boat" has been used in the restricted sense commonly accepted in southern California; *i. e.*, it refers to rather large boats, generally of between twenty-four and forty-two gross tons, furnished with turntables, on which the seine is piled, and purse seines of the type described in the appendix to this report (see frontispiece).

In the analysis, differentiation has been made between purse seine boats and "small boats." A further classification, according to gear, of the small boats, which, of course, would have been highly desirable, was not possible, since necessary data were lacking.

The statistical data for the years preceding 1922 and used in this report are not based on the records published in the quarterly magazine, CALIFORNIA FISH AND GAME, but on revised, unpublished figures from the Commission's archives.

The local names of fish have been used throughout the paper. The scientific names are given in chapter II.

A fairly great number of tables have been included in order to enable the reader to extend the analysis further than has been done in this report.

I take a special pleasure in using this opportunity to thank Mr. W. F. Thompson, in charge of the California State Fisheries Laboratory, for the help he has rendered me during the preparation of this report. In conference with him, I have received many good suggestions, and in several other ways benefited from his extensive knowledge of sea fisheries in general and of those of California in particular. I also wish to thank Mr. Elmer Higgins, Mr. S. H. Dado and other members of the California Fish and Game Commission for their assistance in my work.

The purse seine problem of southern California is of great complexity. Its successful solution is essential to the sound development of the whole fishing industry of this region. I wish to express the sincere hope that this report will contribute to a better understanding of this problem and prove a stimulus to further investigations in this field.

San Pedro, California, January 31, 1923.

2. I. GENERAL CONSIDERATIONS

2.1. 1. Relative importance of the different counties of southern California with regard to purse seine fishing

The term southern California as used in this report includes San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange, and San Diego counties, although this can hardly be regarded as natural from the point of view of physical geography. It probably would have been more rational to leave out San Luis Obispo County. For hydrographical reasons, Point Conception, located in Santa Barbara County, probably forms the most natural point of division between southern and middle California. That in this report San Luis Obispo has been included in southern California is due mainly to the fact that this county is united with Santa Barbara and Ventura counties in the statistical records of the California Fish and Game Commission. However, the question is of minor importance, since San Luis Obispo County plays a very insignificant role in the fishing industry.

of the sixty-five purse seine boats that operated in southern California in 1922, sixty-three belonged to the Los Angeles fishing fleet, and only two had San Diego as their home port. San Luis Obispo, Santa Barbara, Ventura, and Orange counties had no purse seine boats of their own; and as far as known, they have never had any.

That a purse seine boat has a certain town as its home port does not imply, of course, that it always delivers its catches there. It often happens, indeed, that the Los Angeles purse seine fishermen sell their products at San Diego, and that the San Diego purse seiners come to Los Angeles harbor (San Pedro) to seek a market. But, on the other hand, it probably holds true that the fishermen, as a rule, pick as their home port the place where they can and do sell most of their fish.

Table 1 and figure 1 illustrate the relative importance of the different counties of southern California with regard to the barracuda, white sea bass (including the sea trout, see p. 17), and yellowtail fisheries in which the purse seine boats play a very prominent part.

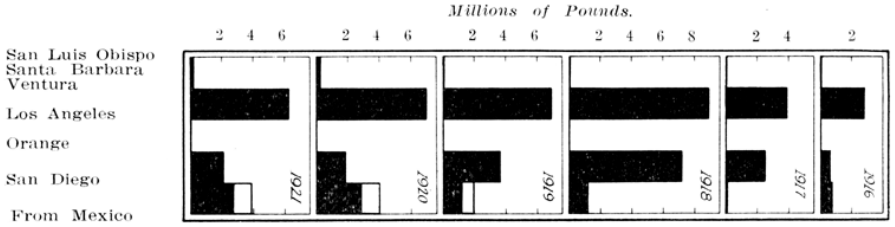

FIG. 1. Total yearly landings of barracuda, white sea bass and yellowtail in southern California according to counties. Of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black. (See Table 1.)

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(See Table 1)

They show that from 1916 to 1921, inclusive, San Luis Obispo, Santa Barbara, Ventura, and Orange counties received but very small yearly catches of the mentioned species. The largest yearly catch during this period landed in San Luis Obispo, Santa Barbara, and Ventura counties amounted to only 304,502 pounds (in 1920), and the highest yearly total for Orange County was only 58,948 pounds (in 1919). Moreover, none of these four counties showed any signs of becoming more influential in these fisheries.

The two remaining counties, Los Angeles and San Diego, on the other hand, were both very important, from 1916 to 1921, inclusive, with regard to the amounts of barracuda, white sea bass, and yellowtail landed. Furthermore, Los Angeles County was always predominant in these fisheries during this period and showed a tendency to become increasingly so. In 1919, for instance, a total of 6,917,070 pounds of barracuda, white sea bass, and yellowtail were caught in local waters and landed in Los Angeles County, as compared to 3,660,568 pounds landed in San Diego county. For 1920, the corresponding values were 6,985,840 pounds and 1,841,080 pounds. (The recent, 1921, slight decrease in Los Angeles County and increase in San Diego County of the amounts of these fish landed was probably temporary and can hardly be considered as significant.) The prominence of Los Angeles County becomes still more conspicuous if

TABLE 1.—Amounts, in Pounds, of Barracuda, White Sea Bass (including Sea Trout) and Yellowtail, Landed in Various Counties of Southern California (see Figure 1).

	San Luis Obispo, Santa Barbara and Ventura counties	Los Angeles County	Orange County	San Diego County	From Mexico
1916	118,582	2,845,416	29,164	670,236	797,535
1917	78,876	3,920,913	36,142	2,522,317	134,854
1918	126,615	8,934,999	12,398	7,241,785	1,246,392
1919	167,506	6,917,070	58,948	3,660,568	1,994,261
1920	304,502	6,985,840	51,680	1,841,080	4,086,809
1921	268,109	6,292,029	34,130	2,147,895	3,887,507

TABLE 1.—Amounts, in Pounds, of Barracuda, White Sea Bass (including Sea Trout) and Yellowtail, Landed in Various Counties of Southern California (see Figure 1)

the fish caught in Mexican waters also is considered. In 1919, out of the 1,994,261 pounds of barracuda, white sea bass, and yellowtail imported to California from Mexico, not less than 1,262,297 pounds were sold in Los Angeles County. In 1920 the corresponding values were 4,086,809 pounds and 2,851,074 pounds. In 1921 they were 3,887,507 pounds and 2,780,297 pounds.

As to the bluefin tuna, which at times has been of the greatest importance to the purse seine industry of southern California, no landings were ever recorded from San Luis Obispo, Santa Barbara, Ventura, and Orange counties. In 1919, not less than 14,952,462 pounds of this fish were sold in Los Angeles County, as compared to 38,398 pounds in San Diego County. In 1920 and 1921, all the bluefin tuna landed in southern California, 10,530,272 pounds and 2,031,648 pounds respectively, was handled in Los Angeles County. In 1922, out of the total catch of 3,326,421 pounds of bluefin tuna, 1,000,064 pounds were landed at San Diego.

The fact that San Luis Obispo, Santa Barbara, Ventura, and Orange counties have no purse seine boats of their own, and the fact that these counties certainly receive but negligible amounts of fish caught by purse seiners, of course, justify the little attention given to them in this report. The decided predominance of Los Angeles County with regard to the barracuda, white sea bass, yellowtail, and bluefin tuna fisheries on which the purse seine industry mainly depends, and the fact that almost all the purse seine boats of southern California use Los Angeles harbor (San Pedro) as their base of operation undoubtedly justify a concentration of this investigation upon the condition of the fishing industry of this county. A careful analysis of the fisheries of San Diego County originally was planned as a part of this work, but lack of time prevented its being carried out. Such an analysis is, of course, highly desirable and should be undertaken as soon as possible.

The present paper, therefore, is mainly an analysis of the fisheries of Los Angeles County, where the purse seine industry is concentrated. While the purse seine industry of Los Angeles County can be considered as representative of the whole purse seine industry of southern California, this county is very different from the remaining counties with regard to the relative amounts of fish landed by boats of different gears. These facts should be kept in mind in studying this report.

2.2. 2. Development of the purse seine industry of southern California

Purse seine fishing was begun in southern California as early as 1893. In that year the first purse seine boat, appropriately named the *Alpha*, was built at Los Angeles for operation in home waters. It was equipped with a purse seine 296 fathoms long and 20 fathoms deep, *i. e.*, of about the same size as those used at the present time, and it fished more or less steadily during several years for mackerel, sardine, yellowtail, and other "white fish." Between 1895 and 1898 two other purse seine boats were built at the same place, but they were in southern California waters for a few years only. These three boats fished mostly for canneries. Their effect on the fresh fish trade was probably very slight.

Purse seine fishing on a relatively large scale was not started in southern California before 1915, when five boats, all built at Los Angeles, one in 1914 and four in 1915, began extensive operations. (An additional purse seine boat was built at Los Angeles in 1914, but it left for Seattle after a few months.) In the two following years four more purse seine boats were completed at the same place, two in 1916 and two in 1917, and immediately joined the fishing fleet of southern California. During these years, from 1915 to 1917 inclusive, purse seine fishing for barracuda, white sea bass, yellowtail, and mackerel was very successful. Purse seining for tuna, on the other hand, was still in the experimental stage. The largest yearly catch of this fish landed by the purse seiners amounted to only about 600,000 pounds (in 1917), according to a statement made by a person well informed about the canning industry of Los Angeles and San Diego. The results clearly established the fact that purse seiners could be used successfully in these waters.

In 1918 eight purse seine boats were built at Los Angeles for operations in home waters, and about the same number came to southern California from Puget Sound. The yield of the purse seine operations for ?? white sea bass, yellowtail, and mackerel was decidedly better than during previous years. Furthermore, very large catches proved conclusively the efficiency of the purse seine method in the bluefin tuna fishery. According to the records of the Fish and Game Commission, not less than 6,240,971 pounds of "tuna" were landed. By far the larger part of this total was made up of bluefin tuna and therefore taken with purse seines. During the "tuna season" most of the purse seiners earned from $1,000 to $2,000 a share.

In 1919 the success of the previous years caused more purse seine boats to come down from the north, and about seventeen were built at Los Angeles and one at San Diego for the home fleet. The yield of the barracuda, white sea bass, yellowtail, and mackerel fisheries continued to increase. During the "tuna season" enormous catches of bluefin tuna were made, allowing the purse seine fishermen a return of about $1,000 to $3,000 a share. According to the statistics of the Fish and Game Commission, 14,990,860 pounds of bluefin tuna were landed. The climax was reached in the economic success of the purse seine fishermen. During the following years these men had to struggle against greater and greater difficulties.

In 1920 the great "boom" in the purse seine industry brought more boats and men from the north to southern California, and about fifteen more purse seine boats were built at Los Angeles for use in local waters.

In that year the fishing fleet of Los Angeles and San Diego probably included more than one hundred purse seine boats; according to a newspaper notice the number amounted to 125.* The "tuna season" was successful as far the total yield was concerned; according to the records of the Fish and Game Commission, not less than 10,530,272 pounds of bluefin tuna were landed. However, the total amount caught was about a third less than that of the previous year; and the decrease in the average catch per boat was still greater, because of the decided increase in the number of operating boats. The yellowtail fishery yielded much less than during the previous years, due probably to the collapse of the demand. While in 1918 not less than 11,515,372 pounds of yellowtail were landed in southern California, and 5,005,265 pounds in 1919, the corresponding amount for 1920 only totaled 2,704,937 pounds (see below, p. 12). The yield of the barracuda and the white sea bass fisheries, on the other hand, increased from 1919 to 1920. of barracuda, local and Mexican, 5,725,160 pounds were landed in southern California in 1919, and 8,095,492 pounds in 1920. For white sea bass the corresponding values were 2,067,928 pounds and 2,469,482 pounds. However, the good results in the last mentioned fisheries hardly balanced the failure, from the viewpoint of the fishermen, of the operations for bluefin tuna and yellowtail. A consequence of these circumstances was that a great number of the purse seiners who had come to southern California from the north were forced to leave these waters.

In 1921 the situation went from bad to worse. The bluefin tuna operations failed; only 2,031,648 pounds were landed. The yield of the yellowtail fishery amounted to only 2,490,796 pounds, and the total landings of barracuda declined to 7,625,091 pounds. Only the white sea bass fishery was more successful; 2,513,783 pounds, local and Mexican, were landed. Probably between sixty-five and eighty-five purse seine boats were operating, and only one purse seine boat was built at Los Angeles.

In 1922 the bluefin tuna fishery gave a somewhat better return than in the previous year; a total amount of 3,326,421 pounds was recorded. In spite of this fact it was disastrous to the purse seine industry. Out of about fifty purse seine boats that went out for bluefin tuna, only a few were comparatively successful; most of them did not even cover their expenses for equipment, upkeep, and operations. The failure was so decided, indeed, that many of the fishermen expressed their intentions not to take any more chances on this fishery. The "white fish" operations, *i. e.*, the operations for barracuda, white sea bass, yellowtail, and mackerel, were of moderate success; the final annual totals are, however, not available at the present writing. The number of purse seine boats operating during a longer or shorter period of the year was sixty-five. About twenty purse seine boats were either tied up or running as tenders for various canneries during the time of the tuna and albacore operations. No purse seine boats were built.

The amount of money invested in the purse seine industry of southern California is considerable. In 1920, when, as previously mentioned, more than one hundred purse seine boats were operating in the waters of this region, it probably approximated $2,000,000. The larger part

* Because of the incompleteness of the boat registration of the Fish and Game Commission, it is unfortunately impossible to give the actual number of purse seine boats operating from 1919 to 1921 inclusive.

of this money was invested by the fishermen themselves. It was their life savings these men put into the industry.

During the unsuccessful years the purse seiners had to borrow more and more money, mainly from bankers and canners, in order to be able to continue their operations. Their economic losses during the years 1920, 1921, and 1922 were very heavy. At the present time only about half a dozen of the purse seine boats of southern California are independent. The rest are more or less heavily mortgaged to, or owned by, banks, canneries, or other corcerns. This fact should be remembered when the purse seiners are being denounced as aliens prospering at the expense of Americans.

A few examples, picked out at random and based on inquiries among the owners of the purse seine boats, may suffice to illustrate the economic condition in this industry.

Example 1: A boat and one purse seine cost $19,500 in 1919, toward which the captain forwarded $14,000, the balance of $5,500 being a mortgage on the boat and net. The mortgage has been increased to $8,000, covered only by the present value of the boat and net, which is between $3,000 and $5,000 if the creditors force the sale at auction. Applying the value of the boat and net on the mortgage, the captain finds himself still in debt to the amount of between $3,000 and $5,000, a large part of the original debt, and without any part of his original investment of $14,000, therefore with a total loss of between $17,000 and $19,000.

Example 2: A boat and one seine cost $21,000 in 1920; four fishermen invested $11,000; present mortgage, $6,000; present probable value of boat and net if sold at forced auction, between $3,000 and $4,000; results, besides losing their investment, the fishermen are between $1,000 and $3,000 in debt.

Example 3: A boat and one seine cost $18,500 in 1920; three fishermen invested $12,000; present mortgage, $10,000; present probable value of boat and net if sold at forced auction, between $3,000 and $4,000; result, besides losing their investment, the fishermen are between $6,000 and $7,000 in debt.

Example 4: A boat and one seine cost $15,000 in 1920; four fishermen invested $8,000; present mortgage, $11,500; present probable value of boat and net if sold at forced auction, between $3,000 and $4,000; result, besides losing their investment, the fishermen are between $7,500 and $8,500 in debt.

However, not only the purse seine fisherman, but almost everybody economically interested in this industry, has had to stand more or less heavy losses. The only reason for continuing the purse seine operations, besides the importance of the catch to the fish trade, is the fact that the purse seine boats are not usuable for other fisheries, and a continuance is the only hope of return on the investment.

The extraordinary growth of the purse seine industry of southern California undoubtedly was largely due to the war "boom" in the canning industry. Its rapid decline certainly was not caused by the overfishing of the species, on which it depends (see below, pp. 50, 61, 70, and 74). Many circumstances have contributed to bring it about. A more or less full discussion of the contributing factors would lead too far; a mere enumeration of the most important ones must suffice. The prices of gear, machinery and oil, the cost of repair and overhauling, in short, the

cost of operation, which during the last years of the World War had become extremely high, showed during 1919, 1920, and 1921, no, or very little, tendency to fall. At the same time the intense competition between the many boats brought about a recurrent oversupply in the market, causing a considerable decrease in the wholesale prices of fish. Strikes broke out among the boat pullers during the best fishing seasons. Canned yellowtail proved to be unsuccessful in the market. In 1918 (according to one estimation, see below, p. 71) not less than about 7,000,000 pounds of this fish were canned in southern California in the flush of the war demand, in 1919 only about 4,000,000 pounds, in 1920 about 400,000 pounds, and in 1921 and 1922 practically nothing. The bluefin tuna operations of 1921 and 1922 failed, probably due to natural fluctuations in abundance. At the same time the demand for this fish declined.

It may be just to say that the purse seine industry of southern California became a victim of the economic crisis following the war "boom." It grew and collapsed as a result of market conditions. If conditions do not improve in the near future, the short, meteor-like history of the purse seine industry of southern California probably will be brought to a sudden end. However, the development of superior and more economical types of boats and methods may possibly result in the evolution of a new fleet upon the ruins of the old.

2.3. 3. Cost of operation of purse seine boats

Purse seine fishing is to be considered relatively expensive. Even among the purse seine fishermen themselves, one often hears the opinion expressed that this method is too costly to be maintained.

The following summary illustrates this phase of the purse seine problem.

Boat: During the past few years (1917–1921), the building of a purse seine boat, as a rule, has cost between $10,000 and $15,000; in exceptional cases as much as $20,000 has been paid. The boat has to be put on the ways three or four times a year, costing each time (in 1922) about forty to fifty dollars, the fishermen doing most of the work themselves. To this is to be added the cost for extra repair work, which often amounts to a considerable sum yearly.

Seine: Two purse seines are required, one for the bluefin tuna and one for the "white fish," *i.e.*, barracuda, white sea bass, yellowtail, and mackerel. The tuna seines are about 240 to 320 fathoms long and 23 to 34 fathoms deep, stretched web, and their web is stronger and has larger mesh than the web of the seines for white fish. The seines for white fish are about 200 to 250 fathoms long and 12 to 24 fathoms deep, stretched web. (For further information about the purse seines, see the detailed descriptions in the appendix to this report.) A new purse seine costs, on the average, between $4,000 and $5,000. The web is the most expensive part of the seine. In the tuna seines, as a rule, the web must be renewed every season, at least in part, and in the white fish seine every second or third season. Furthermore, it happens rather frequently that parts of web and ropes are lost by accidents due to submarine rocks, strong currents, and other causes.

Fuel, etc.: Most of the purse seine boats operating in southern California are equipped with "Standard" motors, generally of about 50 to

85 horsepower, which in most cases use distillate for fuel, sometimes a mixture of distillate and gasoline, very seldom pure gasoline. This "Standard" engine is supposed to require about one-tenth of a gallon of distillate per horsepower an hour; an engine of 50 horsepower, therefore, should use about five gallons of distillate an hour. It is, however, a matter of fact that, for one reason or another, more distillate is consumed. When run at full speed, a "Standard" engine of 50 horsepower in most cases probably requires about seven gallons of distillate per hour (or about six gallons of gasoline). When run at about half speed, a speed often used on the fishing grounds, the same engine averages about four to five gallons of distillate. of lubricating oil it requires about one gallon every three hours. Supposing seven gallons of distillate and one-third of a gallon of lubricating oil had been used by the 50 horsepower "Standard" engine which was picked out as an example, then the running expenses per hour would have amounted to about $1.32 during the summer of 1922, when the distillate cost sixteen cents and the lubricating oil 59.5 cents a gallon.

A few purse seine boats are equipped with crude oil engines. When crude oil is used, the cost of fuel is comparatively low. As an example may be mentioned a purse seine boat in which recently a 90 horsepower "Atlas-Imperial" crude oil engine was installed. According to a statement given by the owner of this boat, the cost of fuel for this engine averaged about twenty-five cents or somewhat less an hour in the summer of 1922.

The expense for fuel and lubricating oil is a very important factor to reckon with, because of the long distances to be covered by the purse seiners during their fishing trips. In 1921 the average oil bill for a fishing trip to Mexico was $170 for a purse seine boat with a 50-horsepower "Standard" engine and- $33 for the boat mentioned above furnished with an "Atlas-Imperial" crude oil engine.

Other running expenses: In the case of a fishing trip to Mexico, there were, in the summer of 1922, the following extra expenses: ice, about $90 to $100 ($1 per block of ice); Mexican fishing license, monthly, $25; clearance, $21.45; entry, $3.50.*

Insurance: Most of the boats pay about $400 a year for insurance.

Wages: The gross income is divided into twelve or thirteen shares, according to the number of men in the crew; twelve, when, besides the captain, seven men are hired; thirteen, when eight men are hired. The captain and the boat pullers receive one share each, four shares go to the boat and the net.

As a result of their expensive method of fishing, the purse seiners depend on large yearly catches. Competition between a great number of purse seine boats is very likely to bring about recurrent oversupply of the fresh fish markets. This will cause a lowering of the wholesale prices, a decline which, under the present conditions, almost certainly will mean ruin for many or most of the boat owners.

* Since 1922, (written in December, 1924) the expenses for a purse seine boat operating in Mexican waters are as follows: monthly Mexican license, $27.50; yearly license for each member of the crew, $1.10; clearance from San Perdo, $25.50; entry at San Pedro, all charges, $8.27; Mexican entry and clearance are additional fees; Mexican duty per ton of fish exported, $30.

2.4. 4. Number and nationality of the purse seine fishermen

Unfortunately, it is impossible to give with full accuracy the number of fishermen in southern California who at the present time depend on purse seine fishing for their living. No records on this question are available. A license for commercial fishing entitles a person to use any lawful fishing gear; and furthermore, the crews of the purse seine boats always are changing.

In order to handle a "white fish" seine efficiently, six or seven men are required, besides the captain; the handling of a tuna seine requires seven or eight men, besides the captain. The full crew of a purse seine boat, therefore, is made up of seven to nine men. In 1922 there were sixty-five purse seine boats fishing. If all these boats had been operated at the same time, probably about 500 men would have been needed. However, this was not the case; most of the boats were operated only during relatively short periods of the year. The number of men wholly or partially dependent on the purse seine trade in southern California, therefore, probably did not exceed 300 to 350 in 1922.

The number of our purse seine fishermen is presumably declining. There is a growing disinclination among these men to continue in their trade because of the great uncertainty with regard to wages. It is hardly possible for a man to support a family on purse seining under present conditions. It is a fact worth consideration that most of the purse seine fishermen of southern California are single.

The great majority (probably about 90 per cent) of our purse seiners are Jugo-Slavs ("Austrians"), mostly from Dalmatia; about 7 per cent to 8 per cent of them are Scandinavians, in most cases Norwegians; a very small number only are born Americans. The Jugo-Slavs are, as a rule, still aliens, while most of the Scandinavians are naturalized.

It may be worth mentioning in this connection that the greater part of our gill net fishermen are Italian, and that our round haul fishermen in most cases are Italian and Japanese. The majority of the Italian gill net and round haul fishermen probably are aliens. of course, other nationalities also are represented among these men.

2.5. 5. Effect of the purse seine fishery in southern California on animals and plants living on or near the sea bottom and not utilized by the fishermen

A complaint against the purse seiners often heard is that they are destructive to the "feeding grounds" of the commercial fish. Therefore, it may not be out of place to devote a few lines to this subject in the present report, although no systematic investigations have been carried out as yet along these lines.

The complaint *possibly* may be justified in the case of purse seine operations in regions with relatively shallow waters, and with a rich and more or less low-growing bottom vegetation. It should be remembered, however, in this connection that in European countries using the otter trawl such damage is not held to be considerable. See also the decided views on this question expressed by Alexander, Moore, and Kendall in their report on the "Otter Trawl Fishery."* In the case of southern California, the complaint probably contains no, or but very little truth. This statement is based mainly on the following observations:

* Report United States Bureau of Fisheries 1914, Document 816, page 43.

1. Purse seine operations for bluefin tuna are undertaken almost exclusively in deep water, where the seine can not possibly reach the bottom.

2. Purse seining for barracuda, white sea bass, and yellowtail, on the other hand, almost always is carried on inside the three-mile limit. Generally speaking, the depths in these regions vary between seven and twenty-five fathoms. The bottom is made up largely of sand and gravel, mixed with broken shells, and has no or very scanty vegetation and a fairly poor invertebrate fauna. The purse seines used for barracuda, white sea bass, and yellowtail are comparatively narrow. It should be remembered that the width given in one of the previous pages, 12–24 fathoms, represents stretched web; it also should be remembered that the purse seines are built in such a way as to make the web slant somewhat toward the center of the seine when this is laid out in a circle in the water; for further information on this point, see the description of the purse seine given in the appendix to this report. From what I have seen and heard during the time of this investigation, it seems probable that in most hauls for barracuda, white sea bass, and yellowtail, the purse seines do not touch the bottom, and that, when they touch it, they do so fairly lightly. Furthermore, whenever a haul is made in waters so shallow that the seine reaches the bottom when laid out, the lower edge of the seine is raised (straight up) from the bottom after a few minutes' pursing. Generally speaking, only very small quantities of bottom invertebrates are caught and destroyed during such hauls. Only twice during the purse seine hauls (about fifteen) which I observed in the summer of 1922, had bottom invertebrates become entangled in the web. These animals, a few starfishes (Asteropecten), were thrown overboard and certainly survived.

It very seldom happens that the kelp beds, the extensive submarine pastures of southern California, are disturbed by the purse seiners. The danger of losing parts of the seine by getting the seine tangled up in the tough kelp is altogether too great. During one of my trips on board a purse seine boat in the summer of 1922, we remained for two days outside a kelp bed in which a school of about fifteen tons of big white sea bass had been located. The fish clearly could be seen swimming around among the kelp. The fishermen waited in vain for the fish to come outside the kelp bed and left without having made any haul. A few days before we arrived, two purse seine boats had tried to catch this school in the kelp bed but had only succeeded in getting their seines torn.

On the other hand, from what I have observed during my fishing trips, it seems likely that considerable quantities of cheap fish and fish illegal to market are killed by the purse seiners without being utilized. On several occasions I saw rather large quantities (one to several hundred pounds) of kingfish (Genyonemus lineatus) and yellowfin croaker (Umbrina roncador) accidentally caught and thrown overboard. As far as I was able to judge, the great majority of these fish were killed.* It is not probable, however, that the purse seiners do more damage to these fish than some other gear, such as the Italian and the Japanese round haul nets. It is a fact not generally appreciated that all marine fisheries are extremely wasteful and can not be carried on under present

* I should like to recommend in this connection regulations allowing the utilization of croakers accidentally caught during purse seine and round haul operations. The simplest way probably would be to allow the fishermen to land a limited daily amount of those fish.

market conditions without being so. The great halibut fisheries of the North Pacific destroy more fish than they take. The quantity of culled fish from the otter trawl fisheries of the Atlantic is enormous, and for many years vast amounts of very young plaice, haddocks, cod, etc., have been destroyed and marketed. The destruction by the purse seine fleet in southern California, of cheap fish, fish illegal to market, and young fish is not comparable in any respect.

3. II. THE PURSE SEINERS AS A SOURCE OF SUPPLY OF FISH

3.1. 1. Relative importance of different kinds of fish

In order to establish the relative importance of all the different kinds of commercial fish landed in southern California, Table 2 has been prepared, presenting the average yearly landings for the period of 1919, 1920, and 1921. The annual yield of each species is, of course, subject to fluctuations, brought about by natural and commercial factors. Indeed, during the last few years such fluctuations have been very great in the case of the bluefin tuna and the yellowtail. In spite of this fact the values presented in the table may be considered as representative. In figure 2 the average yearly landings of the most important of these fish are represented graphically.

TABLE 2.—Fish Products of Southern California (including San Luis Obispo County). Average yearly catches, in pounds, for 1919, 1920, and 1921. (See Figures 2 and 3.)

	Los Angeles County	Southern California	Mexico	Southern California and Mexico
Sardine	35,348,139	44,128,571	1,062	44,129,633
Albacore	13,148,252	15,901,373	26,691	15,928,064
Tuna, bluefin	9,151,516	9,164,315	19,945	9,184,260
Barracuda	2,947,039	4,335,810	2,812,771	7,148,581
Skipjack	3,150,908	5,319,118	9,115	5,328,232
Halibut	1,289,859	2,411,650	1,775,525	4,187,175
Yellowtail	1,989,645	3,165,975	234,357	3,400,333
Tuna, unclassified	1,319,212	2,941,562	223,998	3,165,560
Mackerel	2,191,214	2,479,451	53,155	2,532,606
Sea Bass, white	1,786,280	2,059,005	270,428	2,329,433
Rockfish (rock cod)	1,046,148	1,824,549	70,678	1,895,227
Bonito	1,084,858	1,269,863	294,829	1,564,692
Tuna, yellowfin	1,008,843	1,008,862	174,712	1,183,574
Grayfish	76,502	527,279	4,209	531,489
Smelt	144,350	354,988	9,386	364,374
Rockbass	179,917	335,111	6,378	341,488
Kingfish	324,672	332,691	786	333,477
Anchovies	197,282	307,389		307,389
Sea bass, black	44,274	101,354	52,225	153,579
Sole	72,993	113,358	479	113,837
Stingaree	68	80,672	8,295	88,967
Perch	56,416	64,602	5,602	70,204
Sculpin	33,717	39,725	104	39,829
Pompano	31,152	31,504	200	31,704
Whitefish	14,965	21,563	2,159	23,722
Croakers	23,209	23,211	98	23,310
Sea trout	8,682	15,662	5,302	20,964
Sheepshead	4,711	18,766	55	18,821
Swordfish	14,297	15,098	91	15,189
Mullet	190	10,327	4,522	14,848
Flounders	7,771	11,341	258	11,599
Sandabs	8,808	10,051		10,051
Skates	4,400	5,005		5,005
Carp	17	2,593		2,593
Boccaccio		1,566		1,566
Cultus cod	777	1,380		1,380
Greenfish	939	939		939
Herring		126		126
Eels		60		60
Sablefish	44	50		50
Shad	8	8		8
Salmon	3	3		3
Surf fish	3	3		3
Miscellaneous	171,975	247,427	6,335	253,762
Totals	76,884,058	98,683,957	6,073,748	104,757,706

TABLE 2.—Fish Products of Southern California (including San Luis Obispo County). Average yearly catches, in pounds, for 1919, 1920, and 1921. (See Figure 2 and Figure 3.)

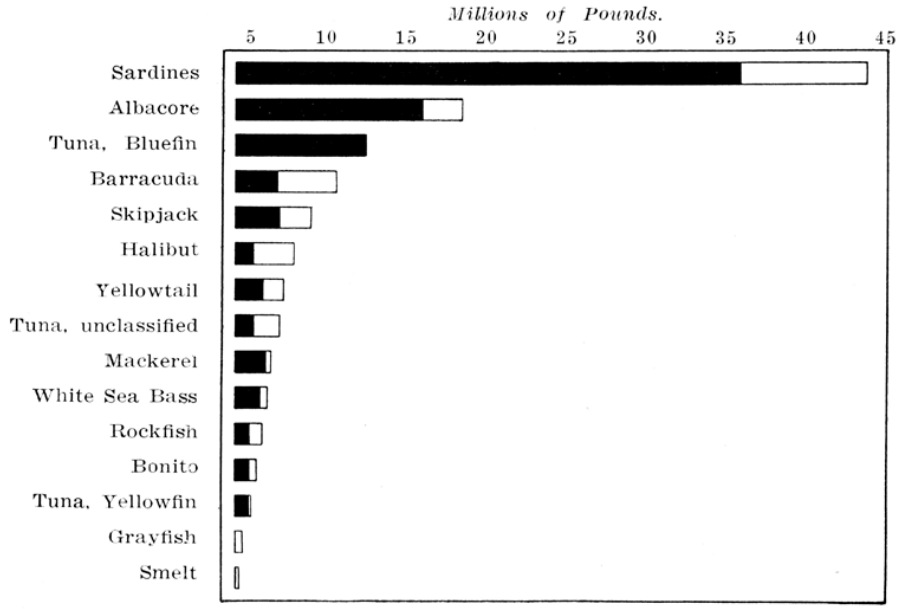

FIG. 2. Relative importance of common marine fish in southern California. Average annual landings for the years 1919 to 1921. Black, of local origin landed in Los Angeles County. (See Table 2.)

FIG. 2. Relative importance of common marine fish in southern California. Average annual landings for the years 1919 to 1921. Black, of local origin landed in Los Angeles County. *(See Table 2)*

The table and the figure show that the sardine (Sardinea caerulea) overshadows vastly all the other species. Out of the grand total, 104,757,706 pounds, not less than 44,129,633 pounds, 42.1 per cent, are made up of sardines.

Next to the sardine in importance is the albacore (Thunnus alalunga), representing about 15.2 per cent of the grand total.

The third place is occupied by the bluefin tuna (Thunnus thunnus). of this fish, on the average, 9,184,260 pounds, *i. e.*, 8.8 per cent of the grand total, were landed during these three years. This comparatively high value is due to the large catches made in 1919 and 1920.

Only as number four in importance comes the barracuda (Sphyraena argentea), the species with which this report primarily is concerned. Its total is 7,148,581 pounds, *i. e.*, 6.8 per cent.

After the barracuda comes the skipjack (Katsuwonus pelamys), with 5.1 per cent of the grand total, followed by the California halibut (Paralichthys californicus) with 4.0 per cent.

of the yellowtail (Seriola dorsalis), on the average, as much as 3,400,333 pounds, *i. e.*, 3.2 per cent were landed during these three years. This comparatively high value is due to the exceptionally large yearly catch in 1919, *viz.* 5,005,265 pounds.

Under the term "tuna," unclassified, both bluefin tuna (Thunnus thunnus) and yellowfin tuna (Thunnus macropterus) are included; it can not be established which of the two species makes up the larger part of this item.

of the remaining species the most important are arranged in the following order: Mackerel (Scomber japonicus and Trachurus symmetricus), 2.4 per cent of the grand total; white sea bass (Cynoscion nobilis), including the "sea trout," which is a name for the young white sea bass, frequently used by southern California fishermen and dealers,

2.2 per cent; rockfish or rock cod (various species of the genus Sebastodes), 1.8 per cent; bonito (Sarda chilensis), 1.5 per cent; yellowfin tuna (Thunnus macropterus) 1.1 per cent; grayfish (various kinds of sharks, probably mainly Squalus sucklii), 0.5 per cent; smelt (several species belong to the family Atherinidae), 0.3 per cent.

3.2. 2. Species handled by the canneries

of the various species enumerated in the previous subchapter, the three most important ones, viz., the sardine, the albacore, and the bluefin tuna, are handled almost solely by the canneries. The skipjack, the bonito, and the yellowfin tuna also are utilized mainly for canning purposes.

of the barracuda, a comparatively small percentage is canned as "fish cake." The amounts of this fish received by the canners vary widely from year to year, depending on the market conditions. According to the records of the Fish and Game Commission, which are based on the reports of the canners, the following amounts were packed during the period 1916 to 1921 inclusive: in 1916, nothing; in 1917, 7021 cases, 6850 cases at San Pedro and 171 cases at San Diego; in 1918, 24 cases at San Diego; in 1919, 8 cases at San Pedro; in 1920, 676 cases at San Pedro, and in 1921, 11,497 cases at San Pedro. On the average about twenty cases of fish cake correspond to 1000 pounds of fresh fish. As to the reliability of these figures, comparisons should be made with similar figures given for the yellowtail on page 71. In the first six months of 1922, out of the 2,999,455 pounds* of barracuda landed at San Pedro, 376,004 pounds, or 12.5 per cent, were used for fish cake.

The amounts of yellowtail canned annually between 1916 and 1921 inclusive, are presented in tables 39 and 40. In 1918 the canning of this fish was very important, but during the last two years this industry had to cease because of unfavorable market conditions.

As to the amounts of fish reduced to fertilizer by the canneries, see chapter III. However, it may be mentioned here that the grayfish and stingaree landed are largely used for reduction purposes.

From the statements given above it is evident that, of the fish landed in southern California, by far the greater part (approximately 75 per cent) is handled by the canneries.

3.3. 3. The purse seiners as a source of supply of fish to the canneries

of the fish used for canning purposes the sardine, the albacore, and the skipjack are taken almost solely with small boats; the sardine is taken with round haul nets, the albacore and the skipjack with troll, *i. e.*, with hook and line. Almost all bluefin tuna are taken by purse seiners, who also land a large portion of the yellowfin tuna and the bonito used in the canning industry. A rather large portion of yellowfin tuna is taken with troll from small boats. of the barracuda made into fish cake probably about half is taken by the purse seiners; the rest is caught mainly by the Japanese round haul fishermen. In the

* According to the published records of the California Fish and Game Commission, 3,060,802 pounds of barracuda were landed in Los Angeles County. The discrepancy of 61,347 pounds between this amount and the amount given above is due to the fact that the published records of the Fish and Game Commission include *all* barracuda landed in Los Angeles County as a whole, whereas I have disregarded the spoiled fish and included only the landings at San Pedro.

first six months of 1922 the purse seiners caught 161,242 pounds, that is 42.9 per cent, out of the 376,004 pounds of barracuda used for canning.

From the above summarized statements it is evident that the small boat fishermen land by far the larger portion (approximately 85 per cent) of the fish used in the canneries. However, the purse seiners are of a very great importance to the canning industry because of their ability to catch the bluefin tuna.

3.4. 4. Species handled by the fresh fish markets

When compared to the canning industry, the fresh fish trade of southern California is of a relatively small importance. Only about 25 per cent of all the fish landed is handled by the fresh fish markets. The relative importance of the various kinds of fish which principally are sold to the fresh fish markets is represented graphically in figure 3. This figure is based on the values given in Table 2 and therefore represents the yearly averages for 1919, 1920 and 1921.

The figure clearly shows that during these three years the barracuda was vastly more important to the fresh fish trade than any other species. The average yearly landing of this fish, local and Mexican, was 7,148,581 pounds. By far the greater (approximately 90 per cent) of this amount was handled by the fresh fish markets. More than half of the amount was of local origin, the rest was taken by California fishermen in Mexican waters (see further, page 41).

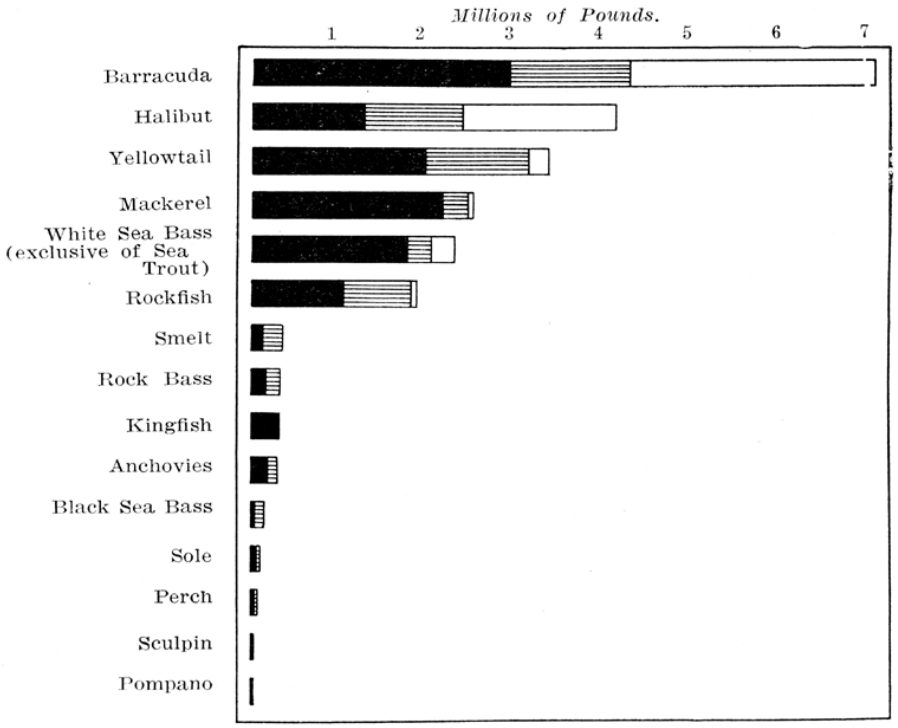

FIG. 3. Relative importance of fish handled by fresh fish markets in southern California. Average yearly catches for 1919, 1920, and 1921. Black, of California origin landed in Los Angeles County; shaded, of California origin but landed elsewhere in southern California; white, of Mexican origin. (See Table 2.)

FIG. 3. Relative importance of fish handled by fresh fish markets in southern California. Average yearly catches for 1919, 1920, and 1921. Black, of California origin landed in Los Angeles County; shaded, of California origin but landed elsewhere in southern California; white, of Mexican origin. (See Table 2.)

Next in importance was the California halibut with an average yearly landing of 4,187,175 pounds. This species is handled by the fresh fish markets only. A large portion, almost half, of the amount landed was taken by California fishermen in Mexican waters. The amount caught locally and sold in Los Angeles County did not even equal half the corresponding amount of barracuda.

The yellowtail also occupied a very important position, with a yearly average landing of 3,400,333 pounds. During 1920 and 1921, however, the annual amounts of this fish were comparatively small, viz., 2,704,937 pounds and 2,490,796 pounds, respectively. In 1920 and 1921 almost all the yellowtail landed was sold to the fresh fish markets; only relatively small amounts were canned. (See page 71.) Only a small portion of the yearly catch was taken by California fishermen in Mexico. The amount caught locally and landed in Los Angeles County surpassed the corresponding value for the halibut. (See also page 67.)

The yearly average for the mackerel was 2,532,606 pounds. This species is handled by the fresh fish markets only. By far the larger portion of the amount landed was taken in local waters and landed in Los Angeles County.

The white sea bass, which never is used for canning purposes, also was very important to the fresh fish trade. The average catch during 1919, 1920, and 1921 was 2,329,433 pounds, exclusive of the 20,964 pounds of sea trout. The supply imported from Mexico was of little consequence. Most of the fish was taken locally and landed in Los Angeles County. (See also page 57.)

of rock fish or rock cod the average annual total was 1,895,227 pounds, most of which was caught in California waters. The species included in this category never are used in the canning industry.

All the remaining species were of minor importance to the fresh fish trade.

Although, as previously mentioned, the fresh fish trade is not so highly developed as the canning industry with regard to the total amount of fish utilized, it nevertheless is of vital import, and its further development should be followed carefully. While, to a very large extent, the canned products are shipped out of the state, most of the products handled by the fresh fish markets serve to fill the growing demands of our home population.

3.5. 5. The purse seiners as a source of supply of fish to the fresh fish markets

As we have seen from the last subchapter, the barracuda, the white sea bass, and the yellowtail are among the most important species in the fresh fish trade. Table 3 and Table 4, and figure 4 and figure 5 present the results of an analysis of the catches of these three fish, considered as a whole, landed at San Pedro during the first six months of 1922. In the tables are given the monthly and weekly amounts, the amounts taken in local (California) waters, and the amounts landed by purse seiners.

TABLE 3.—Monthly Amounts, in Pounds, of Barracuda, Yellowtail, and White Sea Bass Landed at San Pedro between January 1, and July 1, 1922.

	Totals sold in markets	Caught locally by all gears		Caught by purse seine, both local and Mexican	
		Amounts	Per cent of total	Amounts	Per cent of total
January	440,474	8,410	1.9	413,954	94.0
February	261,015	82,038	31.4	254,996	97.7
March	878,634	537,296	61.2	710,465	80.8
April	592,661	592,661	100.0	505,419	85.3
May	1,139,624	1,139,624	100.0	716,303	62.9
June	979,811	979,811	100.0	193,706	19.7
Totals	4,292,219	3,339,840	77.8	2,794,843	65.1

TABLE 3.—Monthly Amounts, in Pounds, of Barracuda, Yellowtail, and White Sea Bass Landed at San Pedro between January 1, and July 1, 1922

TABLE 4.—Weekly Amounts, in Pounds, of Barracuda, Yellowtail, and White Sea Bass Landed at San Pedro January 1, and July 1, 1922.

	Totals sold in markets	Caught locally by all gears		Caught by pur both local and	
		Amounts	Per cent of total	Amounts	Percen of tota
January 1-7	126,061	147	0.1	125,984	99.9
January 8-14	103,332	486	0.5	95,908	92.8
January 15-21	59,705	6,655	11.1	42,437	71.1
January 22-28	130,984	1,088	0.8	129,267	98.8
January 29-February 4	45,651	119	0.3	45,532	99.7
February 5-11	13,291	298	2.2	12,993	97.6
February 12-18	94,901	29,252	30.6	92,748	97.7
February 19-25	78,669	28,264	35.8	75,232	95.6
February 26-March 4	142,778	29,590	20.7	138,449	97.0
March 5-11	87,524	23,758	27.1	72,480	82.8
March 12-18	88,844	26,591	29.9	84,522	95.1
March 19-25	299,769	204,076	68.1	241,886	80.7
March 26-April 1	334,400	303,206	90.7	247,030	73.9
April 2-8	90,285	90,285	100.0	82,010	90.8
April 9-15	31,004	31,004	100.0	26,343	85.0
April 16-22	223,316	223,316	100.0	180,823	81.0
April 23-29	222,270	222,270	100.0	191,190	86.0
April 30-May 6	246,234	246,234	100.0	224,884	91.3
May 7-13	229,314	229,314	100.0	193,474	84.4
May 14-20	153,905	153,905	100.0	107,086	68.6
May 21-27	387,944	387,944	100.0	161,440	41.6
May 28-June 3	208,401	208,401	100.0	39,839	19.1
June 4-10	366,625	366,625	100.0	72,531	19.7
June 11-17	296,903	296,903	100.0	46,223	15.6
June 18-24	118,399	118,399	100.0	32,663	27.6
June 25-30	111,710	111,710	100.0	31,869	28.5
Totals	4,292,219	3,339,840	77.8	2,794,843	65.1

TABLE 4.—Weekly Amounts, in Pounds, of Barracuda, Yellowtail, and White Sea Bass Landed at San Pedro January 1, and July 1, 1922

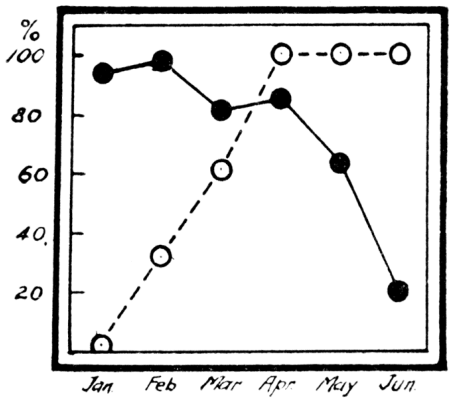

FIG. 4. Solid black, percentage of barracuda, white sea bass and yellowtail landed at San Pedro by the purse seiners; based on monthly totals, 1922. Open-faced, percentage of barracuda, white sea bass and yellowtail caught locally by all types of boats and landed at San Pedro; based on monthly totals, 1922

The analysis shows that the fresh fish markets are almost entirely dependent on the purse seiners for their supply of these threee fish during the first four months of the year (Fig. 4). In January, 94.0 per cent of the total amount of these fish landed was taken with purse seine boats. For February the corresponding figure was even as high as 97.7 per cent; for March it was 80.8 per cent; and for April 85.3 per cent. In May the small boats began to play a more important role, landing 37.1 per cent of the total catch; and in June as much as 80.3 per cent of the amount of these three fish landed was taken with these boats. During the period from January 1 to July 1, 1922, of the total amount recorded, 65.1 per cent was landed by the purse seiners.

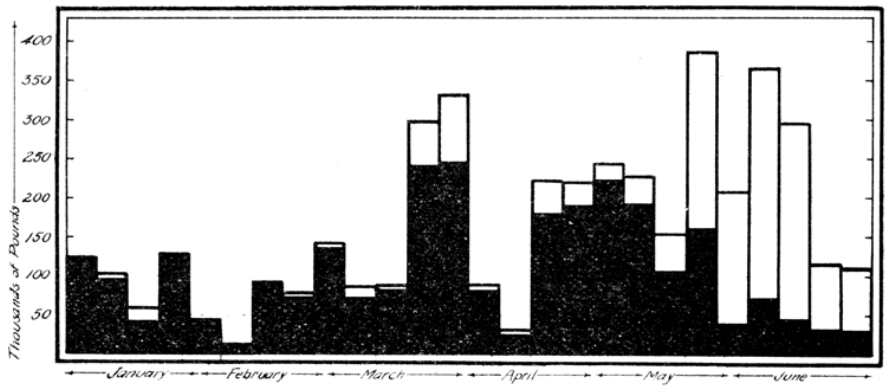

FIG. 5. Comparison of the amount of barracuda, white sea bass and yellowtail caught by purse seiners and that taken by other boats. Black, weekly landings by purse seiners at San Pedro, 1922. White, weekly landings by other boats at San Pedro, 1922.

FIG. 5. Comparison of the amount of barracuda, white sea bass and yellowtail caught by purse seiners and that taken by other boats. Black, weekly landings by purse seiners at San Pedro, 1922. White, weekly landings by other boats at San Pedro, 1922

The analysis also shows that 77.8 per cent of this fish was caught in local waters. Most of the local fish was caught during May and June, *i. e.*, when the small boats were predominant. On the other hand, during January and February, when the purse seiners almost had the field to themselves, most of the barracuda, white sea bass, and yellowtail landed in California was taken in Mexican waters; in January the local catch amounted to only 1.9 per cent of the monthly landing.

No such analysis of the landings of the barracuda, the white sea bass, and the yellowtail has been undertaken as yet for the last six months of the year, and the following statements are based on information gathered from fishermen and dealers, on personal observations, and on the records of the Fish and Game Commission.

In July the small boats continue to be predominant. This is true especially in the case of the barracuda fishery and, to somewhat less extent, in the case of the white sea bass fishery. of the yellowtail but small quantities are landed during that month. In August the importance of the small boats declines very decidedly. The gill netting for

barracuda ceases at about the middle of the month. of yellowtail only small catches are landed, and, furthermore, most of this fish is taken with purse seine. From the middle of August to the end of the year the importance of the purse seiners as a source of supply of barracuda, white sea bass, and yellowtail, generally speaking, increases steadily. During November and December their role is about the same as in January and February; *i. e.*, almost all the barracuda, white sea bass, and yellowtail landed during these two months is taken with purse seine. It should be mentioned, however, that Japanese round haul fishermen and hook and line fishermen contribute considerably to the supply of yellowtail in the fresh fish markets during October and November.

In July and August almost all the landings of these three fish are from local waters. From September to the end of the year the Mexican supply of these fish becomes increasingly important; very large quantities of Mexican barracuda are landed in southern California during October, November, and December. In other words, during the last half of the year, just as during the first half, the percentage of barracuda, white sea bass, and yellowtail taken with purse seine is high in the months during which the percentage of these fish taken locally is low, and *vice versa;* and the percentage of these fish taken with small boats is high, when the percentage of local fish is high, and *vice versa.*

No halibut is taken with purse seine. However, it happens occasionally that the purse seine fishermen, leaving their seine at home, go out fishing for halibut with their boats. In such cases they generally go down to Mexico. Thus, out of the 1,196,091 pounds of halibut, local and Mexican, landed in Los Angeles County from January 1 to July 1, 1922, 119,841 pounds, *i. e.*, 10 per cent, were taken with purse boats. This amount does not include the landings by former purse seine boats rebuilt for halibut fishing.

TABLE 5.—Monthly Amounts, in Pounds, of Mackerel Landed at San Pedro between January 1, and July 1, 1922

	Totals sold in markets	Caught by purse seine	
		Amounts	Per cent of total
January	165,884	14,018	8.5
February	99,997	11,023	11.0
March	177,859	29,827	16.8
April	235,575	111,509	47.3
May	169,954	52,550	30.9
June	164,494	14,880	9.1
Totals	1,013,763	233,807	23.1

TABLE 5.—Monthly Amounts, in Pounds, of Mackerel Landed at San Pedro between January 1, and July 1, 1922

Table 5 presents monthly amounts of mackerel, analyzed according to gear, landed in Los Angeles County during the first six months of 1922. It shows that, although the purse seiners landed only a comparatively small portion of the semiannual total, viz, 23.1 per cent, nevertheless, in some months a fairly high percentage of the mackerel landed was taken by them; for instance, in May, 1922, they caught 30.9 per cent of the monthly total, and in April, 1922, even as much as 47.3 per cent. Furthermore, the purse seiners certainly would be much more important in this fishery, if it were not for the fact that the mackerel is a relatively cheap and perishable fish, and that the wholesale

markets are very easily oversupplied with this product. The following observations made in the summer of 1922 very strongly confirm this statement. During one of my trips with a purse seine boat several hauls were made in order to catch schools of yellowtail. The yellowtail, which is a very active fish, hard to catch, escaped, but the seine repeatedly contained mackerel (Scomber) in large quantities. Probably about thirty tons (60,000 pounds) thus were caught in one day. As soon as the fishermen saw that the seine did not contain anything but mackerel, they ceased pursing, opened one side of the net, and let the fish escape. (It may be worth mentioning that all the fish thus liberated certainly survived.) The captain declared that it was not worth while to bring this fish to the market, since he probably would not be able to sell. When we returned to San Pedro, my inquiries in the markets fully confirmed this statement. During some of my other trips with the purse seiners in the summer of 1922, large schools of mackerel repeatedly were located, but no attempt to catch them was made.

The rockfish or rock cod never are caught with purse seine.

of some of the species of minor economic importance, the following quantities were taken by the purse seiners between January 1 and July 1, 1922, and landed in Los Angeles County:

Smelt: 3900 pounds, which is only 3.0 per cent of the total amount, 132,074 pounds, landed during this period.

Rockbass (mostly Paralabrax clathratus and some Paralabrax nebulifer): 12,745 pounds, *i. e.,* 17.5 per cent of the semiannual total, 72,910 pounds.

Kingfish (Genyonemus lineatus): 100 pounds. of this fish rather large quantities are caught accidentally during the purse seine operations but thrown overboard because of the low market price (see also page 15).

Black sea bass or jewfish (Stereolepis gigas): of the 20,782 pounds of this fish landed between January 1 and July 1, 1922, in Los Angeles County, 4,664 pounds, *i. e.,* 22.4 per cent, were taken with purse seine.

Small amounts of other fish of minor importance also are taken accidentally by the purse seine fishermen.

The above analysis shows that the fresh fish markets to a very large extent depend on the purse seine industry for their supply. of the species of major importance to the fresh fish trade, only the halibut and the rockfish are not taken with purse seines. of the remaining species the mackerel is caught mainly with small boats, and the barracuda, the white sea bass, and the yellowtail principally with purse seine boats. During November, December, January, February, March, and April the barracuda and the white sea bass are landed almost exclusively by the purse seiners. Taking into consideration that the mackerel is a fish of a relatively low market value and that the barracuda and the white sea bass are high-priced fish, much appreciated be the fish-eating public, we are fully justified in saying that *without the purse seiners the fresh fish markets would not be able to furnish the public in southern California with a more or less steady and sufficient supply of desirable fish throughout all the months of the years.*

of the fish sold by the fishermen to the fresh fish markets about 55 per cent is taken by the purse seiners. However, it must be remembered that among the "small boats" a few, operated by Japanese fishermen, are equipped with a seine of almost the same type as that used on board

the true purse seine boats. Because of the fact that these Japanese boats sometimes change their gear, I have not been able to include them as a special category in the results of my analysis. If these boats had been considered as purse seine boats in my analysis, the importance of the purse seine industry as a source of supply to the fresh fish markets, of course, would have become still more striking.

4. III. THE PURSE SEINERS AND THE DAILY FLUCTUATIONS IN THE SUPPLY AND PRICE OF FRESH FISH

A serious complaint made against the purse seine fishermen is that they unsettle the fresh fish trade. The argument runs in about the following way: When the small boats operate, most of them have some fish to market every day. The relatively large number of small boats now operating in southern California, can, therefore, even by comparatively small individual catches, furnish the fresh fish markets with a sufficient and fairly steady daily supply of fish. Moreover, because of their very limited carrying capacity, the small boats are not apt to cause over-supply in the fresh fish markets. On the other hand, because of their method of fishing, the purse seiners depend mainly on large, occasional catches; they often have to stay out fishing for weeks without any success; when often have to stay out fishing for weeks without any success; when a big catch is made by them, it often has to compensate for losses suffered during more or less long periods of unsuccessful toil. This circumstance, in connection with the fact that only a rather small number of purse seine boats operate for barracuda, white sea bass, and yellowtail at the same time, often causes very decided daily fluctuations in the amounts of these fish landed during the periods the fresh fish markets depend mainly on the purse seiners for their supply. In other words, during the purse seine seasons periods of oversupply of fresh fish often alternate with periods of scarcity.

TABLE 6.—Daily Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and June 30, 1922 and Price per Pound in Cents.

Days	January		February		March		April		May		June	
	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price
1	2,101	10.0	5,212	10.2	50,265	7.3			41,538	3.9	9,543	2.2
2			4,443	10.5	3,290	7.0	685		21,184	4.0	16,887	4.2
3	44,342	9.9	4,851	15.0	23,660	8.0	14,275	4.4	32,209	3.1	50,688	3.0
4	655	10.0	10,330	15.0	12,577	8.0	16,340	7.1	25,075	3.0	274	3.0
5	11,051	11.6					1,242	10.9	11,179	2.9	47,325	2.0
6	16,051	12.0	4,753	15.7	10,829	8.9			18,461	4.0	44,971	1.6
7					2,822	10.0	4,351	12.5	30	2.5	19 942	1.9
8			8,240	15.9			9,920	14.0	27,618	3.6	79,972	1.1
9	14,651	12.8			29,874	12.1			20,341	3.6	9 455	1.4
10	4,623	12.8			4,361	11.0	1,830	15.0	1,497	6.7	6,582	1.9
11					29,128	12.0	23,300	15.0	3,950	7.5	280	4.0
12	2,268	15.0	6,680	17.0			26	15.0	79,155	3.9	11 222	2.5
13	10,241	13.5	3,946	17.3	21,622	11.9			67,848	2.0	19 821	3.7
14					1,055	12.0			3,783	1.5	27,970	2.9
15			4,337	18.0	3,596	13.0	2,790	19.0	59,689	2.0	10,807	4.0
16			17,496	16.7	9,737	11.8			5,382	2.9	7,623	4.2
17	8,475	15.0	1,337	18.0	12,164	9.6	9,149	19.0	14,670	3.6	3,712	5.0
18	7,212	15.0	39,565	10.5	19,035	11.0	5,368	18.0	4,025	4.6		
19	7,747	14.8					19,016	11.9	24,456	4.1	4,226	8.2
20	1 313	15.0	24,752	10.5	7,129	11.8	26,348	10.1	595	6.0	16,447	9.1
21	12,684	15.4	17,027	11.0	19,468	7.5	37,952	6.1	360	2.0	15,135	9.9
22			4,615	10.0	89,903	4.5	15,389	6.2	31,084	5.3	27,705	8.1
23	28,685	10.6	15,034	10.4	34,363	3.8	1,087	5.0	17 826	4.4	10,504	7.9
24	47,669	9.8	5,302	12.9	24,991	3.8	68,452	3.2	9,996	4.0	1,280	8.0
25	5,996	9.7	8,344	11.0	3,623	3.2	44,218	2.2	8,426	3.6		
26	6,914	11.4	855	10.0			2,904	3.1	17,530	3.7	14,208	8.0
27	10,279	10.0	38,867	10.1	27,565	3.8	12,688	5.9	67,222	1.9	22,215	7.1
28	12,964	10.4	9 112	7.9	8,381	3.9	1,115	5.1	120	1.5	15,092	8.0
29					57,698	3.4	28,381	4.3	37,157	1.7	7,217	8.2
30	11,264	11.8			39,371	2.6			16,118	1.6	9,573	9.4
31	9,094	9.9			6,059	3.4			33,360	2.0		
Totals	276,279		235 078		552,606		346,826		701 886		510,776	

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TABLE 6.—Daily Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and June 30, 1922 and Price per Pound in Cents

TABLE 7.—Daily Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and June 30, 1922, and Price per Pound in Cents.

Days	January		February		March		April		May		June	
	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price
1	1,273	12.0			40	15.0	17,954	4.1	1,315	7.0	7,454	5.9
2			52	16.9			35	4.0	3,509	9.3	905	6.8
3	7,449	12.3			1,249	22.0	5,981	6.3	9,090	9.5	697	7.5
4	22,725	10.3			1,347	21.4	12,629	7.0	3,109	7.5	384	6.2
5	6,435	11.2					192	8.0	26,954	6.0	12,807	8.6
6	566	14.0			3,000	21.5	14,241	6.1	5,484	6.1	21,266	7.1
7			65	16.6	1,646	21.6	202	10.2			34,154	5.7
8					3,178	22.0	19	12.0	11,595	7.0	14,519	5.1
9	23	15.0	175	19.6	218	19.0	1,650	14.0	92	7.0	13,131	4.9
10	515	15.0			656	22.0	369	15.3	285	8.2	8,233	5.0
11	66	12.0			489	22.0	20	20.0	200	8.0	1,324	4.0
12			23	18.0	23	22.0			878	9.3	52,998	4.0
13	172	15.0			575	22.0	281	21.0	1,468	8.1	40,372	4.3
14			115	24.0	1,408	22.0	506	19.3			13,887	4.0
15			24	20.0	494	21.2	232	21.3	3,745	8.0	59,575	3.0
16	161	15.0			394	22.3			14,638	8.0	11,480	2.7
17	1,310	16.0			45	22.0	253	20.0	132	8.5	22,145	2.6
18	210	16.6					3,555	20.0	113	9.5		
19	115	15.0			235	20.3	19,742	10.6	530	9.7	6,884	4.2
20			80	22.0	929	19.9	18,005	10.6	2,358	11.7	2,458	5.5
21			78	18.0	534	20.6	6,313	10.0	100	10.0	9,951	7.5
22			150	20.0	366	22.0	38,883	6.4	23,922	10.0	2,128	8.0
23	77	14.7			2,075	15.5	415	6.0	19,998	10.0	5,813	9.0
24	240	17.0	75	16.0	192	12.8	10,252	6.1	7,159	9.9	1,462	9.0
25			1,992	9.0	34,187	8.4	3,175	7.9	87,677	4.0	429	8.4
26	110	15.0					36,638	5.6	12,661	3.8	2,990	9.0
27	140	15.6	26	20.0	33,135	4.7	3,574	5.8	7,148	3.6	11,817	9.4
28	105	18.0	20	20.0	2,519	6.0	7,538	7.0	225	3.6	13,351	9.5
29					1,445	6.0	118	7.0	9,432	5.2	9,239	9.4
30	17	15.0			56,780	4.6			512	5.1	2,688	9.4
31					15,714	3.8			4,704	4.4		
Totals	41,909		2,875		157,503		203,172		259,033		384,541	

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TABLE 7.—Daily Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and June 30, 1922, and Price per Pound in Cents

TABLE 8.—Daily Amounts, in Pounds, of Ye'lowtail Landed at San Pedro between January 1, and June 30, 1922, and Price per Pound in Cents.

Days	January		February		March		April		May		June	
	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price	Amounts	Price
1	810	6.0	16	10.0			7,832	3.4	15,989	5.0		
2			332	10.0					29,758	3.8		
3	7,544	6.0			1,455	2.0	1 402	4.5				
4	3,613	5.1	20	8.0			8,741	4.5	110	4.0	5 105	2.0
5	1,446	6.0			260	5.0			1,270	5.0	4,934	2.9
6											8,029	2.9
7					130	8.0					13 235	2.0
8							30	10.4	11,540	5.0	1,747	2.0
9	15,833	8.2							2,253	5.0	19,277	1.3
10	10,108	9.0	58	10.0					54	5.0	1,183	1.5
11	10,066	10.0			933	12.0					180	3.0
12	33,012	8.2	558	14.0					80	6.0	3,988	2.0
13	1,754	8.0			3,086	13.0			350	5.0	3,993	2.1
14											2,486	2.3
15									9,876	4.4	309	2.8
16	7,794	9.0			15,570	11.5			1,475	5.0	615	2.0
17	8 518	8.2	10,279	12.0					3,490	5.0	2,116	3.1
18	1,832	8.2	10,541	9.9					4,700	6.0		
19	2,134	10.0							246	6.0		
20			655	10.6			235	8.0			172	4.6
21			565	12.0	35,858	8.0	12,462	6.6			3,815	5.0
22					11,637	8.0	10,246	4.6	9,346	5.5	2,115	4.0
23					15,108	5.4			26,972	3.9	8,274	4.7
24	14,750	10.0			18,356	3.3			22,363	2.3	30	5.0
25					185	4.3	1,715	5.0	2,200	2.0		
26	2,145	10.0							2,304	2.0	715	6.0
27	720	11.4	35	13.0					13,650	1.9	95	6.0
28	160	8.2			29,578	4.0					1,937	5.0
29					9,623	3.1			1,967	2.2	17	5.0
30					25,891	2.3					27	5.0
31	17	10.0			855	4.0			18,632	2.0		
Totals	122,280		23,062		168,525		42,663		178,705		84,494	

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TABLE 8.—Daily Amounts, in Pounds, of Ye'lowtail Landed at San Pedro between January 1, and June 30, 1922, and Price per Pound in Cents

In order to illuminate this important phase of our fishing industry table 6, 7, and 8 have been prepared. These tables present the daily fluctuations in the landings of barracuda, white sea bass, and yellowtail at San Pedro during the period from January 1 to July 1, 1922. They should be compared with Table 4, and figures 4 and 5, presenting the weekly landings of these fish, considered as a whole, analyzed according to origin and fishing gear. It should be remembered that on Sundays on fish, or only small quantities are landed, the markets in most cases being closed on those days.

The fluctuations in the daily landings shown by these tables justly may be called enormous. For instance, on one day, March 30, not less than 116,042 pounds were recorded, while on other days, *e. g.*, on January 7 and 14, nothing or only a very small quantity was landed. An analysis of the tables shows that very great fluctuations occurred during the time the markets depended largely on the small boats for their supply of these three fish as well as during the period when most of these fish was landed by the purse seiners. Were the fluctuations more serious during the purse seine period than during the small boat period? This question probably must be answered in the affirmative. On the whole, they were somewhat more serious and undesirable during the period from January 1 to May 21, when the markets depended largely on the purse seiners for their supply of these fish, than after May 21, when the small boats began intensive operations. To be more specific, the weekly landings, in pounds, of these fish during the first period were as follows (Table 4) :

126,061	13,291	88,844	223,316
103,332	94,901	299,769	222,270
59,705	78,669	334,400	246,234
130,984	142,778	90,285	229,314
45,651	87,524	31,004	153,905

During the first two weeks following March 19 the markets received not less than 634,169 pounds of these fish and during the two preceding and the two following weeks (March 5 to 18, and April 2 to 15) only 176,368 pounds and 121,289 pounds, respectively. After May 21, the weekly landings of these fish were:

387,944	366,625	118,399
208,401	296,903	111,710

The question now arises: Were these fluctuations in the market supply of these fish due to seasonal changes in "abundance," in other words, to seasonal variations in the difficulty of catching the fish, or to differences in the methods of fishing? This question can not be settled as yet. However, the fact that during the last part of the purse seine period, *i. e.*, from April 16 to May 13, the weekly landings of these fish were much more uniform than during the small boat season, viz., 223,316, 222,270, 246,234, and 229,314 pounds (Fig. 5), seems to indicate that the fluctuations were caused by differences in "abundance" rather than by differences in the methods of fishing.

The result of this summary analysis is, therefore, (1) that in the fresh fish markets the daily supply of barracuda, white sea bass, and yellowtail is subject to very great fluctuations during the small boat season as well as during the purse seine season, (2) that probably the small boats as well as the purse seine boats can bring about oversupply, and (3) that there are indications of the fluctuations being due to changes in "abundance" rather than to changes in the methods of fishing.

TABLE 9.—Monthly Amounts of Barracuda, Mackerel, Bonito and Yellowtail Landed by Purse Seiners at San Pedro during 1920, 1921, and 1922, and Reduced to Fertilizer.

	Barracuda			Mackerel			Bonito			Yellowtail		
	1920	1921	1922	1920	1921	1922	1920	1921	1922	1920	1921	1922
January				[1]5,975								
February	[1]1,160	[1]32,475			[1]87,417						[1]17,984	
March	[1]104,157	[1][2]109,995			[1]36,483							
April	[1]70,525	[1]49,960		[1]162,691		[1]6,460						[1]16,000
May	[1]2,640			[1]37,256		[1]34,431						
June				[1]9,600								
July				[1]3,640			[1]7,472					
August	[1]10,208			[1]23,112			[1]24,038			[1]1,361	[1]14,790	
September	[1]1,600	[1]14,044	[1]4,808	[1]6,170	[1]9,110		[1]7,122	[1]2,280	[1]18,855		[1]64,251	[1]52,179
October	[1][3]168,549			[1]5,963	[1]1,873		[1]25,458			[1]35,800		
November	[1]12,627			[1]2,860								
December	[1]12,380									[1]3,240		
Totals	383,846	206,474	4,808	257,267	134,883	40,891	64,090	2,280	18,855	40,401	97,025	68,179

TABLE 9.—Monthly Amounts of Barracuda, Mackerel, Bonito and Yellowtail Landed by Puise Seiners at San Pedro during 1920, 1921, and 1922, and Reduced to Fertilizer

However, this analysis may not be representative of the corresponding period of the last few years. This assumption seems to be substantiated by the records of the California Fish and Game Commission for the amounts of fish caught with purse seine and reduced into fertilizer. Table 9 represents these records for Los Angeles County during the years 1920, 1921, and 1922. In this table the number of loads turned into fertilizer is indicated by the small figures. Reference also is made to an article by N. B. Scofield in "CALIFORNIA FISH AND GAME," volume 5, page 154. According to statements on the reduction permits issued by the Fish and Game Commission, the cause of the diversion of the product from human consumption and its reduction into fertilizer, in most cases, was oversupply. In 1920, the amount of barracuda landed by purse seiners and made into fertilizer was not less than 383,846 pounds; for 1921 and 1922 the corresponding amounts were 206,474 pounds and 4,808 pounds, respectively. In other words, the amounts decreased steadily during these years, and in 1922 the amount was negligible. The same condition is to be found in the case of the mackerel. This seems to indicate that the fresh fish markets were oversupplied more frequently in 1920 and 1921 than in 1922. It should be remembered in this connection that in 1920 the number of purse seine boats amounted to about 125 (p. 10) and in 1922 to only 65 (p. 10). This reduction in the number of operating purse seine boats undoubtedly has greatly decreased the risk of oversupply in the fresh fish markets.

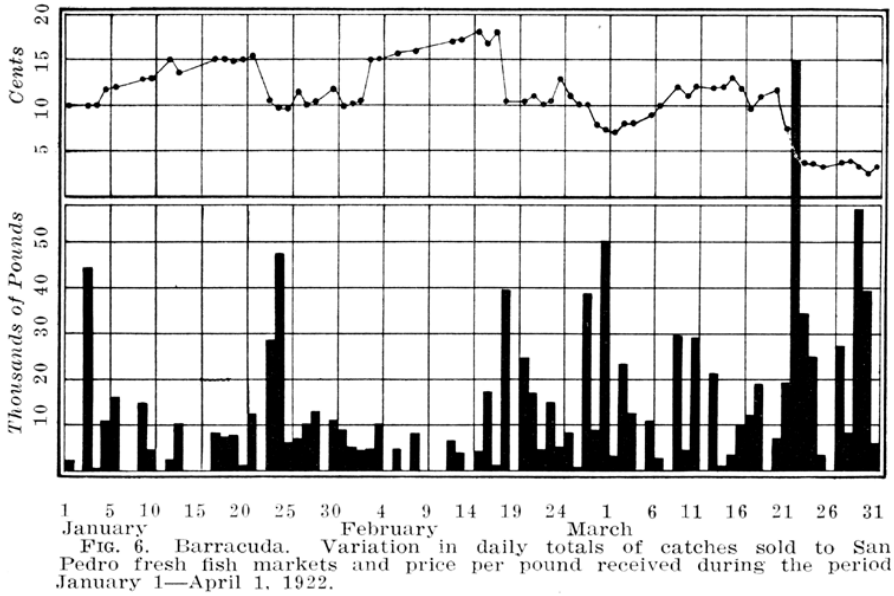

FIG. 6. Barracuda. Variation in daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period January 1—April 1, 1922.

FIG. 6. Barracuda. Variation in daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period January 1—April 1, 1922

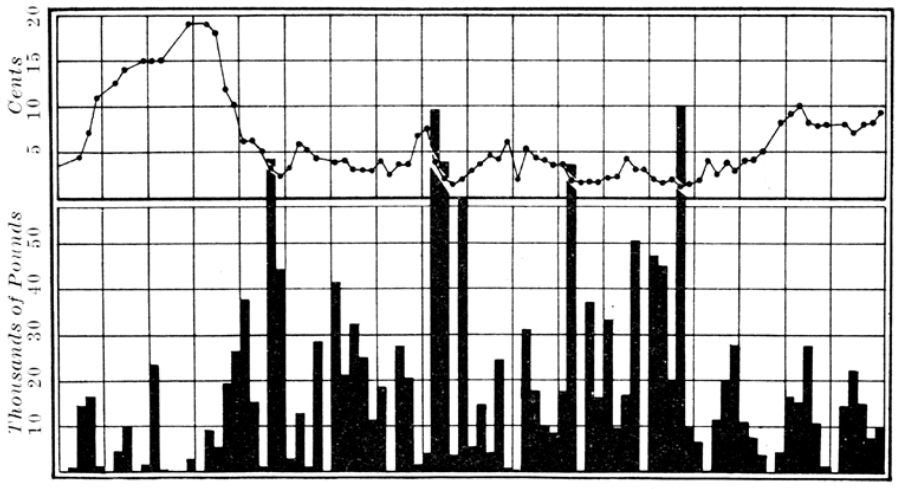

FIG. 7. Barracuda. Variations in daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period April 1—July 1, 1922.

FIG. 7. Barracuda. Variations in daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period April 1—July 1, 1922

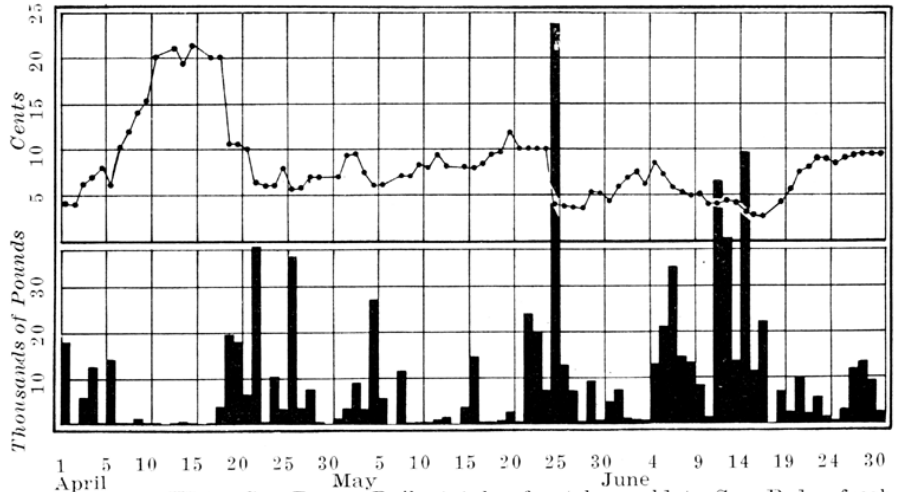

FIG. 8. White Sea Bass. Daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period April 1—July 1, 1922.

FIG. 8. White Sea Bass. Daily totals of catches sold to San Pedro fresh fish markets and price per pound received during the period April 1—July 1, 1922

The great fluctuations in the accumulated supply in the fresh fish markets cause great fluctuations in the prices of fish paid to the fishermen. The fluctuations in the prices of barracuda, white sea bass, and yellowtail paid to the fishermen at San Pedro have been recorded for the period between January 1 and July 1, 1922. These data are given in tables 6, 7, and 8 and in figure 6, 7, and 8. The prices presented in these tables and graphs are the weighted daily average ones. Unfortunately, lack of time prevented me from carrying out a detailed analysis and discussion of these data. However, Messrs. W. F. Thompson and O. E. Sette of the California Fish and Game Commission have undertaken a preliminary analysis of the accumulated material. Their results, which seem to indicate that the fluctuations in the prices were due to the seasonal changes in the available supply rather than to the methods of fishing, are as follows:

"1. There is very little correlation between the individual day's catch and that day's price—as far as concerns the changes from one day to another."

"2. There is equally little correlation between the individual day's catch and the price of the succeeding day—considering again only the changes from one day to the other."

"3. There is a correlation, not exceedingly high to be sure, between the changes in supply accumulated during two days and the changes in price shown on the last day."

"4. There must be granted a high correlation between long period changes in catch (seasonal abundance) and price, as may be seen from the tables and figures."

"These points covered by our calculations show merely that the large individual day's catches do not produce an invariable nor marked immediate effect on the market that day or the next, but that the effect is due to the supply over at least two days combined. It would seem that the correlation would be higher, could the available supply at all ports and in all points of distribution be combined. The *degree of change* in price which results from fluctuations in supply of two succeeding days does not seem to be very great, however great the apparent correlation, ½ cent to a change of 10,000 pounds in supply."

While it still is a mooted question as to whether or not the purse seiners by their occasional large individual catches upset the market conditions more than do the small boats by their relatively small but numerous individual catches, there seems to be but little doubt that the great fluctuations in the prices of fish paid to the fishermen have a profound effect on the purse seine industry. This last effect is twofold. 1. The purse seine business is run on a very narrow margin of profit. The great fluctuations in the prices implies that in the long run most of the boats will encounter periods of "bad luck," *i. e.,* periods with prices too low to cover the high running expenses. During such periods the owner of the boat often is forced to borrow money and to mortgage his equipment. The results of these transactions are evident in the general economic conditions of our purse seine industry (see pages 9 to 12). 2. The risk of more or less long periods of unprofitable work discourages the stable and dependable elements of the fishing population to take hire as "boat pullers" on board the purse seine boats.

If these conditions of instability continue, then, fairly soon, it probably will be nearly impossible for the boat owners to hire good fishermen because of the uncertain wages. A lowering of the standard of the fishermen will render more difficult or even endanger the enforcement of our laws for the protection of the natural supply of fish. On the other hand, if a relative stabilization of the wages of the boat pullers could be established by a policy of smooth cooperation between the wholesale dealers and the fishermen, there probably would be a diversion of first-class fishermen to southern California. This would be of an extraordinary value to our present policy of conservation, since such men are foreseeing enough to take good care of the natural supply of fish on which they depend. When talking with the fishermen, I have been struck by the fact that the more intelligent elements are willingly listening to arguments in favor of conservation or even raise this subject themselves. The less intelligent elements, on the other hand, think only of their immediate income.

At the present time, there is among the fishermen of southern California a general conviction that they are badly exploited, and a feeling of despair is prevailing.

In the twenty-sixth biennial report of the California Fish and Game Commission (page 74), Mr. N. B. Scofield, discussing the recurrent

oversupply in the fresh fish markets, writes as follows: "Provisions should be made by the markets to freeze and hold these overcatches for there are times in the winter when the markets are practically bare of fish." This recommendation should be acted upon. Lack of adequate cold storage facilities is one of the basic causes of the instability of our present fresh fish trade.

It is not only necessary to protect the natural supply of fish but also to safeguard the fishermen in their legitimate pursuit of a living through which they render a most important service to the community.

5. IV. THE MOST IMPORTANT FISH CAUGHT AND MARKETED BY THE PURSE SEINERS IN SOUTHERN CALIFORNIA, WITH SPECIAL REGARD TO THE PROBLEM OF OVERFISHING

5.1. 1. Barracuda

5.1.1. A. Occurrence in the waters of southern California

The following statements as to the occurrence of the barracuda in the waters of southern California are to a very large extent based on information which I have gathered from purse seine and gill net fishermen operating in these waters. My own observations are limited to about six weeks in May and June, 1922, when, as mentioned previously, I made a number of fishing trips on board purse seine and gill net boats.

In most years the barracuda begin to appear in large quantities near the coast, inside the three-mile limit and often just outside the kelp beds, in the first two or three weeks of March. During March and April they are caught almost solely, as far as southern California waters are concerned, in the region from Los Coronados Islands to a point about half way between Oceanside and Point San Juan (Fig. 9). During March a fairly large number of purse seine boats still continue their operations for barracuda in Mexican waters, but in April the barracuda have increased to such an extent in the region from Los Coronados to a point about half way between Oceanside and Point San Juan that the fishing for this species almost ceases in Mexico. In April, sometimes even in March, *i. e.*, a rather short time after their first appearance in large quantities in California waters, the barracuda are found in very large schools. A fairly great percentage of the fish in these schools weigh less than three pounds each. Later in the spring the large schools seem to split up into smaller units. In May the barracuda also occur around Point San Juan, Newport, San Clemente Island, and Santa Catalina Island. The region between Oceanside and Point San Juan is then considered as rather poor fishing grounds in so far as the barracuda is concerned. In June and July the barracuda are caught along the kelp beds of the whole coast of southern California. In August and September they are found mainly north of San Pedro, *e. g.*, off Redondo, Santa Monica, Point Dume, Santa Cruz Island, Santa Rosa Island, and Santa Barbara. In the beginning or middle of August most of the barracuda appear to leave the kelp beds. However, according to statements given by fishermen, they probably do not migrate very far from their summer haunts but leave for neighboring, somewhat deeper waters where, as a rule, they remain during the winter months. This supposition is strongly supported by the fact that fairly large quantities of this fish are caught by purse seiners in California

waters throughout the whole winter. Most of these catches seem to be made off Point Dume and around Santa Cruz Island and Santa Rosa Island, especially in the strait between these two islands. In October and November, 1922, large catches of barracuda were made near Point Conception. Late in the fall and in the winter, the catches in local waters often are made up of relatively large fish, and occasionally very large schools are located. It should be mentioned in this connection, however, that a part of the winter fish marked local in the tables and graphs of this paper is certainly of Mexican origin, due to errors in the original data.

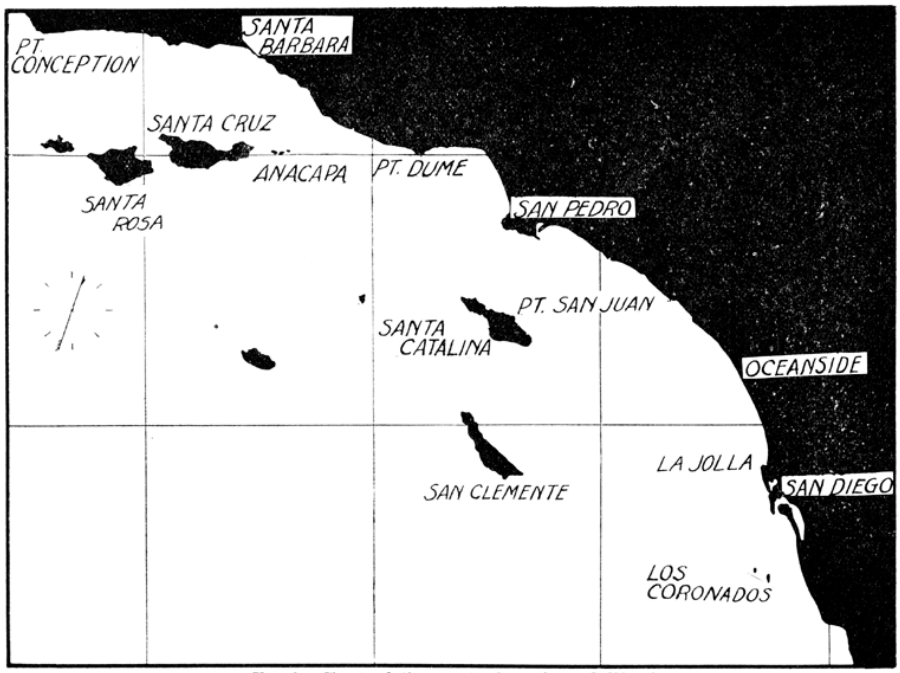

FIG. 9. Chart of the coast of southern California.

FIG. 9. Chart of the coast of southern California

In other words, barracuda fishery on a large scale begins in California waters in the latter part of March and ends in the middle of August or in September. In the first part of the season most of the fish is taken south of San Pedro, in the later part north of this place. This shifting of the operations to the north as the season advances is a characteristic not only of the barracuda fishery but also of several other fisheries of southern California. In the winter months most of the barracuda landed is caught in Mexico, but rather large quantities also are taken locally.

5.1.2. B. *Spawning*

The following statements are based partly on information given by fishermen and fish dealers, and partly on my own examination of the fish in the fresh fish markets of San Pedro.

The spawning of the barracuda seems to take place in relatively shallow waters, mainly just outside the kelp beds, along the whole coast of southern California. It seems to extend over the entire summer, but we do not know with certainty as to when it begins and when it ends. May is probably the first month of heavy spawning. The climax of the spawning probably is reached in June. However, as late as August 13, 1922, out of about twenty tons of barracuda caught locally by two purse seine boats, about 65 to 75 per cent had running spawn. (According to a statement by the men who cleaned this fish, "the running, watery spawn covered the deck like wet snow.")

TABLE 10.—Spawning Barracuda Found in the Fresh Fish Markets, San Pedro, 1922.

	Number specimens examined		Number with running spawn		Per cent with running spawn	
	Males	Females	Males	Females	Males	Females
July 9	42	53	42	12	100.0	22.6
July 12	36	64	36	10	100.0	15.6
July 13	61	40	61	4	100.0	10.0
July 19	48	14	48	5	100.0	35.7
July 19	84	28	84	14	100.0	50.0
July 20	79	38	79	8	100.0	21.0
July 20	10	6	10	0	100.0	0.0
July 21	27	7	27	1	100.0	14.3
July 24	27	30	27	0	100.0	0.0
July 24	12	18	12	0	100.0	0.0
July 24	29	18	29	0	100.0	0.0
July 25	52	32	52	0	100.0	0.0
July 25	8	10	8	0	100.0	0.0
July 26	26	10	26	0	100.0	0.0
July 26	24	13	24	0	100.0	0.0
July 26	18	10	18	0	100.0	0.0
July 26	9	11	9	0	100.0	0.0
July 29	13	21	13	3	100.0	14.3
July 29	6	9	6	1	100.0	11.1
August 2	15	11	15	0	100.0	0.0
August 2	58	46	58	9	100.0	19.6
August 3	10	9	10	3	100.0	33.3
August 3	34	17	34	6	100.0	35.3
August 3	61	38	61	9	100.0	23.7
August 4	36	29	36	8	100.0	27.6
August 4	45	47	45	10	100.0	21.3
August 4	24	30	24	12	100.0	40.0
August 8	6	10	6	3	100.0	33.3
August 8	17	20	17	9	100.0	45.0
August 9	7	21	7	*0	100.0	0.0
August 9	16	20	16	14	100.0	70.0
August 10	38	17	38	2	100.0	11.8
August 18	17	27	17	0	100.0	0.0
August 24	14	12	14	1	100.0	8.3
August 29	5	6	5	1	100.0	16.7
Totals	1,014	792	1,014	145	100.0	18.3

*Most of them nearly ready to spawn.

TABLE 10.—Spawning Barracuda Found in the Fresh Fish Markets, San Pedro, 1922

During July and August, 1922, I examined thirty-five samples and 1806 specimens of barracuda in the fresh fish markets of San Pedro. The results of this investigation are to be found in Table 10. When in this table more than one sample is recorded on the same day, fish from different boat loads were examined. All the males examined seemed to be in a spawning condition; when the fingers were pressed along the belly of these fish, the milky milt came out through the vent. The percentage of spawning females was found to vary greatly and with no apparent periodicity during these two months. Only 18.3 per cent of all the females examined had running, watery spawn. In most of the remaining females the gonads seemed to be in different stages of recuperation. This seems to indicate that each female spawns its eggs in batches during each spawning season, as is the case in many other species.

The barracuda begin to spawn long before they reach legal marketable weight, *i.e.*, three pounds or more. Specimens, both males and females, weighing between one and one and a half pounds, repeatedly were found to have running spawn.

A fairly remarkable feature of the results given in Table 10 is the numerical predominance of the males; out of the 1806 specimens examined, not less than 1014 were males and only 792 were females. However, in some of the samples the females were more numerous than the males.

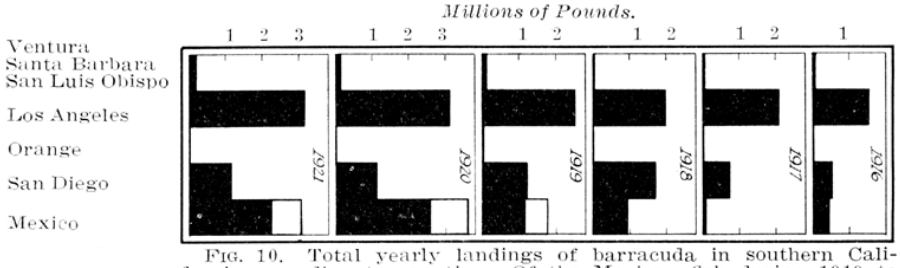

FIG. 10. Total yearly landings of barracuda in southern California according to counties. Of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black.

FIG. 10. Total yearly landings of barracuda. in southern California according to counties. of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black

5.1.3. C. *Fishery*

a. Seasonal Distribution of Catch.—To illustrate the seasonal distribution of catch in the barracuda fishery of southern California, the monthly totals of this fish recorded in Los Angeles County will suffice. That these totals (Tables [12], [13], [14], [15] and figure 11) are representative is shown by the decided predominance of this county in the statistics of the California Fish and Game Commission for 1919, 1920, and 1921 ([Table 11] and figure 10).

Tables 12, 13, 14, and 15, and figure 11 clearly show that the months of April, May, and June always yield the heaviest local catches of barracuda. In 1919, 18.2 per cent of the yearly total catch of local barracuda was landed in April, 36.9 per cent in May, and 13.9 per cent in June. For 1920 the corresponding figures were 27.4 per cent, 26.8 per cent, and 18.2 per cent; for 1921 they were 17.5 per cent, 28.3 per cent, and 18.6 per cent. The corresponding averages for these three years were 21.2 per cent, 30.2 per cent, and 17.1 per cent.

In July, as a rule, fairly heavy local catches of barracuda also are made. In 1919, 12.2 per cent of the yearly local catch was landed

during this month, and in 1921, 11.8 per cent. However, in 1920 the local catch during this month amounted to only 4.2 per cent of the yearly local total.

During the seven months from August to February inclusive, the local catches of barracuda, as a rule, are rather small. These months show the following average local catches expressed in percentages of the average yearly local total: August, 4.2 per cent; September, 4.7 per cent; October, 3.5 per cent; November, 0.9 per cent; December, 1.5 per cent; January, 0.8 per cent; and February, 1.2 per cent. The averages, both monthly and annual, are calculated on the basis of the records of the California Fish and Game Commission for the three years 1919, 1920, and 1921 (Table 15).

In March, the catch of local barracuda generally shows a decided increase. In this month, as mentioned previously (p. 34), the barracuda begin to appear in large quantities near the coast in the region from Los Coronados Islands to a point about half way between Oceanside and Point San Juan. It is true that in March, 1919, the local catch of this species amounted to only 0.4 per cent of the yearly local total, but in 1920 and 1921 the corresponding values were 6.3 per cent and 8.2 per cent, respectively. The last two values certainly are more typical than the first one, judging from the amount landed in March, 1922, and from information given by fishermen and fish dealers.

TABLE 11.—Amounts of Barracuda, in Pounds, Landed in Southern California.

	San Luis Obispo, Santa Barbara and Ventura counties	Los Angeles County	Orange County	San Diego County	From Mexico
1916—Jan. 1-Mar. 31	20,500	287,852	558	54,547	57,427
Apr. 1-June 30	34,900	743,079	18,180	446,374	46,581
July 1-Sept. 30	24,864	340,601	8,943	28,822	14,790
Oct. 1-Dec. 31	20,000	191,615		5,705	341,571
Totals	100,264	1,563,147	27,681	535,448	460,369
1917—Jan. 1-Mar. 31	3,650	423,110		44,880	28,942
Apr. 1-June 30	1,660	1,174,574	12,662	203,014	11,948
July 1-Sept. 30	37,367	300,796	12,718	169,926	
Oct. 1-Dec. 31	27,102	221,466		332,168	54,065
Totals	69,779	2,119,946	25,380	749,988	94,955
1918—Jan. 1-Mar. 31		71,411		451,492	136,840
Apr. 1-June 30	3,325	1,048,430	9,343	468,816	29,300
July 1-Sept. 30	21,307	762,950		573,677	116,692
Oct. 1-Dec. 31	16,553	105,807		230,949	668,761
Totals	41,185	1,988 598	9,343	1,724,934	951,593
1919—Jan. 1-Mar. 31	35,575	37,653		101,498	434,451
Apr. 1-June 30		1,749,273	37,840	535,436	22,719
July 1-Sept. 30	56,756	616,964	13,714	474,366	127,569
Oct. 1-Dec. 31	45,421	129,368	242	104,949	1,201,366
Totals	137,752	2,533,258	51,796	1,216,249	1,786,105
1920—Jan. 1-Mar. 31	39,378	254,759		136,241	1,740.664
Apr. 1-June 30	912	2,258,943	27,783	601,753	21,604
July 1-Sept. 30	62,152	306,971	11,072	369,663	322,748
Oct. 1-Dec. 31	78,716	298,008	251	32,943	1,530,931
Totals	181,158	3,118,681	39,106	1,140,600	3,615,947
1921—Jan. 1-Mar. 31	33,041	352 118		332,060	1,757,921
Apr. 1-June 30	13,815	2,054,474	14,603	650,292	35,355
July 1-Sept. 30	88,758	684,126	2,006	105,084	83,969
Oct. 1-Dec. 31	68,432	98,461		91,559	1,159,017
Totals	204,046	3,189,179	16,609	1,178,995	3,036,262
1922—Jan. 1-Mar. 31	24,080	490,078	145	191,632	780,065
Apr. 1-June 30	490	1,880,048	8,915	486,442	19,343

TABLE 11.—Amounts of Barracuda, in Pounds, Landed in Southern California

TABLE 12.—Monthly Landings of Barracuda in Los Angeles County according to Source—1919.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	23,478	7.83	0.93	276,345	23.74	299,823	8.11
February	4,279	30.58	0.17	9,706	0.83	13,985	0.38
March	9,896	23.33	0.39	32,502	2.79	42,398	1.15
April	461,644	100.00	18.22		0.00	461,644	12.48
May	934,152	100.00	36.86		0.00	934,152	25.27
June	353,477	100.00	13.95		0.00	353,477	9.56
July	310,548	100.00	12.25		0.00	310,548	8.40
August	183,058	100.00	7.23		0.00	183,058	4.95
September	123,358	89.10	4.87	15,083	1.30	138,441	3.74
October	48,513	25.51	1.91	141,627	12.17	190,140	5.14
November	16,282	5.95	0.64	257,682	22.14	273,964	7.41
December	64,573	13.02	2.55	431,086	37.05	495,659	13.40
Totals	2,533,258	68.53	99.97	1,164,031	100.02	3,697,289	99.99

TABLE 12.—Monthly Landings of Barracuda in Los Angeles County according to Source—1919

TABLE 13.—Monthly Landings of Barracuda in Los Angeles County according to Source—1920.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	6,936	1.40	0.22	489,010	18.80	495,946	8.67
February	50,777	10.77	1.63	420,609	16.16	471,386	8.24
March	197,046	26.38	6.32	550,165	21.14	747,211	13.06
April	855,540	99.50	27.41	4,554	0.17	860,094	15.03
May	835,777	100.00	26.79		0.00	835,777	14.61
June	567,626	100.00	18.18		0.00	567,626	9.93
July	129,741	100.00	4.16		0.00	129,741	2.27
August	64,385	100.00	2.06		0.00	64,385	1.13
September	112,845	89.20	3.62	13,755	0.53	126,600	2.21
October	211,377	37.59	6.78	351,178	13.50	562,555	9.84
November	30,173	7.44	0.97	375,677	14.44	405,850	7.10
December	56,458	12.48	1.81	395,950	15.22	452,408	7.91
Totals	3,118,681	54.54	99.95	2,600,898	99.96	5,719,579	100.00

TABLE 13.—Monthly Landings of Barracuda in Los Angeles County according to Source—1920

TABLE 14.—Monthly Landings of Barracuda in Los Angeles County according to Source—1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	41,781	8.83	1.31	431,359	19.10	473,140	8.69
February	48,528	9.05	1.52	487,747	21.60	536,275	9.85
March	261,809	36.75	8.21	450,636	19.95	712,445	13.07
April	559,605	100.00	17.54		0.00	559,605	10.27
May	901,665	100.00	28.26		0.00	901,665	16.54
June	593,204	100.00	18.59		0.00	593,204	10.88
July	375,450	100.00	11.77		0.00	375,450	6.89
August	126,926	99.64	3.98	435	0.02	127,361	2.34
September	181,750	92.80	5.70	14,279	0.63	196,029	3.60
October	49,027	20.21	1.54	193,573	8.58	242,600	4.45
November	33,665	6.85	1.06	457,545	20.26	491,210	9.02
December	15,769	6.61	0.49	222,709	9.87	238,478	4.38
Totals	3,189,179	58.54	99.97	2,258,283	100.01	5,447,462	99.98

TABLE 14.—Monthly Landings of Barracuda in Los Angeles County according to Source—1921

TABLE 15.—Monthly Landings of Barracuda in Los Angeles County according to Source. Averages 1919 to 1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	24,065	5.69	0.82	398,905	19.87	422,970	8.54
February	34,528	10.14	1.17	306,021	15.25	340,549	6.87
March	156,250	31.21	5.32	344,434	17.17	500,684	10.11
April	625,596	99.76	21.21	1,518	0.08	627,114	12.66
May	890,531	100.00	30.20		0.00	890,531	17.96
June	504,769	100.00	17.12		0.00	504,769	10.19
July	271,913	100.00	9.23		0.00	271,913	5.49
August	124,790	99.88	4.24	145	0.00	124,935	2.52
September	139,318	90.64	4.73	14,372	0.72	153,690	3.10
October	102,972	31.03	3.49	228,793	11.40	331,765	6.69
November	26,707	6.84	0.91	363,635	18.11	390,342	7.88
December	45,600	11.53	1.55	349,915	17.42	395,515	7.98
Totals	2,947,039	59.49	99.99	2,007,738	100.02	4,954,777	99.99

TABLE 15.—Monthly Landings of Barracuda in Los Angeles County according to Source. Averages 1919 to 1921

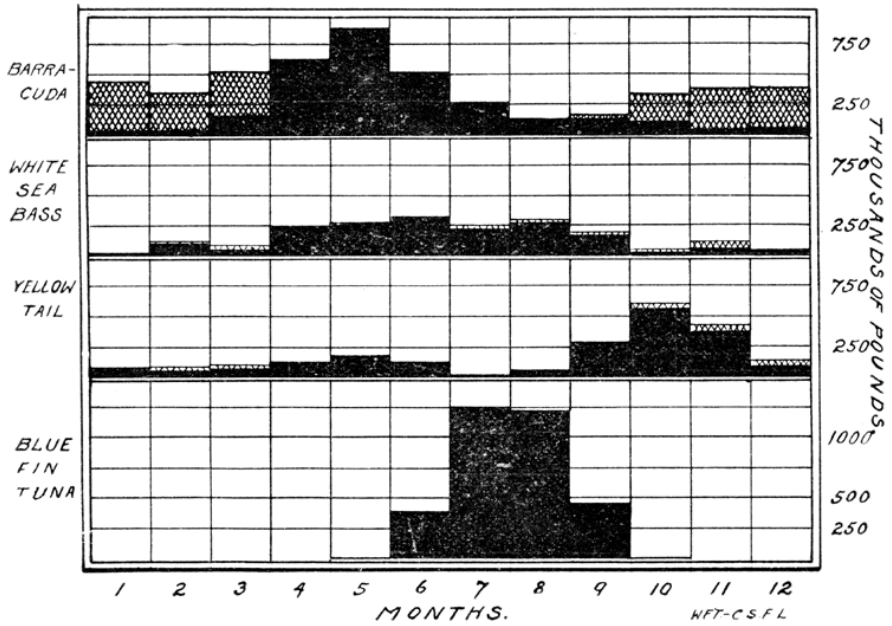

FIG. 11. Catch of chief purse-seined fish in Los Angeles County, according to months. Fish caught in local waters shown in solid black; those in Mexican, shaded. Quantities shown are averages for 1919, 1920 and 1921, save those for bluefin tuna, which are values for 1922 only.

FIG. 11. Catch of chief purse-seined fish in Los Angeles County, according to months. Fish caught in local waters shown in solid black; those in Mexican, shaded. Quantities shown are averages for 1919, 1920 and 1921, save those for bluefin tuna, which are values for 1922 only

Part of the barracuda landed during the eight months from August to March inclusive, and classified as local in the records of the Fish and Game Commission, undoubtedly is of Mexican origin. In other words, the amounts of local barracuda for these months as presented above, certainly are somewhat too high.

From the data given in the previous paragraphs it is evident that if the fresh fish markets of southern California depended entirely on the local catch for their supply, the barracuda available for consumption would be subject to very great and highly undesirable fluctuations during the various months of the year. Fortunately, however, this is

not the case. During 1919 only 68.5 per cent of the yearly total amount of barracuda landed in Los Angeles County was of local origin and in 1920 and 1921 the corresponding values were 54.5 per cent and 58.5 per cent, respectively. The remainder was brought in by California fishermen from Mexican (Lower California) waters.

Most of the Mexican barracuda are landed during the months of poor local supply, viz., from October to March inclusive. These six months show the following average catches of Mexican origin expressed in percentages of the average yearly Mexican total: October, 11.4 per cent; November, 18.1 per cent; December, 17.4 per cent; January, 19.9 per cent; February, 15.2 per cent; March, 17.2 per cent. The averages, both monthly and annual, are calculated on the basis of the records of the California Fish and Game Commision for the three years 1919, 1920, and 1921 (Table 15 and Fig. 11).

From April to September inclusive, the landings of Mexican barracuda are very small. In 1919 and 1921, no barracuda of Mexican origin was recorded for April in Los Angeles County; and in April, 1920, 99.5 per cent of the total amount of this fish was of local origin. In May, June, and July of 1919, 1920, and 1921, all the barracuda landed in this county were of local origin. In August of 1919 and 1920, no Mexican barracuda were landed, and in August, 1921, 99.6 per cent of the monthly catch of this species was of local origin. In September the average catch for 1919, 1920, and 1921, expressed in percentage of the average yearly Mexican total, was only 0.7 per cent.

Thus the supply of barracuda in the fresh fish markets of San Pedro is fairly evenly distributed throughout the whole year because of the alternation of the local and the Mexican fisheries; see the last column in Table 15 and the upper section in figure 11.

b. Increase in, and Ports of Entry of, the Mexican Supply.—Tables 16 and 20, and figure 13 show the changes in amounts and ports of entry of the barracuda taken in Mexican waters by California fishermen and landed in southern California.

TABLE 16.—Yearly Amounts, in Pounds, of Barracuda Landed in Southern California according to Source.

	Landed in Southern California			Landed in Los Angeles County	
	Total weight from Southern California and Mexico	Total weight of Mexican origin	Per cent of Mexican origin	Total weight of Mexican origin	Per cent of Mexican origin
1916	2,686,909	460,369	17.1		
1917	3,060,048	94,955	3.1		
1918	4,715,653	951,593	20.2		
1919	5,725,160	1,786,105	31.2	1,164,031	65.2
1920	8,095,492	3,615,947	44.7	2,600,898	72.0
1921	7,625,091	3,036,262	39.8	2,258,283	74.4

TABLE 16.—Yearly Amounts, in Pounds, of Barracuda Landed in Southern California according to Source

Table 16, which presents the yearly amounts of barracuda landed in southern California, shows that, generally speaking, the Mexican supply has become increasingly important during the last few years, in spite of the enormous growth in the yield of the local barracuda fishery. In 1916 only 17.1 per cent of the yearly total catch for southern California and Mexico was of Mexican origin. In 1918, 1919, and 1920 the

corresponding values were 20.2 per cent, 31.2 per cent, and 44.7 per cent, respectively. 1921 shows a rather slight decrease in comparison with 1920, 39.8 per cent of the yearly total catch of barracuda being brought in from Mexico.

If we compare the actual amounts of Mexican barracuda landed in southern California during the years from 1916 to 1921 inclusive, the increase becomes still more striking. In 1916 only 460,369 pounds were imported, in 1920 not less than 3,615,947 pounds, an increase of more than 3,000,000 pounds.

Unfortunately, it is impossible to decide, what portion of this vast increase in the importance of the Mexican supply of barracuda is due to defects in our statistics for the earlier years. However, the close correspondence between this increase and the growth of the purse seine fleet, upon which it depends, indicates that the data given above are largely correct.

Most of the Mexican barracuda is landed at San Pedro, in Los Angeles County; and this port has become increasingly important in this respect during the last few years. of the yearly total of Mexican barracuda landed in southern California 65.2 per cent was landed at San Pedro in 1919, 72.0 per cent in 1920, and 74.4 per cent in 1921. The remainder of the barracuda of Mexican origin is landed at San Diego.

c. Relative Importance of Different Fishing Gear.—In the early days most of the barracuda caught in southern California probably was landed by hook and line fishermen. Coincident with the increase in amount, the gill net and round haul methods gradually became more and more important in this fishery. From about 1915 the purse seines have been used. Nowadays nearly all the barracuda landed in San Pedro are taken with nets.

In order to establish the relative importance of the purse seine method in the barracuda fishery of Los Angeles County, the records of the Fish and Game Commission for this county covering the first six months of 1922 have been analyzed. As shown previously (Fig. 11), these six months are the most important as far as the barracuda fishery is concerned. Unfortunately, it is impossible to establish to what extent this analysis is representative of the corresponding period in other years. However, information gathered from fishermen and dealers seems to indicate that it is fairly representative. The results of this analysis are shown in tables 17, 18, and 19 and in figure 12.

TABLE 17.—Monthly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1922

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
January	276,279	5,306	1.9	263,725	95.5
February	235,078	79,419	33.8	229,608	97.7
March	552,606	287,544	52.1	471,222	85.3
April	346,826	346,826	100.0	320,167	92.3
May	701,886	701,886	100.0	448,460	63.9
June	510,776	510,776	100.0	113,769	22.3
Totals	2,623,451	1,931,757	73.7	1,846,951	70.4

TABLE 17.—Monthly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1922

TABLE 18.—Weekly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1922

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
Jan. 1-7	74,200		0.0	74,200	100.0
Jan. 8-14	31,783	225	0.7	26,374	83.0
Jan. 15-21	37,431	4,224	11.3	31,143	83.2
Jan. 22-28	112,507	857	0.8	111,650	99.2
Jan. 29-Feb. 4	45,194	42	0.1	45,152	99.9
Feb. 5-11	12,993		0.0	12,993	100.0
Feb. 12-18	73,361	29,090	39.7	71,370	97.3
Feb. 19-25	75,074	26,194	34.9	71,637	95.5
Feb. 26-Mar. 4	138,606	25,453	18.4	138,414	99.8
Mar. 5-11	77,014	14,311	18.6	70,746	91.8
Mar. 12-18	67,249	23,652	35.2	64,807	96.4
Mar. 19-25	179,477	124,889	69.6	139,491	77.7
Mar. 26-Apr. 1	139,074	123,332	88.7	106,578	76.6
Apr. 2-8	46,813	46,813	100.0	46,813	100.0
Apr. 9-15	27,946	27,946	100.0	26,260	94.0
Apr. 16-22	113,222	113,222	100.0	108,727	96.0
Apr. 23-29	158,845	158,845	100.0	138,367	87.1
Apr. 30-May 6	149,646	149,646	100.0	136,863	91.5
May 7-13	200,439	200,439	100.0	172,495	86.1
May 14-20	112,602	112,602	100.0	92,020	81.7
May 21-27	152,444	152,444	100.0	39,981	26.2
May 28-June 3	163,873	163,873	100.0	17,394	10.6
June 4-10	208,521	208,521	100.0	40,312	19.3
June 11-17	81,435	81,435	100.0	37,077	45.5
June 18-24	75,297	75,297	100.0	15,594	20.7
June 25-30	68,405	68,405	100.0	10,493	15.3
Totals	2,623,451	1,931,757	73.7	1,846,951	70.4

TABLE 18.—Weekly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1992

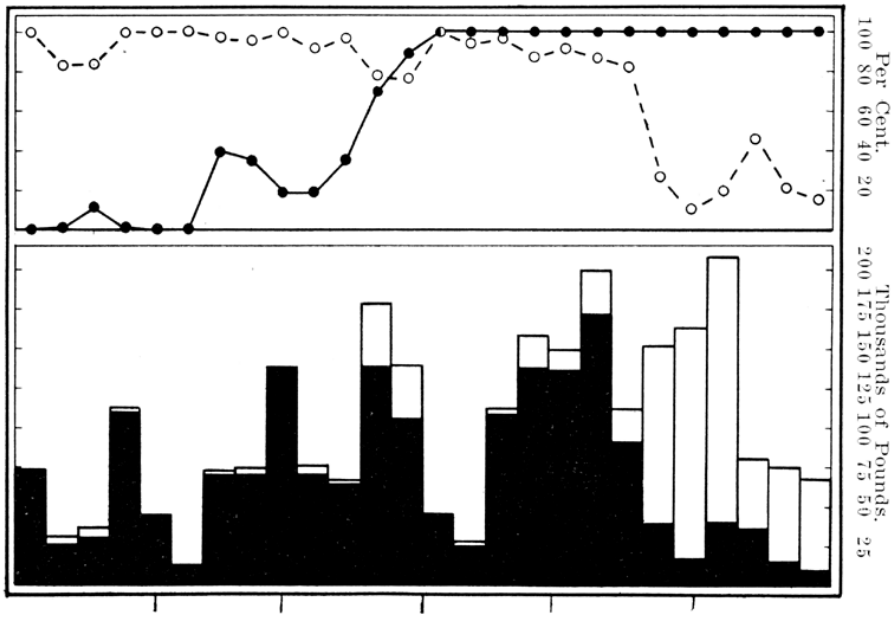

FIG. 12. Weekly landings of barracuda at fresh fish markets of San Pedro, from January 1, to July 1, 1922, according to source and gear.
Below: Black, amounts caught by purse seiners; white, by other boats.
Above: Solid line, percentage of local origin; broken line, percentage landed by purse seiners.

FIG. 12. Weekly landings of barracuda at fresh fish markets of San Pedro, from January 1, to July 1, 1922, according to source and gear

Table 17 presents the monthly amounts of barracuda sold in the fresh fish markets of San Pedro from January to June inclusive, 1922. In January, February, March, and April by far the greater portion of this

product was landed by purse seine boats. In January 95.5 per cent of all the barracuda handled by the fresh fish markets was taken with purse seine; the corresponding values for February, March, and April were 97.7 per cent, 85.3 per cent, and 92.3 per cent, respectively. In May the small gill net and round haul boats (see also page 24) began to be more important, landing 36.1 per cent of the monthly total of the markets; in June they were predominant, landing not less than 77.7 per cent of the corresponding total. During the first six months of 1922 not less than 70.4 per cent of all the barracuda handled by the fresh fish markets of San Pedro were taken with purse seine. Table 18 and figure 12 are based on the same material as Table 17, but instead of the monthly amounts they present the weekly amounts.

TABLE 19.—Monthly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1922 and Made into Fish Cake.

	Total amounts	Caught locally		Caught with purse seine		Average price in cents
		Amounts	Per cent of total	Amounts	Per cent of total	
January	19,420		0.0	19,420	100.0	4.4
February	18,703	17,843	95.4	18,703	100.0	3.5
March	69,761	60,921	87.3	38,872	55.7	3.4
April	45,589	45,589	100.0	15,367	33.7	3.2
May	221,649	221,649	100.0	67,998	30.7	2.9
June	882	882	100.0	882	100.0	4.0
Totals	376,004	346,884	92.2	161,242	42.9	

TABLE 19.—Monthly Amounts, in Pounds, of Barracuda Landed at San Pedro between January 1, and July 1, 1922 and Made into Fish Cake

Table 19 presents an analysis of the barracuda bought at San Pedro for canning purposes (fish cake) from January to June inclusive, 1922. It shows that the purse seiners during this period were less important to the canneries than to the fresh fish markets as a source of supply of barracuda. In January and February all barracuda sold to the canneries were caught by purse seiners; in March only 55.7 per cent; in April, 33.7 per cent; and in May 30.7 per cent. In June only a negligible quantity was canned. During these six months only 42.9 per cent of the total amount of barracuda sold for fish cake was landed by the purse seiners.

The last six months of the year have not been analyzed in the same careful way as the first six. The following statements are based on information gathered from dealers and fishermen, on personal observations, and on statistics of the California Fish and Game Commission.

In July, the small boats continue to be important in the barracuda fishery, not quite so important, however, as in June, many of them concentrating their efforts on the albacore. As soon as the barracuda leaves the neighborhood of the kelp beds, in other words in the middle of August, the gill net operations for this fish practically cease. In August, 1922, some of the gill net fishermen went as far as Point Conception in order to catch barracuda but with very poor results. On August 15, 1922, hardly any of them were operating. From the middle of August to the end of the year, the purse seiners are almost the only ones to bring in barracuda. As we have seen previously, most of the barracuda landed during this period is of Mexican origin. In 1922, the first purse seine boat left for Mexico on August 19.

That the purse seiners play such an unimportant role in the barracuda fishery during the summer is largely due to the fact that most of them are fishing for bluefin tuna during this time.

The main results of this analysis, therefore, are as follows: The small boats, *i. e.*, the gill net and round haul boats, can furnish the fresh fish markets at San Pedro with a rich supply of barracuda only from the middle of May to the middle of August. Furthermore, they depend almost entirely upon local waters for their catches. During the remainder of the year, the markets depend upon the purse seiners for their supply of this fish. The barracuda landed during the purse seine period are largely of Mexican origin.

It should be emphasized in this connection that gill netting for barracuda occurs almost solely during the spawning period of this fish. The purse seiners, on the other hand, operate for barracuda largely when this fish is not spawning.

Los Angeles County is by far the most important center of the barracuda fishery of southern California. In so far as purse seining is concerned, it dominates, as nearly all purse seine boats of this region have San Pedro as their home port. The last fact makes it very probable that in the remaining counties purse seining for barracuda is decidedly less important relatively. The analysis given above, therefore, can not be considered as representative of the other counties of southern California.

d. Why is Gill Netting Successful Only During The Summer?—The fact that the gill net fishermen of southern California land but small quantities of barracuda from September to May evidently seems to indicate that they are unable to catch this fish in profitable amounts during this period. In this connection it should be remembered, that, as a rule, the prices obtained by the fishermen for this fish are decidedly higher during the winter months than in the summer.

Has gill netting for barracuda in southern California always been restricted largely to the summer? In order to obtain an understanding of this important question, inquiries have been made at San Pedro among dealers and fishermen who have been in the fishing industry of southern California for a good many years. The information thus gathered is highly contradictory and probably not always unbiased. Some of these persons said that in former times the small boats made fair catches of barracuda throughout the whole year, and assumed that overfishing caused by purse seiners was the reason why these boats nowadays can not operate profitably for this fish from September to May. They expressed the conviction that the small boats could have supplied even the present great demand for barracuda throughout the year, if the purse seiners had never been operating in our waters. They admitted, however, that even formerly these boats caught but rather small quantities of this fish in January and February. On the other hand, other persons maintained that the small boats made large catches only occasionally during the period from September to May even before the purse seiners began their operations. Furthermore, they expressed the opinion that the small boats would have been unable to furnish the fresh fish markets nowadays with a sufficient supply of barracuda during the winter months, even if the purse seine method had never been introduced here.

For further illumination of this important phase of the purse seine problem, a number of old ledgers belonging to fish dealers at San Pedro were examined. These ledgers covered the years 1912, 1913, and 1914, in other words the period preceding the year in which the first purse seine boats began extensive operations (1915). The incompleteness of the sources made it impossible to reach any definite conclusions. For instance, the sizes of the individual catches could not be established. In those years as well as now, large catches were divided between several dealers. However, the examination showed that the small boats during those three years landed comparatively large quantities of barracuda at San Pedro between September and May. When compared with the summer catches, the winter catches were small even then. January and February were represented poorly. It seems very doubtful that the supply of barracuda landed would have been sufficient to cover, even to a reasonable extent, the present highly increased demand.

However, even granted that in those early years the small boats landed fairly large catches, it does not necessarily follow that the change is due to the operations of the purse seiners. Great fluctuations often occur in marine fisheries as the results of hydrographic and biological changes. Indeed, we have reasons to suppose that great natural fluctuations do occur in the barracuda fishery of California. For instance, during the last ten years the species has repeatedly disappeared and reappeared in the northern part of its range of distribution, yet these fluctuations can not possibly have been caused by periodical over-fishing. In 1916 only 453 pounds of barracuda were landed in the districts north of San Louis Obispo County, and in 1917 and 1921 the corresponding values were 275 pounds and 71 pounds, respectively. On the other hand, the landings of this fish in 1918, 1919, and 1920 amounted to not less than 121,631 pounds, 99,797 pounds, and 105,843 pounds, respectively. Furthermore, it must be remembered that the gill net and round haul boats certainly would have greatly increased in number, if the purse seine method had not been introduced. It is a moot question whether this increase would not have resulted in as much injury to our natural supply of barracuda as that caused by the purse seiners. It should be remembered in this connection that gill netting for barracuda is most sucessful during the spawning season of this fish.

e. Catching of Undersized Barracuda.—The gill net fishermen catch but relatively small amounts of illegal, "undersized" barracuda, in other words barracuda weighing less than three pounds each. This is due to the fact that they use nets with meshes so large that the undersized fish can pass through.

The purse seiners, on the other hand, frequently catch undersized barracuda, sometimes even in large quantities. According to information given by a great number of purse seine fishermen, most of the undersized barracuda are taken in March and April in the district from Los Coronados Islands to a point half way between Oceanside and Point San Juan. During these two months, as we have seen previously (page 34), the barracuda frequently occur in very large schools in this district, and a fairly great percentage of the fish in these schools weigh less than three pounds each. However, during the remaining months

of the year and in other districts of southern California undersized barracuda also are taken by the purse seiners. Generally speaking, the smallest barracuda caught with purse seine weigh between one pound and one pound and a half.

In order to establish with as great certainty as possible the season during which most of the undersized barracuda are taken, the records of seizures of undersized fish, made by the California Fish and Game Commission, have been examined. Unfortunately, these records do not permit any conclusions regarding this problem. The seizures recorded apparently were made sporadically, and most of them represented but small quantities, usually only a few hundred pounds each. When a catch of barracuda is made up of legal sized and undersized fish, the undersized fish, as a rule, are either liberated after the legal sizes have been picked out from the "bunt" of the seine while this is kept in the water, or they are picked out and thrown overboard after the catch has been landed on board the purse seine boat. Generally speaking, when undersized barracuda are seized on board the boats or in the markets, they are fish overlooked by the fishermen in the process of sorting the catch.

The question now arises: What percentage of the undersized barracuda caught by the purse seiners is killed? In order to obtain evidence illuminating this important phase of the purse seine problem, several trips were made on board purse seine boats in May and June, 1922. Unfortunately, the data collected during these trips are not sufficient for a well founded judgment of the question. This failure is due to the circumstance that large, supposedly destructive catches of small barracuda apparently are very rare in May and June; in any case, no such catches were seen. An investigation to settle this question should be undertaken in March and April, when, according to available information (see above), most of the undersized barracuda probably are caught.

However, the following observations made on board a purse seine boat may be of a certain importance for an understanding of this question. Some hauls for barracuda were made with a purse seine, in which a part of the web had 3½ to 4-inch mesh and the rest 2½-inch mesh. In the located schools undersized fish, weighing from one to three pounds each, were mixed with legal sized fish. When the seine was hauled in, the web with 3½ to 4-inch mesh contained a very large amount of gilled, undersized barracuda; on the other hand, in the portion of the sein with the 2½-inch mesh only a few barracuda were gilled. The gilled fish were pulled out of the web with all possible speed and thrown overboard. Probably more than 90 per cent of them apparently were strong and active, when thrown back into the water; with more or less powerful swimming strokes, they disappeared almost immediately into deeper water. However, a great number of these fish probably succumbed fairly soon; in most cases, their gill covers were badly broken, or they were injured in other ways to an extent probably sufficient to cause death.

In this connection it may be mentioned, that purse seine fishermen have told me, that they sometimes find the bottom of the sea or the beach littered with dead barracuda at places where a few days before purse seine hauls were made in which a great quantity of undersized

barracuda were gilled and thrown overboard. Furthermore, the purse seiners admit that, when very large quantities of undersized barracuda are gilled, knives sometimes are used to cut the gilled fish in two parts in order to save time and to prevent the tearing of the web.

In hauls observed by me, the undersized barracuda that did not gill were liberated after the legal sized fish had been picked out, while the "bunt end" of the seine was still in the water. All the fish thus liberated survived, as far as I was able to judge. However, it should be mentioned that these catches were rather small; the fish, therefore, were kept in the "bunt end" of the seine for a short while only, and were not badly crowded. On the other hand, when very large catches are made, the fish are kept fairly long in the "bunt end," where they are badly beaten and crammed. In such cases the great majority of the undersized fish probably are dead or nearly so before they are liberated, even if they never are pulled out of the water. Moreover, when very large catches are made, the undersized barracuda generally are not picked out and thrown overboard until the catch is landed on the boat and the fish are dead. Because of their destructiveness to the young fish, very large catches should be avoided as much as possible. Generally speaking, the most destructive catches of this kind seem to be made, as mentioned previously, in March and April in the region from Los Coronados Islands to a point half way between Oceanside and Point San Juan.

The great majority of the purse seine fishermen prefer web of 2½-inch mesh in the "white fish" seines, because undersized barracuda do not gill so readily in this kind of web. The gilling of the young barracuda results in hard and unprofitable work. When large meshes are used, it sometimes happens, that the crew must work for twelve hours or more in order to clean the seine from the gilled fish. Furthermore, gilling is detrimental to the seines for two reasons: the meshes are apt to be torn when the gilled fish are pulled out, and the fish slime, which is very hard to wash off, contributes greatly to the spoiling of the web. The general use of small sized mesh in the web of the "white fish" seines is the result of extensive practical experience. Mesh smaller than 2½ inches probably will not be used by the purse seiners, since small meshes mean expensive web and heavy pulling in the closing of the seine. Speedy pursing is of vital importance in this fishery.

Generally speaking, what is true in the purse seine fishing is also true in the round haul fishing.

As will be seen from this section, our knowledge about the destruction of undersized barracuda in southern California is very incomplete and unsatisfactory. The gill net fishermen catch almost solely legal sized barracuda. On the other hand, the purse seiners and the round haul fishermen undoubtedly kill large quantities of undersized fish of this species. Large catches of barracuda made with purse seine and round haul net are more destructive relatively than small catches or catches of moderate sizes. Most of the large catches seem to be made in March and April. Further investigations in this field should be undertaken as soon as possible.

f. Effect of Weight Limit. Proposed Change to Length Limit.—Opponents to the present size limit on barracuda maintain that it is

a loss to the state to let the caught undersized fish go to waste by throwing them overboard in a dead or dying condition. Although this is true, it does not disprove the efficiency of the regulation. This statement is based on the following observations. Purse seining for barracuda in southern California to a large extent is carried on during the night, when the fish are located by the "phosphorescence" in the water. This method of fishing enables the fishermen to tell with a fair degree of accuracy whether the located schools are made up predominantly of small or of large fish. I was able to verify this statement on several occasions during my trips in the summer of 1922. Also by daylight the purse seiners can distinguish fairly well, although with less accuracy, between schools of large and small fish. An unsuccessful purse seine haul or a haul of moderate success requires about one hour for completion. In order to avoid loss of time and unprofitable work, the fishermen, as a rule, refuse to take chances on schools of barracuda which they have reasons to suppose are composed largely of undersized fish. The loss of time caused by a haul for such a school might result in the loss of a big catch of legal sized fish. Thus large quantities of small barracuda are saved. Furthermore, the fishermen sometimes open their seine and liberate the catch as soon as they find out that the fishes largely are undersized. At any rate, the better elements among the fishermen are apt to do so; others, led by greed, might not hesitate to destroy a large quantitiy of undersized fish for the sake of a small amount of legal sized.

It should be mentioned in this connection that it seems to be rather difficult for most of the fishermen, when sorting out the undersized barracuda, to determine with a fair amount of accuracy whether or not the fish between 2 ½ and 3 ½ pounds are of legal size. Some purse seiners were tested in this respect and were found to make many mistakes. The weight of fish of the same length is fairly variable. Another argument against the weight limit is that large quantities of barracuda (nearly all the Mexican) are landed in a gutted condition. It has been suggested by fishermen and dealers that the present weight limit on barracuda should be replaced by a length limit. A length of twenty-five inches, measured from the tip of the snout to the middle of the posterior edge of the caudal fin, would correspond fairly closely to the present weight limit. The barracuda should be landed without their heads removed.

It also should be mentioned that the present size limit on the barracuda seems to be arbitrary. If a size limit on this fish should be maintained, which is a problem of its own requiring a careful investigation, it would be most reasonable to apply, for instance, the principle that has been suggested in the case of the plaice of the North Sea. In other words, the barracuda should be permitted to be marketed when, after its period of relatively rapid growth, it enters into its period of relatively slow growth. In order to establish the most rational size limit, an investigation of the rate of growth of this fish should be undertaken.

g. Relative Destructiveness of Different Gear.—It may be regarded as certain that damage to the natural supply of barracuda is caused by the killing of small fish in the purse seine and round haul operations. However, we may be apt to over-estimate the amounts of small

fish destroyed by these fishing methods and to carry our generalizations regarding the relative importance of small fish beyond the limits of established facts. As a matter of fact, an attempt to penetrate below the surface of these important phases of the problem of conservation will show how surprisingly little we know in this field. The natural mortality among the abundant young year classes presumably is very high, but nothing certain is known on this point; in other words, the relative value to the commercial fisheries of these year classes of barracuda is not established as yet. It can not be too urgently recommended that these problems be submitted to a careful and exhaustive investigation. Their solutions are essential to a rational consideration of future regulations of the barracuda fishery. It probably would be best to begin such an investigation in the early months of the spring, *e. g.*, in March.

Furthermore, even though the gill net fishermen catch but negligible amounts of undersized barracuda, they certainly are far from harmless to the natural supply of this species. This statement is contrary to the opinion generally held by persons interested in the future of our harracuda fishery. As has been emphasized previously, gill netting for barracuda in southern California is carried on largely in May, June, July, and August. These months constitute the spawning period of this fish. In other words, the gill net fishermen curtail the propagation of the barracuda by destroying ripe spawn in enormous quantities just before it is ready to be discharged. This curtailment should be remembered when the future of the barracuda and the regulation of the purse seine fishery are under consideration. However, again it must be emphasized that an investigation of the biology of this species is needed. We know that a very large quantity of ripe spawn is destroyed; but we do not know, what would have been the relative importance of this spawn to the repopulation of the species, had it not been destroyed.

5.1.4. D. *Over-Fishing*

The question as to whether or not the barracuda of southern California is being over-fished at the present time, of course, can not be settled as yet. No scientific proofs bearing on this problem are available. A solution of this important problem requires a careful analysis of the catches of several consecutive years. Investigations in this field should be begun as soon as possible.

Table 20 and figure 13 present, as far as statistical data are available, the annual yields of the barracuda fishery in California (in local and in Mexican waters) since 1889. The values from 1889 to 1915 inclusive are from the Reports of the United States Bureau of Fisheries;* those for 1916 to 1921 inclusive are from the statistics of the California

* Wilcox, W. A.—The Fisheries of the Pacific Coast; pp. 160–167. Rep. U. S. Com. Fish. Part XIX (1895).

Fish and Game Commission. Only the values for the last four years can be considered to be of relatively high accuracy.** But even though the data presented should be accepted with a certain reservation, they certainly give a fairly good illustration of the development and general trend of this fishery.

This table and figure show that the barracuda fishery of California has increased almost steadily from 1889 to 1921 inclusive. The decrease from 1915 to 1916 probably is apparent; very likely it is due to the change in the statistical methods.

TABLE 20.—Annual Amounts, in Pounds, of Barracuda landed in California, according to Origin.

	Southern California	Mexico	California	California and Mexico
1889	467,658			500,714
1890	488,689			511,078
1891	677,208			694,793
1892	326,804			326,804
1895	938,674			979,674
1899				1,191,505
1904	1,922,412			2,159,282
1908				3,205,000
1915				3,592,646
1916	2,226,540	460,369	2,226,993	2,687,362
1917	2,965,093	94,955	2,965,368	3,060,323
1918	3,764,060	951,593	3,885,691	4,837,284
1919	3,939,055	1,786,105	4,038,852	5,824,957
1920	4,479,545	3,615,947	4,585,388	8,201,335
1921	4,588,829	3,036,262	4,588,900	7,625,162

TABLE 20.—Annual Amounts, in Pounds, of Barracuda landed in California, according to Origin

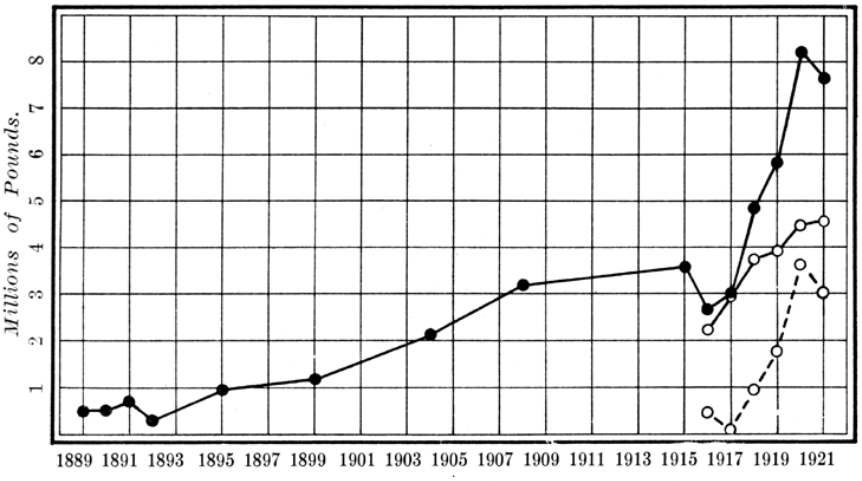

FIG. 13. The development of the barracuda fishery in California. Solid line and dots, total landings. Solid line and circles, landings of local origin in southern California. Broken line, of Mexican origin.

FIG. 13. The development of the barracuda fishery in California. Solid line and dots, total landings. Solid line and circles, landings of local origin in southern California. Broken line, of Mexican origin

The annual landings of local barracuda, represented by the unbrokenline and open circles in figure 13, show during the period from 1916 to 1921 inclusive, an increase from 2,226,540 pounds to 4,588,829 pounds; in other words, the annual yield of this fishery about doubled during these six years. The past two years of this period, i. e., 1920 and 1921, yielded about equal amounts. This last fact is remarkable when

** The discrepancy between these figures and those given by Mr. W. F. Thompson in his paper on "The Fisheries of California and Their Care," published in CALIFORNIA FISH AND GAME, is due to the fact that Mr. Thompson used the figures published by the Commission in CALIFORNIA FISH AND GAME, while the ones used in the present report are revised and unpublished figures.

the decrease in the number of operating purse seine boats is considered. In 1920 there were more than 100, possibly 125, in 1921 only between 65 and 85 purse seine boats operating in southern California. Judging from a comparison between the amount landed during the first six months of 1921 and the corresponding amount for 1922, viz., 3,450,403 pounds and 3,081,830 pounds, respectively, 1922 probably will show a decline in the yield of local barracuda. (As we have seen previously, the first six months of the year represent by far the most important period of the local barracuda fishery.)

Nearly all the barracuda caught in California waters are taken in the southern counties. Only small amounts are landed north of San Luis Obispo County; for instance, in 1921 only 71 pounds of this fish were recorded north of this county. (However, the yield of the barracuda fishery of the northern counties has been subject to decided fluctuations during the last few years; page 46 and Table 1.

Still more striking is the increase, since 1916, in the amount of Mexican barracuda landed in California; in figure 13 this category is represented by a broken line and open circles. In 1916 only 460,369 pounds were landed, in 1921 not less than 3,036,262 pounds. 1920 was the highest year during this period, yielding 3,615,947 pounds. The decrease in 1921 certainly was caused by the decrease in the number of operating purse seine boats. As to the inaccuracy of the records of Mexican barracuda, see above, page 40.

The total yearly catches, therefore, do not indicate any decline in the natural supply of the local and Mexican barracuda. However, the evidence from an increase in the total annual yields of a fishery is too deceptive to serve as a basis for the conclusion that overfishing is not taking place. It has been shown repeatedly that overfishing can occur even while the annual yields are increasing steadily.

The shifting of the fishing operations to more distant regions often is indicative of depletion of the home supply. However, the enormous increase in the landings of Mexican barracuda in southern California during the last few years hardly can be considered as a sign of overfishing of the local barracuda. As has been pointed out previously, this species is decidedly periodical in the waters of southern California. Practically all the Mexican barracuda landed by California fishermen in southern California are taken during the season of scarcity of local barracuda. During April, May, June, and July, when the local barracuda operations are most successful, hardly any of our boats go to Mexico for this fish. It may be mentioned in this connection, that the elimination of the purse seine fleet, upon which our supply of Mexican fish depends, almost certainly would increase the strain on the local barracuda.

Among the more intelligent barracuda fishermen and fish dealers at San Pedro, there is, however, a very strong feeling almost amounting to conviction that even now the toll taken from the natural supply of local barracuda is too heavy, and that the stock begins to show decided indications of decrease. These persons have repeatedly suggested to me that some protective laws be passed in order to safeguard the natural supply of barracuda in southern California. Some of them want the purse seine method eliminated, others want a size limit on the mesh of the purse seines established, and still others prefer a close

season. All of them seem to agree that if no protective measures are taken, this important fishery will be seriously damaged within a few years.

The enormous increase in the annual yields during the last few years certainly makes every friend of conservation wonder whether the local baracuda can stand such a strain, and whether it would not be wise to pass measures to counteract the disastrous effects of our highly developed fishing methods.

5.2. 2. White Sea Bass

5.2.1. A. *Occurrence in the waters of southern California*

Judging from information gathered among fishermen operating in these waters, the white sea bass has about the same occurrence in southern California as the barracuda. However, in some years this fish appears in large quantities as early as February, and, as a rule, it does not disappear until the last part of September or even October.

5.2.2. B. *Spawning*

Very little information can be given as yet as to the spawning of the white sea bass in southern California. During July and August 1922, white sea bass were examined in the fresh fish markets of San Pedro. The fish examined seemed to be spent, and the ovaries contained eggs of different sizes. Fish cleaners in these markets informed me that this fish is full of spawn in April, May, and June. According to the ledgers of the fish dealers, fairly large quantities of white sea bass roe are sold in the beginning and in the middle of May. This roe is used when approaching maturity, and not when ripe. These facts seem to indicate that in southern California this fish has its main spawning season in May and June.

5.2.3. C. *Fishery*

a. Seasonal Distribution of Catch.—For reasons similar to those given in the case of the barracuda (p. 37), the monthly landings in Los Angeles County will suffice to illustrate the seasonal distribution of the catches of white sea bass in southern California. Table 21 and figure 14 show the relative importance of the different counties in this region with regard to this fishery.

TABLE 21.—Amounts of White Sea Bass (Including Sea Trout), in Pounds, Landed in Southern California, according to Counties.

	San Luis Obispo, Santa Barbara and Ventura counties	Los Angeles County	Orange County	San Diego County	Mexico	Total weight for Southern California	Total weight for Southern California and Mexico
1916—Jan. 1-Mar. 31	1,000	81,058		1,445		83,503	83,503
Apr. 1-June 30	2,471	*138 59,198	*10 277	8,229	8,580	71,323	79,903
July 1-Sept. 30	3,561	*632 107,646	130	2,072	289,392	114,041	403,433
Oct. 1-Dec. 31	11,286	17,547	20	1,675	23,052	30,528	53,580
Totals	18,318	266,219	437	14,421	321,024	299,395	620,419
1917—Jan. 1-Mar. 31		57,452	60	4,290	725	61,802	62,527
Apr. 1-June 30	250	*160 354,014	*1,109 6,652	75,390	23,975	437,575	461,550
July 1-Sept. 30	2,405	*371 142,185	2,391	176,596		323,948	323,948
Oct. 1-Dec. 31	5,114	*36 19,776		7,998	6,110	32,924	39,034
Totals	7,769	573,994	10,212	264,274	30,810	856,249	887,059
1918—Jan. 1-Mar. 31	40	23,445		5,370		28,855	28,855
Apr. 1-June 30	1,194	*15 204,785	659	*58 50,957	7,880	257,668	265,548
July 1-Sept. 30	59,384	*537 630,600	395	*276 21,912	146,903	713,104	860,007
Oct. 1-Dec. 31	4,030	*4,350 156,648	*941	*12 10,703	70	176,684	176,754
Totals	64,648	1,020,380	1,995	89,288	154,853	1,176,311	1,331,164
1919—Jan. 1-Mar. 31		*1,655	*15	*862	*42		
Apr. 1-June 30	681	57,357 *5,193	56	5,933 *2,001	3,425	66,559	70,026
July 1-Sept. 30	3,275	720,033 *7,218	295	27,051 *2,698	2,510	757,848	760,358
Oct. 1-Dec. 31	22,018	828,112 *1,319	2,259	63,482 *15	36,490 *335	925,787	962,277
Totals	3,589	230,952	21	7,184	31,852	243,080	275,267
1920—Jan. 1-Mar. 31	29,563	1,851,839	2,646	109,226	74,654	1,993,274	2,067,928
Apr. 1-June 30	1,097	*1,044 395,172	467	*5,689 6,039	*5,562 47,159	409,508	462,229
July 1-Sept. 30	20,353	*8,901 777,062	*250 1,964	*615 124,641	9,845	933,786	943,631
Oct. 1-Dec. 31	71,838	*554 630,705	*20 5,516	72,178	158,156	780,811	938,967
Totals	28,778	60,228	1,134	*42 2,733	31,740	92,915	124,655
1921—Jan. 1-Mar. 31	122,066	1,873,666	9,351	211,937	252,462	2,217,020	2,469,482
Apr. 1-June 30	1,358	*92 43,293	*2,510 142	39,194	*6,568 85,439	86,589	178,596
July 1-Sept. 30	3,427	*29 974,202	*833 1,870	*700 125,739	10,449	1,106,800	1,117,249
Oct. 1-Dec. 31	38,317	*27 552,045	*834 3,365	*387 99,959	192,423	695,734	888,157
Totals	11,604	*15 89,678	*2,033 192	* 135 20,428	*3,400 201,796	124,585	329,781
	56,006	1,659,381	11,779	286,542	500,075	2,013,708	2,513,783

*Sea trout placed above the corresponding amount of "bass." Sea trout is included in all totals.

TABLE 21.—Amounts of White Sea Bass (Including Sea Trout), in Pounds, Landed in Southern California, according to Counties

The monthly landings of this fish in Los Angeles County during 1919, 1920, and 1921, are presented in table 22, table 23, table 24, and table 25, and in figure 11. The data show that, as a rule, April, May, June, July, August, and September, in other words the six summer months, yield the heaviest local catches of this species. In 1919, of the yearly total catch 9.2 per cent was landed in April, 16.2 per cent in May, 13.7 per cent in June, 16.6 per cent in July, 18.2 per cent in August, and 10.3 per cent in September. For 1920, the corresponding values were 17.1 per cent, 13.6 per cent, 11.3 per cent, 5.7 per cent, 16.7 per cent, and 11.2 per cent. For 1921, they were 13.8 per cent, 16.7 per cent, 28.1 per cent, 12.8 per cent, 12.4 per cent, and 8.0 per cent. The corresponding averages for these three years were 13.4 per cent, 15.5 per cent, 17.3 per cent, 11.6 per cent, 15.9 per cent, and 9.9 per cent. From these figures it is evident that the local white sea bass fishery is less concentrated in time than is the local barracuda fishery.

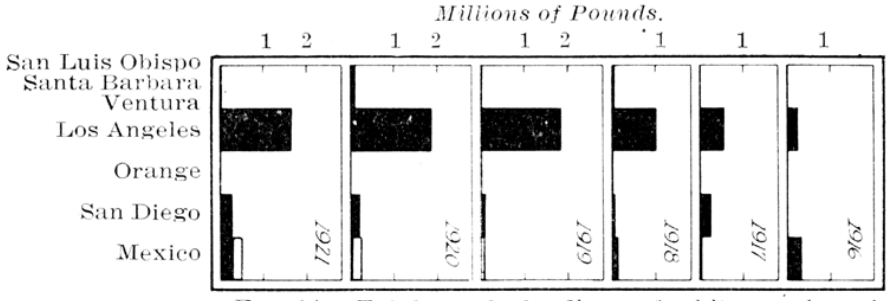

FIG. 14. Total yearly landings of white sea bass in southern California, according to counties. Of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black.

TABLE 22.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1919

TABLE 22.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1919.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	41,898	100.00	2.26		0.00	41,898	2.25
February	5,889	100.00	0.32		0.00	5,889	0.32
March	11,225	79.62	0.61	2,875	21.31	14,100	0.76
April	170,582	100.00	9.21		0.00	170,582	9.14
May	300,932	100.00	16.25		0.00	300,932	16.13
June	253,712	100.00	13.70		0.00	253,712	13.60
July	307,119	100.00	16.58		0.00	307,119	16.46
August	337,945	99.86	18.24	475	3.52	338,420	18.14
September	190,266	99.94	10.27	110	0.82	190,376	10.21
October	43,842	87.64	2.37	6,186	45.83	50,028	2.68
November	107,693	97.01	5.81	3,224	23.89	110,917	5.95
December	80,736	99.23	4.36	626	4.64	81,362	4.36
Totals	1,851,839	99.28	99.98	13,496	100.01	1,865,335	100.00

FIG. 14. Total yearly landings of white sea bass in southern California, according to counties. of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black

TABLE 23.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1920.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	4,246	15.33	0.23	23,429	36.63	27,675	1.43
February	283,536	93.64	15.13	19,261	30.10	302,797	15.62
March	108,434	97.06	5.79	3,280	5.13	111,714	5.77
April	320,304	99.93	17.09	225	0.35	320,529	16.53
May	254,007	100.00	13.56		0.00	254,007	13.11
June	211,652	100.00	11.29		0.00	211,652	10.92
July	107,696	100.00	5.75		0.00	107,696	5.56
August	313,334	100.00	16.72		0.00	313,334	16.17
September	210,229	99.68	11.22	673	1.05	210,902	10.88
October	9,735	61.10	0.52	6,197	9.69	15,932	0.82
November	33,929	79.03	1.81	9,004	14.07	42,933	2.22
December	16,564	89.66	0.88	1,911	2.99	18,475	0.95
Totals	1,873,666	96.69	99.99	63,980	100.01	1,937,646	99.98

TABLE 23.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1920

TABLE 24.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	2,051	94.60	0.12	117	0.04	2,168	0.11
February	11,405	43.51	0.69	14,812	4.50	26,217	1.32
March	29,929	31.59	1.80	64,841	19.71	94,770	4.77
April	229,284	99.86	13.82	324	0.10	229,608	11.54
May	278,021	100.00	16.75		0.00	278,021	13.98
June	466,926	100.00	28.13		0.00	466,926	23.48
July	212,516	97.67	12.81	5,077	1.54	217,593	10.94
August	205,993	81.06	12.41	48,152	14.63	254,145	12.78
September	133,563	78.53	8.05	36,512	11.10	170,075	8.56
October	12,938	32.50	0.78	26,862	8.17	39,800	2.00
November	52,162	28.64	3.14	129,390	39.33	181,552	9.13
December	24,593	89.64	1.48	2,842	0.86	27,435	1.38
Totals	1,659,381	83.47	99.98	328,929	99.98	1,988,310	99.99

TABLE 24.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County, According to Source—1921

TABLE 25.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County According to Source Averages, 1919 to 1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	16,065	6.18	0.90	7,849	5.80	23,914	1.24
February	100,277	89.83	5.59	11,358	8.38	111,635	5.78
March	49,863	67.82	2.78	23,665	17.46	73,528	3.81
April	240,057	99.93	13.37	183	0.14	240,240	12.44
May	277,653	100.00	15.46		0.00	277,653	14.38
June	310,763	100.00	17.30		0.00	310,763	16.10
July	209,110	99.20	11.65	1,692	1.25	210,802	10.92
August	285,757	94.63	15.92	16,209	11.97	301,966	15.64
September	178,019	93.47	9.92	12,432	9.18	190,451	9.87
October	22,172	62.89	1.23	13,082	9.66	35,254	1.83
November	64,595	57.78	3.60	47,206	34.84	111,801	5.79
December	40,631	95.77	2.26	1,793	1.32	42,424	2.20
Totals	1,794,962	92.98	99.98	135,469	100.00	1,930,431	100.00

TABLE 25.—Monthly Landings of White Sea Bass (Including Sea Trout) in Los Angeles County According to Source Averages, 1919 to 1921

In October, November, December, and January the local catches of this species, as a rule, are rather small. These months show the following average local catches expressed in percentages of the average yearly local total: October, 1.2 per cent; November, 3.6 per cent; December, 2.3 per cent; January, 0.9 per cent (Table 25).

In February and March, too, the local catches of this species generally are small; 1920 is an exception to this rule. Expressed in the same way as above, the landings of local white sea bass were 0.3 per cent and 0.6 per cent in February and March 1919. In 1921 the corresponding values were 0.7 per cent and 1.8 per cent. In 1920 they were as high as 15.1 per cent and 5.8 per cent.

For reasons similar to those given in the case of the barracuda (p. 40), the amounts of local white sea bass recorded during the winter months probably are somewhat too high. However, because of the relatively small amounts of white sea bass taken in Mexico, the discrepancy presumably is almost negligible.

While the Mexican barracuda is extremely important to the fresh fish markets of San Pedro because of the fact that it tends to equalize the available supply of this fish throughout the year, the yields of the Mexican white sea bass operations are relatively unimportant to the fish trade of southern California. In 1919 not less than 99.3 per cent of the yearly total amount of white sea bass landed in Los Angeles County was of local origin, and in 1920 and 1921 the corresponding values were 96.7 per cent and 83.5 per cent, respectively.

Most of the Mexican white sea bass landed in California is taken from August to March inclusive. The heaviest catches are in November and in March. From 1919 to 1921 inclusive, these two months yielded on the average 34.8 per cent and 17.5 per cent of the annual Mexican catch of this species.

b. Increase in, and Ports of Entry of, the Mexican Supply.—The trend of the supply of Mexican white sea bass landed in California is shown in tables 26 and 29 and in figure 17. In 1916 not less than 51.7 per cent of all the white sea bass landed in California was of Mexican origin. The landings recorded were not very large, however; they amounted to only 321,024 pounds. The corresponding values for 1917 to 1921 inclusive were 3.5 per cent, 11.6 per cent, 3.6 per cent, 10.2 per cent, and 19.9 per cent. These figures show that the Mexican supply of this fish never was important during the last mentioned years. However, from 1919 it shows an upward trend.

TABLE 26.—Yearly Amounts, in Pounds, of White Sea Bass (Insluding Sea Trout) Landed in Southern California.

	Landed in Southern California			Landed in Los Angeles County	
	Total weight from Southern California and Mexico	Total weight from Mexico	Per cent of Mexican origin	Total weight of Mexican origin	Per cent of Mexican total
1916	620,419	321,024	51.7		
1917	887,059	30,810	3.5		
1918	1,331,164	154,853	11.6		
1919	2,067,928	74,654	3.6	13,496	18.1
1920	2,469,482	252,462	10.2	63,980	25.3
1921	2,513,783	500,075	19.9	328,929	65.8

TABLE 26.—Yearly Amounts, in Pounds, of White Sea Bass (Including Sea Trout) Landed in Southern California

The Mexican white sea bass of California is landed either at San Diego or at San Pedro. In 1919 and 1920 most of this fish was landed at San Diego; in these two years only 18.1 per cent and 25.3 per cent, respectively, of the yearly Mexican total of this fish were landed at San Pedro. On the other hand, in 1921 not less than 65.8 per cent was handled by the San Pedro dealers. This change is the more significant as the amount landed in this year was much larger than the amounts of the two preceding years (Table 26).

c. Relative Importance of Different Fishing Gear.—The methods used in the white sea bass fishery of southern California have undergone a development similar to that previously described for the barracuda (p. 42).

In order to establish the relative importance of purse seining in the white sea bass fishery of Los Angeles County, the fishing records of this county for the first six months of 1922 have been submitted to a careful analysis. Information gathered among fishermen and dealers seems to indicate that this analysis is fairly representative of the corresponding period in other years. It should be recalled that all the sea bass landed goes into the fresh fish trade; the species is not used for canning purposes.

TABLE 27.—Monthly Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and July 1, 1922

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
January	41,909	928	2.2	41,046	97.9
February	2,875	2,542	88.4	2,403	83.6
March	157,503	147,345	93.6	110,476	70.1
April	203,172	203,172	100.0	143,471	70.6
May	259,033	259,033	100.0	156,745	60.5
June	384,541	384,541	100.0	40,273	10.5
Totals	1,049,033	997,561	95.1	494,414	47.2

TABLE 27.—Monthly Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and July 1, 1922

TABLE 28.—Weekly Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and July 1, 1922.

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
Jan. 1-7	38,448	147	0.4	38,371	99.8
Jan. 8-14	776	261	33.7	515	66.4
Jan. 15-21	1,996	272	13.6	1,693	84.9
Jan. 22-28	672	231	34.4	467	69.5
Jan. 29-Feb. 4	69	41	59.4	28	40.6
Feb. 5-11	240	240	100.0		0.0
Feb. 12-18	162	162	100.0		0.0
Feb. 19-25	2,375	2,070	87.2	2,375	100.0
Feb. 26-Mar. 4	2,682	2,682	100.0		0.0
Mar. 5-11	9,187	9,187	100.0	411	4.7
Mar. 12-18	2,939	2,939	100.0	1,059	36.0
Mar. 19-25	39,148	28,990	74.1	35,405	90.5
Mar. 26-Apr. 1	121,547	121,547	100.0	90,822	74.7
Apr. 2-8	33,299	33,299	100.0	25,042	75.2
Apr. 9-15	3,058	3,058	100.0	83	2.7
Apr. 16-22	87,151	87,151	100.0	50,017	57.4
Apr. 23-29	61,710	61,710	100.0	51,108	82.8
Apr. 30-May 6	49,461	49,461	100.0	41,135	83.2
May 7-13	14,518	14,518	100.0	6,680	46.0
May 14-20	21,516	21,516	100.0	13,285	61.8
May 21-27	158,665	158,665	100.0	90,634	57.1
May 28-June 3	23,929	23,929	100.0	5,138	21.5
June 4-10	104,494	104,494	100.0	10,298	9.9
June 11-17	201,781	201,781	100.0	7,230	3.6
June 18-24	28,696	28,696	100.0	3,225	11.2
June 25-30	40,514	40,514	100.0	19,393	47.9
Totals	1,049,033	997,561	95.1	494,414	47.2

TABLE 28.—Weekly Amounts, in Pounds, of White Sea Bass Landed at San Pedro between January 1, and July 1, 1922

The results of this analysis are presented in table 27 and table 28, and in figure 15. During January 97.9 per cent of the total monthly catch of white sea bass was landed by the purse seiners; for February the corresponding value was 83.6 per cent; for March, 70.1 per cent; for April, 70.6 per cent; and for May, 60.5 per cent. In June only 10.5 per cent of the total monthly catch was taken with purse seine. During these six months 47.2 per cent of the total amount of sea bass landed was caught by purse seiners. The white sea bass not taken with purse seine was landed mainly by gill net and round haul fishermen. The round haul method probably is more important than the gill net method in this fishery.

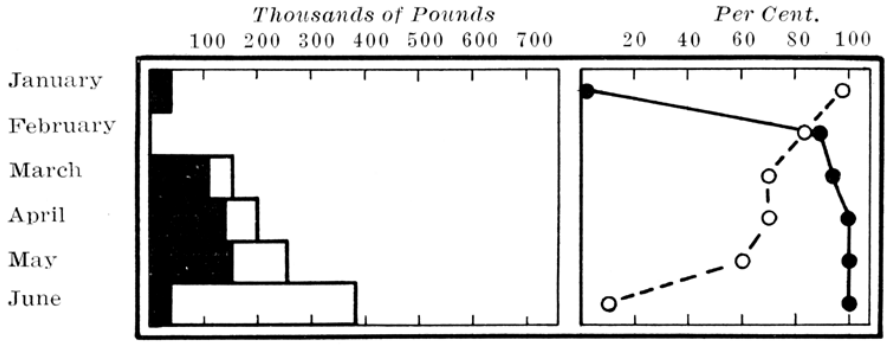

FIG. 15. Monthly amounts of white sea bass landed at fresh fish markets of San Pedro during the first half of 1922 according to source and gear.
Below: Black, amounts caught by purse seiners; white, by other boats.
Above: Solid line, percentage of local origin; broken line, percentage landed by purse seiners.

FIG. 15. Monthly amounts of white sea bass landed at fresh fish markets of San Pedro during the first half of 1922 according to source and gear

The last six months of the year have not been analyzed in the same careful way as the first six. The following statements are, just as in the case of the barracuda, based on information gathered from fish

dealers and fishermen at San Pedro, on personal observations, and on the statistics of the California Fish and Game Commission.

In July the round haul and the gill net fishermen continue to land large amounts of white sea bass. However, the amounts of this fish landed by these men are somewhat less than in June. This is due to the fact that during this month a large number of the small boats are used in the albacore fishery. During the remaining months of the year, *i.e.,* from August to December inclusive, the purse seiners became increasingly important in the white sea bass fishery. In November and December almost all the white sea bass landed in Los Angeles County is taken with purse seine.

The reason why the purse seiners land but small quantities of white sea bass from June to the beginning of September is that during this period most of these men are engaged in operations for blue fin tuna.

The outstanding results of this analysis, therefore, are as follows. The purse seiners have not the same importance in the white sea bass fishery as in the barracuda fishery of southern California. Nevertheless, they furnish the fresh fish markets with very large amounts of white sea bass, and during the winter months they are almost the only source of supply of this product.

For reasons similar to those mentioned on page 45, the analysis given above should not be considered as representative of the other fishing ports in southern California.

d. Catching of Small Fish.—According to information gathered among fishermen and dealers at San Pedro, small white sea bass are caught only occasionally by purse seiners, and by gill net and round haul fishermen. This information was substantiated by my own experience in July, August, and September 1922, when I visited almost daily the fresh fish markets at San Pedro. During this period I saw only four relatively large loads of small sized white sea bass. Only one of these loads, amounting to nearly ten tons, was landed by purse seiners. The rest was brought in by Italian round haul fishermen.

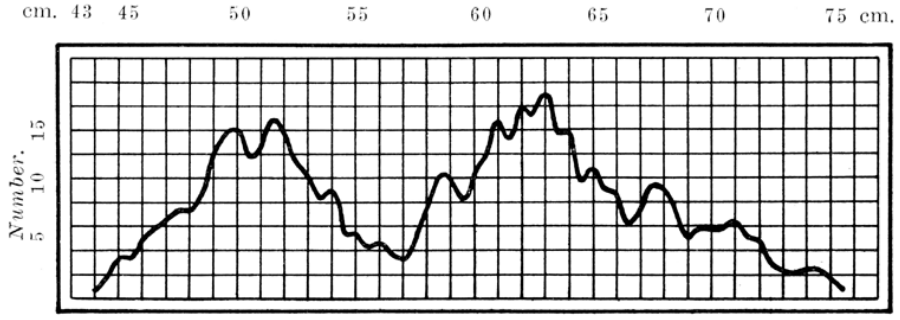

FIG. 16. Length frequency distribution of 506 small white sea bass landed at the fresh fish markets, San Pedro, August 11 to September 20, 1922. Smoothed by a moving average of threes.

FIG. 16. Length frequency distribution of 506 small white sea bass landed at the fresh fish markets, San Pedro, August 11 to September 20, 1922. Smoothed by a moving average of threes

The lengths, measured with steel tape along the lateral curvature of the body from the tip of the snout to the middle of the posterior edge of the tail fin, of 509 of these small fish were secured; 176 specimens were measured on August 11, the rest on September 18, 19, and 20. The lengths of these 509 specimens ranged from 44.5 cm. to 82.5

cm. Only three of the specimens measured exceeded 75.0 cm. (Fig. 16). There were two very distinct length classes with modes at about 51 cm. and 63 cm. The boundary between the two groups, i. e., the point of least frequency, was at about 57 cm. The group of small specimens had an almost symmetrical frequency distribution. On the other hand, the frequency distribution of the larger specimens was decidedly skew, which indicated that this group was compound, i. e., made up of more than one year class.

The small amounts of "sea trout" recorded by the California Fish and Game Commission also indicate that small white sea bass are landed only occasionally and in small quantities (Tables 2 and [Table 21]). "Sea trout" is a name widely applied by fishermen and dealers in southern California to young white sea bass and to Cynoscion parvipinnis. However, a fairly great percentage of the small white sea bass landed undoubtedly is classified correctly in the records of the Commission.

e. Relative Destructiveness of Different Gear.—There is no indication that in the white sea bass fishery of southern California purse seining is more destructive than other methods of fishing. The purse seiners do catch small fish of this species but only occasionally, as we have seen in the last sub-section. The same is true with regard to the round haul fishermen.

5.2.4. D. *Over-Fishing*

There are no scientific proofs available bearing on the question as to whether or not the white sea bass is being overfished at the present time. A careful analysis of the catches of several consecutive years is required for a solution of this important problem. Such an analysis should be undertaken as soon as possible.

Table 29 and figure 17 present, as far as statistics are available, the development of the white sea bass fishery of California, in local and in Mexican waters. The source and the accuracy of these data are the same as in the case of the corresponding values for the barracuda fishery (p. 50).

TABLE 29.—Annual Amounts, in Pounds, of White Sea Bass (Including Sea Trout) Landed in California.

	Southern California	Mexico	California	California and Mexico
1889	97,205			455,347
1890	100,297			325,662
1891	148,667			393,559
1892	109,362			257,712
1895	128,980			669,780
1899				938,156
1904	293,145			1,056,534
1908				1,337,000
1915				1,227,345
1916	299,395	321,024	477,191	798,215
1917	856,249	30,810	868,815	899,625
1918	1,176,311	154,853	1,458,667	1,613,520
1919	1,993,274	74,654	2,380,760	2,455,414
1920	2,217,020	252,462	2,376,293	2,628,755
1921	2,013,708	500,075	2,069,544	2,569,619

TABLE 29.—Annual Amounts, in Pounds, of White Sea Bass (Including Sea Trout) Landed in California

The data presented in this table and figure show that the white sea bass fishery of California has increased very decidedly, though perhaps somewhat irregularly, from 1889 to 1920 inclusive. In 1921 there was a slight decline in the annual yield. Just as in the case of the barracuda fishery (p. 51), the decrease from 1915 to 1916 probably is apparent and due to change of statistical methods.

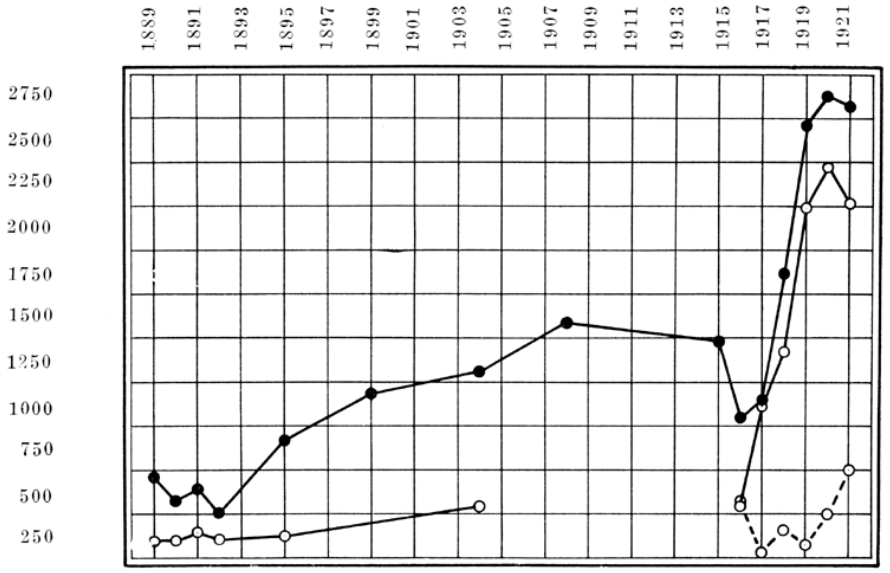

FIG. 17. The development of the white sea bass fishery of Cailfornia. Solid line and dots, total landings. Solid line and circles, landings of local origin in southern California. Broken line, of Mexican origin.

FIG. 17. The development of the white sea bass fishery of Cailfornia. Solid line and dots, total landings. Solid line and circles, landings of local origin in southern California. Broken line, of Mexican origin

The amounts of white sea bass taken annually in the waters of southern California, and represented by the unbroken line and open circles in figure 17, show, from 1916 to 1921 inclusive, an increase from 299,395 pounds to 2,013,708 pounds; in other words, the annual yield of this fishery increased about seven fold during this period. Such a growth justly may be called extraordinary. The year 1920 yielded even a somewhat larger amount than did 1921, viz, 2,217,020 pounds. The decline in 1921 probably was due to the decrease in the number of operating purse seine boats (p. 10). A comparison between the first six months of 1921 and the corresponding period of 1922 shows a slight increase during the last mentioned year; the amounts of white sea bass caught locally in southern California during the first six months of these two years were 1,193,389 pounds and 1,212,674 pounds, respectively. It should be remembered in this connection that in the local white sea bass fishery of southern California the first six months are somewhat, though not much, more important than the last six (Fig. 11).

Nowadays, almost all the California white sea bass of local origin are taken in southern California waters (Table 29). For instance, in 1921, out of an annual total of 2,069,544 pounds, only 55,836 pounds were caught north of San Luis Obispo County. However, in earlier years the situation was quite different. In 1895, out of an annual total of 669,780 pounds, only 128,980 pounds were recorded for southern California.

For 1904 the corresponding figures were 1,056,534 pounds and 293,145 pounds. The causes of this reversal should be investigated.

The amounts of Mexican white sea bass landed in California, represented by a broken line and open circles in figure 17, show a decided upward trend during 1919, 1920, and 1921. However, as mentioned previously, this fishery is of relatively small importance, when compared with the local white sea bass fishery.

The data presented above evidently do not indicate any decline in the natural supply of white sea bass. But, as mentioned in the case of the barracuda (p. 52), an increase in the total yearly catch of a species is too deceptive to be considered as a proof that this species is not being overfished.

Only a few fishermen and dealers at San Pedro complain about an increasing scarcity of white sea bass. Most of the men engaged in this fishery declare that no distinct signs of overfishing of this species are apparent as yet; indeed, some of them maintain that 1922 was a year of unusual abundance.

5.3. 3. Yellowtail

5.3.1. A. Occurrence in the waters of southern California

According to information gathered from fishermen operating in these waters, the occurrence of the yellowtail in southern California appears to be about the same as that of the barracuda. In other words, in the early months of the spring this fish is found in relatively large quantities in the region from Los Coronados Islands to a point half way between Oceanside and Point San Juan. Later in the year it is found in this southern region as well as farther to the north. In September, October, and November it is taken mostly in the waters between San Pedro and Point Dume or somewhat north of the last mentioned place. However, it should be mentioned that the relative abundance of the yellowtail during the various months of the year is very different from that of the barracuda; see the section on "Seasonal Distribution of Catch." The yellowtail do not leave the shallow waters, near the kelp beds, in August but are most abundant during the fall.

5.3.2. B. Spawning

Incoming yellowtail were examined in the fresh fish markets at San Pedro during July and August 1922. In the last part of July the testes and ovaries of this fish, as a rule, were very large, but no running spawn was seen. On August 9 the milt was almost ripe; furthermore, one female was completely ripe, with all the spawn watery, and in two females part of the spawn was running. During the last two weeks of August females with running, watery spawn were found on several occasions, and males with ripe milt also were frequently seen. These facts seem to indicate that the yellowtail begin their spawning in August, and that September is their most important spawning month. However, the data available are too incomplete for a certain solution of this question.

5.3.3. C. Fishery

a. Seasonal Distribution of Catch.—For reasons similar to those mentioned in the case of the barracuda (p. 37), the monthly landings in Los Angeles County will be considered as representative of southern

California and will be used as illustrations of the distribution of the catches of yellowtail throughout the various months of the year. However, a comparison between Table 11 and figure 10 on the one hand and Table 30 and figure 18 on the other shows that in the yellowtail fishery Los Angeles County is less predominant than in the barracuda fishery. In 1918 and 1919 about equal amounts of this fish were recorded in Los Angeles County and San Diego County. In 1920 and 1921, on the other hand, the amounts landed at San Pedro were decidedly higher than those handled at San Diego.

TABLE 30.—Amounts of Yellowtail, in Pounds, Landed in Southern California.

	San Luis Obispo, Santa Barbara and Ventura counties	Los Angeles County	Orange County	San Diego County	Mexico	Total weight for Southern California	Total weight for Southern California and Mexico
1916—Jan. 1-Mar. 31		231,713	39	4,333		236,085	236,085
Apr. 1-June 30		284,594	221	35,509		320,324	320,324
July 1-Sept 30		210,223	210	28,919		239,352	239,352
Oct. 1-Dec. 31		289,520	576	51,606	16,142	341,702	357,844
Totals		1,016,050	1,046	120,367	16,142	1,137,463	1,153,605
1917—Jan. 1-Mar. 31		53,624		1,190		54,814	54,814
Apr. 1-June 30	250	248,362	350	7,700		256,662	256,662
July 1-Sept. 30		355,524	200	1,106,527		1,462,251	1,462,251
Oct. 1-Dec. 31	1,078	569,463		392,638	9,089	963,179	972,268
Totals	1,328	1,226,973	550	1,508,055	9,089	2,736,906	2,745,995
1918—Jan. 1-Mar. 31		48,890		116,356	40,404	165,246	205,650
Apr. 1-June 30		317,609		339,159	1,275	656,768	658,043
July 1-Sept. 30	15,506	2,557,534		3,593,169	17,219	6,166,209	6,183,428
Oct. 1-Dec. 31	5,276	3,001,988	1,060	1,378,879	81,048	4,387,203	4,468,251
Totals	20,782	5,926,021	1,060	5,427,563	139,946	11,375,426	11,515,372
1919—Jan. 1-Mar. 31		178,889	189	39,376	11,253	218,454	229,707
Apr. 1-June 30	191	421,663	26	381,014	4,580	802,894	807,474
July 1-Sept. 30		409,988	3,881	1,539,322	6,933	1,953,191	1,960,124
Oct. 1-Dec. 31		1,521,433	410	375,381	110,736	1,897,224	2,007,960
Totals	191	2,531,973	4,506	2,335,093	133,502	4,871,763	5,005,265
1920—Jan. 1-Mar. 31		258,195	125	18,582	68,838	276,902	345,740
Apr. 1-June 30		548,766	37	73,512	20,890	622,315	643,205
July 1-Sept. 30	287	191,770	1,398	213,659	31,737	407,114	438,851
Oct. 1-Dec. 31	991	994,762	1,663	182,790	96,935	1,180,206	1,277,141
Totals	1,278	1,993,493	3,223	488,543	218,400	2,486,537	2,704,937
1921—Jan. 1-Mar. 31		117,788		76,920	100,794	194,708	295,502
Apr. 1-June 30		241,918	34	83,484	7,769	325,436	333,205
July 1-Sept. 30	7,430	470,047	5,520	266,222	30,902	749,219	780,121
Oct. 1-Dec. 31	627	613,716	188	255,732	211,705	870,263	1,081,968
Totals	8,057	1,443,469	5,742	682,358	351,170	2,139,626	2,490,796

TABLE 30.—Amounts of Yellowtail, in Pounds, Landed in Southern California

Tables 31, 32, 33, 34, and figure 11 present the monthly landings of yellowtail in Los Angeles County during 1919, 1920, and 1921. They show that most of the local yellowtail are taken in the fall, while the local barracuda and white sea bass fisheries are carried on mainly during spring and summer. September, October, and November yield the largest catches of local yellowtail. In 1919, of the total yearly catch 13.9 per cent was landed in September, 31.5 per cent in October, and 22.1 per cent in November. For 1920 the corresponding values were 8.9 per cent, 25.6 per cent, and 20.4 per cent. For 1921 they were 24.5 per cent, 25.7 per cent and 13.4 per cent. The corresponding averages for these three years were 14.8 per cent, 28.1 per cent and 19.5 per cent. On the average, 62.4 per cent of the yearly local catch was taken during these three months. In other words, the local yellowtail fishery of southern California is highly concentrated in time. It may be mentioned in this connection that in September this fish probably has its heaviest spawning (p. 63).

In April, May, and June fairly large landings of local yellowtail were recorded during the three years considered. In 1919 the amount of this fish caught, expressed in the same way as above, was 2.4 per cent in April, 7.0 per cent in May, and 7.2 per cent in June. For 1920 the corresponding values were 11.3 per cent, 10.7 per cent, and 5.5 per cent. For 1921 they were 3.8 per cent, 8.9 per cent, and 4.1 per cent.

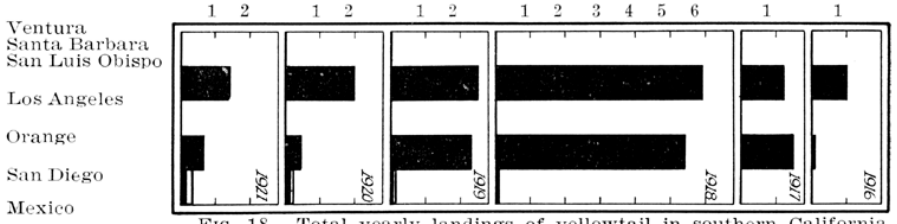

FIG. 18. Total yearly landings of yellowtail in southern California, according to counties. Of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black.

TABLE 31.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1919

TABLE 31.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1919.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	166,448	93.84	6.58	10,935	12.89	177,383	6.78
February	11,441	100.00	0.45		0.00	11,441	0.44
March	1,000	100.00	0.04		0.00	1,000	0.04
April	60,486	100.00	2.39		0.00	60,486	2.31
May	178,537	100.00	7.05		0.00	178,537	6.83
June	182,640	100.00	7.22		0.00	182,640	6.98
July	12,860	100.00	0.51		0.00	12,860	0.49
August	44,216	100.00	1.75		0.00	44,216	1.69
September	352,912	100.00	13.93		0.00	352,912	13.48
October	797,880	96.13	31.50	32,026	37.78	829,906	31.71
November	560 265	95.94	22.12	23,708	27.97	583,973	22.31
December	163,288	90.02	6.45	18,101	21.36	181,389	6.93
Totals	2,531,973	96.76	99.99	84,770	100.00	2,616,743	99.99

FIG. 18. Total yearly landings of yellowtail in southern California, according to counties. of the Mexican fish during 1919 to 1921, the amounts landed in Los Angeles County are shown in black

TABLE 32.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1920.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	55,943	71.18	2.81	22,660	12.17	78,603	3.61
February	19,099	67.51	0.96	9,193	4.94	28,292	1.30
March	183,153	72.34	9.19	70,124	37.64	253,277	11.62
April	224,826	93.11	11.28	16,645	8.94	241,471	11.08
May	213,511	100.00	10.71		0.00	213,511	9.80
June	110,429	100.00	5.54		0.00	110,429	5.07
July	4,754	100.00	0.24		0.00	4,754	0.22
August	10,220	100.00	0.51		0.00	10,220	0.47
September	176,796	98.07	8.87	3,479	1.87	180,275	8.27
October	511,287	94.51	25.64	29,721	15.96	541,008	24.81
November	407,717	92.91	20.44	31,099	16.70	438,816	20.13
December	75,758	95.85	3.80	3,275	1.76	79,033	3.62
Totals	1,993,493	91.46	99.99	186,196	99.98	2,179,689	100.00

TABLE 32.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1920

TABLE 33.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	6,349	73.83	0.44	2,250	1.17	8,599	0.53
February	89,750	53.95	6.22	76,640	39.70	166,390	10.17
March	21,689	68.85	1.50	9,814	5.08	31,503	1.93
April	54,636	100.00	3.79		0.00	54,636	3.34
May	128,499	100.00	8.91		0.00	128,499	7.86
June	58,783	100.00	4.07		0.00	58,783	3.59
July	9,698	100.00	0.67		0.00	9,698	0.59
August	107,321	94.37	7.44	6,400	3.31	113,721	6.96
September	353,028	99.41	24.46	2,102	1.09	355,130	21.70
October	370,605	97.96	25.67	7,713	3.99	378,318	23.11
November	193,671	91.79	13.41	17,295	8.96	210,966	12.89
December	49,440	41.10	3.42	70,871	36.71	120,311	7.35
Totals	1,443,469	88.20	100.00	193,085	100.01	1,636,554	100.02

TABLE 33.—Monthly Landings of Yellowtail in Los Angeles County, According to Source—1921

TABLE 34.—Monthly Landings of Yellowtail in Los Angeles County, According to Source.

Averages, 1919 to 1921.

	Of local origin			Of Mexican origin		Total	
	Weight, pounds	Per cent of monthly total	Per cent of yearly local total	Weight, pounds	Per cent of yearly Mexican total	Weight, pounds	Per cent of yearly grand total
January	76,247	86.45	3.83	11,948	7.73	88,195	4.11
February	40,097	58.34	2.01	28,611	18.49	68,708	3.21
March	68,614	72.02	3.45	26,646	17.23	95,260	4.44
April	113,316	95.33	5.71	5,548	3.59	118,864	5.54
May	173,516	100.00	8.73		0.00	173,516	8.09
June	117,284	100.00	5.90		0.00	117,284	5.47
July	9,104	100.00	0.46		0.00	9,104	0.42
August	53,919	96.19	2.71	2,133	1.38	56,052	2.61
September	294,245	99.37	14.79	1,860	1.20	296,105	13.81
October	559,924	96.03	28.13	23,153	14.97	583,077	27.18
November	387,218	94.15	19.46	24,034	15.53	411,252	19.17
December	96,162	75.77	4.83	30,749	19.87	126,911	5.92
Totals	1,989,646	92.79	100.01	154,682	99.99	2,144,328	99.97

TABLE 34.—Monthly Landings of Yellowtail in Los Angeles County, According to Source. Averages, 1919 to 1921

During the remaining six months of the year, *i.e.*, in December, January, February, March, July, and August, the catches of local yellowtail generally are small. However, fairly large catches were made in December and January 1919 and in March 1920.

For reasons similar to those mentioned in the case of the barracuda (p. 40), the amounts of local yellowtail recorded during the winter months should be considered as somewhat too high. However, this discrepancy is rather small, since the amounts of Mexican yellowtail are relatively small. In 1919, of the total yearly amount of this fish landed in Los Angeles County, 96.8 per cent was of local origin. In 1920 and 1921 the corresponding values were 91.5 per cent and 88.2 per cent, respectively.

Most of the Mexican yellowtail is landed from October to March inclusive. These six months show the following average landings expressed in percentages of the average yearly Mexican total: October, 15.0 per cent; November, 15.5 per cent; December, 19.9 per cent; January, 7.7 per cent; February, 18.5 per cent; and March, 17.2 per cent. These averages are calculated on the basis of the records of the California Fish and Game Commission for the three years 1919, 1920. and 1921.

b. Increase in, and Ports of Entry of, the Mexican Supply.—The trend of the supply of Mexican yellowtail landed in California is shown in Table 35 and in figure 20. In 1916, of the yearly total amount of this fish recorded in California, 1.4 per cent was of Mexican origin. For the years from 1917 to 1921 inclusive the corresponding values were 0.3 per cent, 1.2 per cent, 2.7 per cent, 8.1 per cent, and 14.1 per cent. In other words, the Mexican supply of this product was not important during these years, but it shows a tendency to increase.

Most of the Mexican yellowtail is landed in Los Angeles County. In 1919, of the yearly Mexican total of this fish 63.5 per cent was landed in this county; in 1920 and 1921 the corresponding values were 85.3 per cent and 55.0 per cent (Table 35) .

TABLE 35.—Yearly Amounts, in Pounds, of Yellowtail Landed in Southern California.

	Landed in Southern California			Landed in Los Angeles County	
	Total weight from Southern California and Mexico	Total weight from Mexico	Per cent of Mexican origin	Total weight of Mexican origin	Per cent of Mexican origin
1916	1,153,605	16,142	1.4	----------	----------
1917	2,745,995	9,089	0.3	----------	----------
1918	11,515,372	139,946	1.2	----------	----------
1919	5,005,265	133,502	2.7	84,770	63.5
1920	2,704,937	218,400	8.1	186,196	85.3
1921	2,490,796	351,170	14.1	193,085	55.0

TABLE 35.—Yearly Amounts, in Pounds, of Yellowtail Landed in Southern California

c. Relative Importance of Different Fishing Gear.—In the early years of the yellowtail fishery of southern California this fish was taken mostly with hook and line. At present fairly large quantities of yellowtail are caught with hook and line, but by far the larger portion of the catch of this fish sold at San Pedro is landed by purse seiners and round haul fishermen.

In order to establish the relative importance of the purse seine method in the yellowtail fishery of southern California, the fishery

records of Los Angeles County for the first six months of 1922 have been submitted to analysis. For reasons similar to those given in the case of the barracuda (p. 42), this anaylsis probably is representative of the corresponding period of other years. It should be mentioned that all the yellowtail landed during this period was handled by the fresh fish markets.

Tables 36 and 37, and figure 19 give the results of this analysis; table 36 and figure 19 present the monthly amounts of yellowtail in the fresh fish markets; table 37 gives the same material analyzed by weeks. In January 89.3 per cent of the total monthly catch of this fish was landed by purse seine boats; in February the corresponding value was 99.7 per cent; in March, 76.4 per cent; in April, 98.0 per cent; in May, 62.2 per cent; and in June, 46.9 per cent. During these six months not less than 73.2 per cent of the total landing of yellowtail was taken with purse seine. In other words, in the yellowtail fishery of the first six months of the year, the purse seiners are even more important than they are in the barracuda fishery. The yellowtail not taken with purse seine are landed mainly by round haul boats.

TABLE 36.—Monthly Amounts, in Pounds, of Yellowtail Landed at San Pedro between January 1 and July 1, 1922.

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
January	122,286	2,176	1.8	109,183	89.3
February	23,062	77	0.3	22,985	99.7
March	168,525	102,407	60.8	128,767	76.4
April	42,663	42,663	100.0	41,781	98.0
May	178,705	178,705	100.0	111,098	62.2
June	84,494	84,494	100.0	39,664	46.9
Totals	619,735	410,522	66.2	453,478	73.2

TABLE 36.—Monthly Amounts, in Pounds, of Yellowtail Landed at San Pedro between January 1 and July 1, 1922

TABLE 37.—Weekly Amounts, in Pounds of Yellowtail Landed at San Pedro between January 1 and July 1, 1922

	Totals sold in markets	Caught locally		Caught with purse seine	
		Amounts	Per cent of total	Amounts	Per cent of total
Jan. 1-7	13,413		0.0	13,413	100.0
Jan. 8-14	70,773		0.0	69,019	97.6
Jan. 15-21	20,278	2,159	10.6	9,601	47.3
Jan. 22-28	17,805		0.0	17,150	96.4
Jan. 29-Feb. 4	388	36	9.3	352	90.7
Feb. 5-11	58	58	100.0		0.0
Feb. 12-18	21,378		0.0	21,378	100.0
Feb. 19-25	1,220		0.0	1,220	100.0
Feb. 26-Mar. 4	1,490	1,455	97.7	35	2.3
Mar. 5-11	1,323	260	19.7	1,323	100.0
Mar. 12-18	18,656		0.0	18,656	100.0
Mar. 19-25	81,144	50,197	61.9	66,990	82.5
Mar. 26-Apr. 1	73,779	58,327	80.0	49,630	67.3
Apr. 2-8	10,173	10,173	100.0	10,155	99.8
Apr. 9-15					
Apr. 16-22	22,943	22,943	100.0	22,079	96.2
Apr. 23-29	1,715	1,715	100.0	1,715	100.0
Apr. 30-May 6	47,127	47,127	100.0	46,886	99.5
May 7-13	14,357	14,357	100.0	14,299	99.6
May 14-20	19,787	19,787	100.0	1,781	9.0
May 21-27	76,835	76,835	100.0	30,825	40.1
May 28-June 3	20,599	20,599	100.0	17,307	84.1
June 4-10	53,610	53,610	100.0	21,921	40.9
June 11-17	13,687	13,687	100.0	1,916	14.0
June 18-24	14,406	14,406	100.0	13,844	96.2
June 25-30	2,791	2,791	100.0	1,983	71.0
Totals	619,735	410,522	66.2	453,478	73.2

TABLE 37.—Weekly Amounts, in Pounds of Yellowtail Landed at San Pedro between January 1 and July 1, 1922

The last six months of the year have not been analyzed in the same way as the first six. This is especially unfortunate, since the yellowtail fishery reaches its maximum in the fall (p. 65). The statements given below are based on information that has been gathered among fishermen and dealers at San Pedro, on personal observations, and on the statistics of the California Fish and Game Commission.

During July but small amounts of yellowtail are taken; part of the fish landed is caught with purse seine, part with round haul net. During the remaining months of the year, *i.e.,* from August to December inclusive, the purse seine boats become increasingly important. This condition is due to the fact that an increasing number of purse seine boats take up "white fish" operations after having finished the tuna season. However, even as late as October and November the round haul boats and the hook and line boats land rather large quantities of yellowtail.

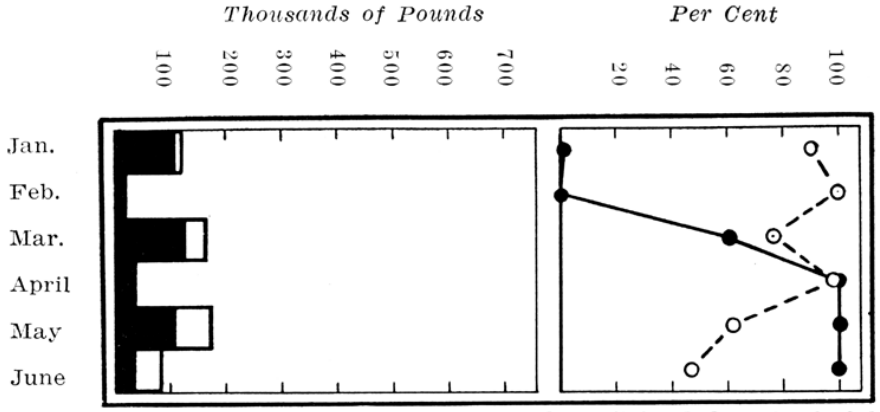

FIG. 19. Monthly amounts of yellowtail landed at fresh fish markets of San Pedro during the first half of 1922, according to source and gear.
Below: Black, amounts caught by purse seiners; white, by other boats.
Above: Solid line, percentage of local origin; broken line,

FIG. 19. Monthly amounts of yellowtail landed at fresh fish markets of San Pedro during the first half of 1922, according to source and gear

The main results of this analysis, therefore, are as follows: In the yellowtail fishery of southern California the purse seiners are predominant. of the total catch in the first six months of the year they land even a higher percentage than they do in the barracuda fishery. Their importance is greater in the winter than in the summer. The yellowtail not taken with purse seine are landed mainly by round haul fishermen, who use a net very similar to the purse seine.

For reasons similar to those mentioned on page 45, this analysis should not be regarded as representative for southern California as a whole.

d. Catching of Small Fish.—According to information from purse seiners and round haul fishermen, small yellowtail hardly ever are caught in southern California. This statement was confirmed by fish dealers at San Pedro. In July, August, and September, 1922, when I watched the incoming fish in the fresh fish markets at San Pedro, no small yellowtail were seen.

e. Relative Destructiveness of Different Gear.—There seems to be no reason to suppose that in the yellowtail fishery the purse seine method is more destructive than the round haul method. In this respect no complaints have been heard.

5.3.4. D. Over-Fishing

No scientific proofs are available bearing on the question as to whether or not the yellowtail are being overfished at the present time.

However, the facts presented below indicate that the yellowtail fishery of southern California has not reached its climax as yet.

TABLE 38.—Annual Amounts, in Pounds, of Yellowtail Landed in California.

	Southern California	Mexico	California	California and Mexico
1889	246,515			246,515
1890	284,851			284,851
1891	229,074			339,732
1892	354,434			354,434
1895	187,736			214,344
1899				204,644
1904	266,640			273,865
1908				571,000
1915				1,218,916
1916	1,137,463	16,142	1,173,832	1,189,974
1917	2,736,906	9,089	2,887,413	2,896,502
1918	11,375,426	139,946	11,658,259	11,798,205
1919	4,871,763	133,502	4,871,763	5,005,265
1920	2,486,537	218,400	2,486,537	2,704,937
1921	2,139,626	351,170	2,139,626	2,490,796

TABLE 38.—Annual Amounts, in Pounds, of Yellowtail Landed in California

Table 38 and figure 20 present, as far as statistics are available, the annual amounts of yellowtail landed in 1889 to 1921, inclusive. With regard to the source and the accuracy of the data, see page 50. The unbroken line and the round dots represent the total annual amounts landed in California from both local and Mexican waters. The broken line and the open circles represent Mexican yellowtail landed in California. Because of the fact that only small amounts of this fish are caught in the waters north of San Luis Obispo County and in Mexico, the first curve practically represents the development of the local yellowtail fishery. For instance, in 1919, 1920, and 1921 no yellowtail were taken north of the mentioned county.

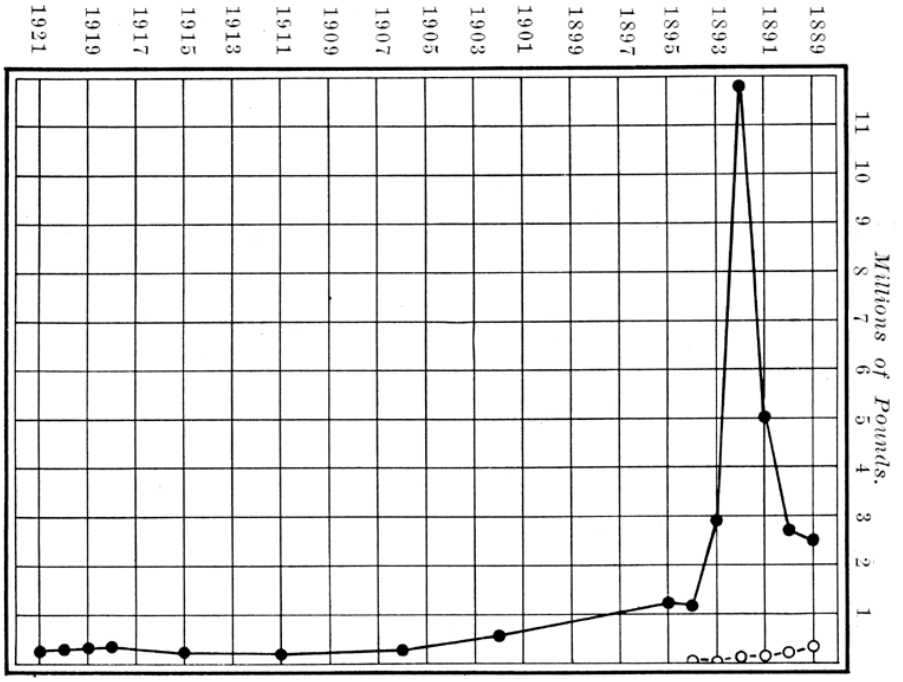

FIG. 20. The development of the yellowtail fishery in California. Solid line, total landings. Broken line, of Mexican origin.

FIG. 20. The development of the yellowtail fishery in California. Solid line, total landings. Broken line, of Mexican origin

The data given in this table show that the yellowtail fishery developed in a quite different way than the barracuda and the white sea bass fisheries. From 1889 to 1916 inclusive, there was a slow and regular growth; 246,515 pounds were landed in the first of these two years, 1,189,974 pounds in the last. During 1917 and 1918 an enormous increase occurred; 2,896,502 pounds were taken in 1917 and not less than 11,798,205 pounds in 1918. The period from 1919 to 1921 inclusive is characterized by a decrease almost as remarkable as the increase during the two preceding years; 5,005,265 pounds were recorded in 1919, 2,704,937 pounds in 1920, and 2,490,796 pounds in 1921.

This sudden and extraordinary decrease certainly does not indicate that the natural supply of this fish is being depleted. Anybody familiar with extensive pelagic sea fisheries must realize that a pelagic fishery as large as that of the yellowtail in southern California can not possibly be depleted to such an extent in so short a period, even with our modern highly developed fishing methods. The explanation of this enormous expansion and sudden decline certainly must be sought for somewhere else. The records of the amounts of yellowtail canned during the period from 1916 to 1921 inclusive seem to offer a very plausible solution of this problem.

Table 39 presents the number of cases of yellowtail packed (not pounds of fresh fish received, for which much more reliable statistics are available), according to the sworn reports which the California Fish and Game Commission received from the canners. The amounts in pounds are estimations; 1000 pounds are assumed to yield on the average about fifteen cases; the yield actually varies between fourteen and fifteen cases to 1000 pounds.

TABLE 39.—Amounts of Yellowtail Canned in Southern California, According to Statements of Packers to Government.

	San Diego		San Pedro		Total	
	Cases	Pounds	Cases	Pounds	Cases	Pounds
1916	11	700			11	700
1917	5,490	366,000	8,850	590,000	14,340	956,000
1918	31,361	2,090,000	40,470	2,697,000	71,831	4,787,000
1919	9,089	606,000	19,308	1,287,000	28,397	1,893,000
1920	456	30,400	1,633	109,000	2,089	139,400
1921			48	3,200	48	3,200

TABLE 39.—Amounts of Yellowtail Canned in Southern California, According to Statements of Packers to Government

TABLE 40.—Amounts of Yellowtail Canned in Southern California, According to Estimate of a Packer.

	Cases	Pounds
1916	15,000	1,000,000
1917	25,000	1,666,000
1918	105,000	7,000,000
1919	60,000	4,000,000
1920	6,000	400,000

TABLE 40.—Amounts of Yellowtail Canned in Southern California, According to Estimate of a Packer

Table 40 gives the amounts in pounds and the number of cases packed, according to an estimation by a person intimately connected with and well informed about the canning industry of southern California. The amounts in pounds are estimated on the same principle as in the previous table.

The discrepancies between these two tables are very large indeed, and it is difficult to decide which of the latter gives the truer values. In the case of 1918 the second table probably is closer to the truth as may be shown by checking against the statistics of yellowtail landed which were compiled by the Fish and Game Commission from copies of the fishermen's receipts. For that year the total catch of this fish landed by fishermen and recorded was 11,798,205 pounds. of this amount about 4,500,000 pounds would have been used by the fresh fish trade on the basis of the second estimation, allowing for possible diversion to production of fertilizer. According to the first table the fresh fish markets would have handled not less than about 7,000,000 pounds. The assumption that the fresh fish trade handled 4,500,000 pounds of yellowtail in that year is by far more reasonable than that it consumed 7,000,000 pounds, since no decided decrease in the fresh yellowtail trade is known to have taken place during the last few years and in 1920 and 1921 the amounts recorded were only 2,704,937 and 2,490,796 pounds, respectively.

Irrespective of the relative accuracy of the two tables, the parallelism between the development of the yellowtail fishery as a whole and the amounts of yellowtail canned is very striking. This being established, the important point is, that the decline in the amounts of yellowtail canned was not due to lack of supply but to unfavorable market conditions.

These facts appear to suggest that at the present time the fishermen do not catch the yellowtail to the limit of their capacity, a conclusion which has been amply corroborated by statements of fishermen and dealers. Furthermore, the large yields in 1918 and 1919 seem to indicate that the natural supply of this fish allows larger yearly catches than those of 1920 and 1921.

The main result of this analysis therefore is that we have no reason to assume that overfishing of yellowtail is taking place in southern California at the present time. No complaints have been heard about an increasing scarcity of this fish.

5.4. 4. Bluefin Tuna

5.4.1. A. *Occurrence in the waters of southern California*

The bluefin tuna, as a rule, begin to appear in the waters of southern California in the last part of May or in the first three weeks of June. In the beginning of the "tuna season" they are caught off San Diego and La Jolla. Soon afterwards they are found farther to the north, and in the last part of summer and in the fall most of the bluefin tuna catches are made north of San Pedro, for instance, off Point Dume, near Anacapa Islands, Santa Cruz Island, and Santa Rosa Island. On June 4, 1922, I saw a rather large school about half way between Santa Catalina Island and San Pedro, and schools had been located several days before at the same place; however, no bluefin tuna fishery was carried on so far to the north at that time.

The shifting of the bluefin tuna fishery to the north as the season proceeds is well illustrated by the amounts of this fish landed in San Diego County and in Los Angeles County during the various months. The following figures from 1922 will suffice as an example. In June 166,667 pounds were landed in Los Angeles County and 226,872 pounds

in San Diego County. (Part of the fish sold in Los Angeles County was taken off San Diego and La Jolla.) In July the corresponding figures were 488,228 pounds and 758,508 pounds; in August, 1,190,510 pounds and 13,930 pounds; in September, 453,768 pounds and 754 pounds.

In the fall, as a rule in October and November, the bluefin tuna disappear from the catch. Nothing is known as to their whereabouts during the period from December to May.

The bluefin tuna usually occur in more or less large schools, which during the feeding apparently split up in smaller units. Almost all the fishing operations are carried on outside the three-mile limit.

5.4.2. B. *Spawning*

Nothing is known with certainty about the spawning of this fish. However, there are strong reasons for assuming that it takes place during the time the fish is absent from our waters, in other words, some time between December and May. Most probably it occurs in the spring. As far as known, ripe spawn has not been found as yet in the fish landed during the "tuna season;" not even in November and December do the ovaries show any pronounced signs of ripening. The ovaries are not even "granular" during this time; in other words, they do not contain eggs large enough to be distinguishable to the naked eye.

5.4.3. C. *Fishery*

a. Seasonal Distribution of Catch.—Almost all the bluefin tuna landed in California are taken in the third quarter of the year, *i. e.*, in July, August, and September, as shown by the seasonal distribution of the catches made in 1920, 1921, and 1922 (Table 41) .

TABLE 41.—Amounts, in Pounds, of Bluefin Tuna Landed in California, According to Origin and to Quarter of Year.

	Of local origin					Of Mexican origin	Local and Mexican
	First quarter	Second quarter	Third quarter	Fourth quarter	Total		
1920		4,340	10,519,862	6,070	10,530,272		10,530,272
1921		87,128	1,829,328	55,357	1,971,813	59,835	2,031,648
1922		393,688	2,905,698	125	3,299,511	26,910	3,326,421

TABLE 41.—Amounts, in Pounds, of Bluefin Tuna Landed in California, According to Origin and to Quarter of Year

In 1920 the bluefin tuna fishery was exceptionally concentrated in time. Out of the 10,530,272 pounds landed in that year, all of which were caught locally, not less than 10,519,862 pounds were taken in the third quarter of the year; in the first quarter nothing was landed; in the second quarter, 4,340 pounds; and in the last quarter 6,070 pounds. With regard to the monthly distribution of the catch of local bluefin tuna the following values from 1922 may suffice as an illustration. In January, February, March, and April no bluefin tuna were landed; in May, only 149 pounds were recorded; in June, 393,539 pounds; in July, 1,246,736 pounds; in August, 1,204,440 pounds; in September, 454,522 pounds; in October, 125 pounds; and in November and December, nothing. It should be mentioned, however, that the second quarter of the year was unusually heavily represented in 1922.

In 1921 all the Mexican bluefin tuna sold in California were taken in the second quarter of the year. In 1922, 18,600 pounds of this fish were caught in April and the remainder, 8,310 pounds, in October.

b. Amounts, and Ports of Entry of, the Mexican Supply.—The supply of bluefin tuna caught in Mexican waters and imported to California always has been negligible, and as yet it does not show any signs of becoming increasingly important. In 1919 and 1920 all the bluefin tuna recorded was taken locally; in 1921 and 1922 only 59,835 pounds and 26,910 pounds, respectively, were of Mexican origin.

Most of the Mexican bluefin tuna are landed in Los Angeles County. In 1922 this county received 18,600 pounds and San Diego 8,310 pounds.

c. Relative Importance of Different Fishing Gear.—At the present time the bluefin tuna fishery is carried on almost exclusively by the purse seiners. Only small amounts of this fish are taken with hook and line. of all the different fishing gear now in use in southern California, the purse seine is the only one with which a sufficient amount of bluefin tuna can be caught to meet the present high demand for this product among the canneries. If our purse seiners for one reason or another discontinued their operations, the bluefin tuna of California, temporarily at least, would be lost for human consumption. A discontinuation of this fishery would be a very hard blow to the fishing industry of southern California, and especially to the canning industry of Los Angeles County, since most of the bluefin tuna catch is handled by the canneries in this county. In 1919, out of the 14,990,860 pounds of bluefin tuna recorded, only 38,398 pounds were landed at San Diego, and the rest were sold in Los Angeles County. In 1920 and 1921 all the bluefin tuna catch was handled by Los Angeles County. In 1922, 2,299,447 pounds out of the total local catch were landed in Los Angeles County, and 1,000,064 pounds at San Diego. Furthermore, most of the fish sold at San Diego is handled by concerns also operating in Los Angeles County.

d. Catching of Small Fish.—Most of the bluefin tuna landed in California are large; as a rule they weigh between 20 and 100 pounds each, or even more. Small bluefin tuna, weighing between ten and twenty pounds each, are caught only occasionally. However, no scientific data are available as to the rôle of the different sizes in the commercial catch.

5.4.4. D. *Over-fishing*

No scientific proofs are available as to whether or not the bluefin tuna are being overfished at the present time.

In 1917, the first year in which bluefin tuna was canned, about 600,000 pounds of this fish were landed, according to the California Fish and Game Commission. 1918 was the first year in which very large quantities of bluefin tuna were taken; 6,240,971 pounds of "tuna" were recorded, most of which were bluefin. In following years the bluefin tuna fishery yielded the following total annual amounts: 14,990,860 pounds in 1919; 10,530,272 pounds in 1920; 2,031,648 pounds in 1921; and 3,326,421 pounds in 1922. In other words, between 1919 and 1921 there was an enormous decline in the bluefin tuna fishery of southern California, and 1919 yielded more than seven times as much as 1921. In 1922 the catch was somewhat higher than in 1921 but nevertheless low when compared with the catches of 1919 and 1920.

What were the causes of this sudden decline in the bluefin tuna fishery? To some extent the decrease in catch certainly was caused by the relatively low prices paid to the fishermen during 1921 and 1922. However, other factors probably were of greater importance. One of these is the great variation in the behavior of the bluefin tuna. Sometimes these fish are sluggish and make very little or no effort to escape the seine; on other occasions they are "wild" and active, and disappear from the surface as soon as the fishermen attempt to corral them. The fishermen believe that these differences in the behavior of the fish mainly are due to differences in the temperature of the water. When the temperature is relatively high, the bluefin tuna are more or less easily captured; when the temperature is low, they are very active and wary, and often disappear from the surface of the water. Observations made by me off La Jolla in the beginning of July, 1922, seem to substantiate this opinion of the fishermen. A few days before our arrival at the fishing grounds, the weather was warm and sunny, and several very large individual catches were made. On the first of the five days during which I was watching the fishing operations, the weather still was rather warm, but gradually it grew cold and foggy. On the first day the bluefin tuna were seen in large quantities, playing and leaping at the surface. However, contrary to their habits a few days before our arrival, they were very cautious. Although a great number of hauls were made by the forty boats present, only a few thousand pounds were caught on that day. In one haul the corralled school still was playing and feeding in the middle of the seine, when the pursing was nearly half done. Everything indicated that the whole school would be captured; but all the fish escaped, although the pursing was performed with great speed. On the following three days the bluefin tuna gradually became scarcer at the surface, and only very small quantities were caught. On the last day of our stay hardly any fish were seen. These facts suggest the possibility that the lack of success in the bluefin tuna fishery of 1921 and 1922 at least partly may have been due to unfavorable hydrographical conditions. Scientific investigations of this highly important and interesting phase of the bluefin tuna fishery should be undertaken. Another factor to be remembered, when considering the causes of the decline in the bluefin tuna fishery, is the decided decrease during 1921 and 1922 in the number of operating purse seine boats. In 1920 they numbered approximately 125, in 1922 only 65; in other words, their number was reduced to nearly one half (p. 10).

In short, the decline in the bluefin tuna fishery of southern California during 1921 and 1922, to some extent, may be explained by the low prices, the possibly increased difficulties of catching the fish, and the very decided decrease in the number of operating purse seine boats. The fact that extensive bluefin tuna operations had been carried on only since 1916, the shortness of the "tuna season," and the suddenness of the decline are indicative that the failure in 1921 and 1922 was not caused by overfishing. It also should be noted that the yield in 1922 was decidedly higher than that in 1921 (Table 41).

The failure of the bluefin tuna fishery in 1921 and 1922 has decidedly discouraged the purse seiners from continuing these operations. The expenses involved are very high, and the economic consequences of a

failure therefore very serious. Many of these men have told me that in the future they will devote the summer months to "white fish" operations, in other words, to catching barracuda, white sea bass, and yellowtail. Such a change would increase considerably the strain the purse seiners cause upon the natural supply of the last three fish, especially upon the barracuda and the white sea bass.

It may be mentioned in this connection that the failure in our bluefin tuna fishery caused the purse seiners of Puget Sound not to carry out their announced intention to come down to southern California after the depletion of the salmon and halibut fisheries of the north.

6. V. POSSIBILITIES AND RESULTS OF PROHIBITIVE OR RESTRICTIVE LEGISLATION AGAINST PURSE SEINERS

As pointed out in the introduction to this report, there is a fairly widespread opinion that, because of supposed destructiveness, purse seining for barracuda, white sea bass, and yellowtail should be prohibited in southern California. In considering the possibilities and probable consequences of regulations of purse seine operations for these three fish, it is necessary, for many reasons, to contemplate at the same time the possibilities and results of similar legislation with regard to round haul operations.

The purse seine boats and the round haul boats have about the same effect on the natural supply of barracuda, white sea bass, and yellowtail. Both types make very large catches of these fish, and both catch and destroy undersized barracuda in great quantities; see pages 29 and 48. Moreover, the round haul boats have some characteristics which make them even less desirable than the purse seine boats. The purse seine boats, because of their advantage of ice capacity and relatively high tonnage, have a large radius of action, extending, generally speaking, from Point Conception in Santa Barbara County to Point San Lucas, *i. e.,* to the southern point of Lower California. The round haul boats, on the other hand, are confined to a rather restricted area around their home ports, on account of their lack of ice capacity and their small size. When the round haul boats go to far-off fishing grounds, they run the risk of having a large part of their catch destroyed before the port of sale is reached. In any case, the quality of their product is apt to be lower than when the fish is handled on board a purse seine boat, since they carry their load on deck and not in the hold. A deck load is exposed to rain and to the detrimental influence of the sunshine, while the fish well iced in the hold of a purse seine boat keeps its good quality for several days. Furthermore, the restricted space on board a round haul boat does not allow the transportation of individual loads large enough to make long trips profitable. The local California waters to which the round haul boats are confined are much more exposed to depletion than distant regions, such as the extended coast of Lower California. Especially exposed to this risk are the waters near San Pedro, which is the most important fishing center of southern California and the home port of a great number of round haul boats. This point hardly can be overemphasized when the future of the fishing industry of southern California is under consideration.

The destructiveness of the round haul method in the "white fish" fishery has been less discussed than that of the purse seine method. This is largely due to the fact that, at the present time, the round haul boats are less numerous and operate on a less scale than the purse seine boats.

In short, the purse seine and the round haul fisheries for barracuda, white sea bass, and yellowtail in southern California are so similar in effect that they should stand and fall together. In other words, legislation concerning any or all of these three species, the barracuda, the white sea bass, and the yellowtail should be made to include the round haul method as well as the purse seine method.

Before entering upon the discussion of the various alternatives with regard to prohibitive or restrictive measures against the purse seine and round haul methods, it is necessary first to give some information with regard to the gear used in the purse seine and round haul fisheries.

6.1. 1. Gear

There are two kinds of purse seines, differing only in details, one used in the tuna fishery, the other used for "white fish," *i. e.,* for barracuda, white sea bass, yellowtail, and mackerel. Intermediate types are to be found. For descriptions of these nets, reference is made to the appendix of this report.

Among the round haul nets a great variety prevails. However, three main types may be distinguished, between which there are numerous intermediate types, viz, round haul nets (1) for sardines, (2) for mackerel, and (3) for barracuda, white sea bass and yellowtail.

Round haul nets used for sardines: Two kinds, differing only in details, can be distinguished, namely the Italian and the Japanese round haul nets. The following descriptions of these nets are taken from an article "Methods of Sardine Fishing in Southern California," by Elmer Higgins and H. B. Holmes, CALIFORNIA FISH AND GAME, volume 7, number 4. For diagrams, illustrating these descriptions, see the original paper.

long and each wing twice as long as the bunt, or 80 fathoms. of this length, about 10 fathoms is 3-inch mesh, six-thread twine, 45 fathoms of 8-inch, six-thread, and 25 fathoms of 12-inch mesh, nine-thread twine. The piece of 3-inch mesh is fastened to the bunt of the net and is the same depth, *e. g.*, 28 fathoms. Each succeeding piece is reduced somewhat in depth so that the wing tapers to 15 or 18 fathoms at the end. This amount of webbing at the end of the wing is, however, gathered into bunches and fastened to a 2-fathom rope or to a wooden brail 2 feet long. Some prefer more pieces in the wings, beginning with smaller mesh, such as 2½-inch, and running 3-inch, 5-inch, and 8-inch mesh at the end of the wings. Others use 8-inch mesh throughout the whole wing." ""A typical Japanese sardine net is from 200 to 250 fathoms long and from 25 to 30 fathoms deep, although many are 300 fathoms long and from 35 to 45 fathoms deep. The bunt is from 30 to 50 fathoms along the cork line, and the wings from three to three and one-half times this length. The mesh is commonly 1-inch, nine-thread in the landing bag; ¾-inch No. 26, cable-laid, in the sides of the bunt; 1-inch No. 26, cable-laid, lower down; and 3½-inch, six-thread, hard-laid, in the bed. The wings are made up of three or five pieces of webbing of different size, of from 3 to 8-inch mesh, arranged as in the Lampara and tapering in depth. A strip of heavy mesh or selvage runs the entire length of the cork line, as in Italian net, but, in addition, a strip of two or three heavy 3-inch meshes runs down the sides of the bunt, making a firm selvage for the attachment of the wings." ""A special feature used in some Japanese nets is the purse line or quarter rope, a ¾-inch rope, one end of which is fastened to the middle of the lead line by a short halter, and the other end to the lead line of one wing about 15 fathoms out. This line is used to raise the middle of the lead line of the bunt more rapidly than could be done by hauling only on the wings.""

The round haul nets used for mackerel, barracuda, white sea bass, and yellowtail differ from those used in the sardine fishery mainly in having 2 to 3½-inch mesh in the whole bag except near the lead line where 4 to 5-inch mesh is used. In the round haul nets for mackerel mostly 15-thread medium-laid cotton seine twine is used and in the round haul nets for barracuda, white sea bass, and yellowtail 17 to 21-thread medium-laid cotton seine twine.

The most important feature of these descriptions is that there are numerous intermediate types between the different kinds of purse seines as well as between the different kinds of round haul nets. Legal differentiations between the main types will cause extreme difficulties and also are apt to hamper the rational evolution of the gear.

6.2. 2. Alternatives for prohibitive or restrictive measures

A. Prohibition of possession of purse seines.—Legislation prohibiting the possession of purse seines, *i. e.*, nets furnished with a purse line, running through rings fastened to the lead line, and permitting the possession of round haul nets, probably would result in the purse seine boats being equipped with round haul nets instead of with purse seines. The round haul nets would be used for barracuda, white sea bass, and yellowtail, and so the prospective good of such a legislation would be nullified. The bluefin tuna, because of its peculiar habits, probably could not be caught in profitable quantities with round haul nets and, therefore, would be lost for human consumption.

B. Prohibition of possession of purse seines and of round haul nets.—A regulation prohibiting the possession of both purse seines and round haul nets would result in the cessation of the sardine and the bluefin tuna fisheries, on which the great canning industry of southern California mainly depends. This alternative, therefore, does not need any further consideration.

C. Prohibition of possession of purse seines and round haul nets which can be used profitably for catching barracuda, white sea bass, and yellowtail.—This alternative implies the necessity of distinguishing between purse seines used for barracuda, white sea bass, and yellowtail and those used in the tuna fishery, as well as between round haul nets used for sardine and mackerel and those used for barracuda, white sea bass, and yellowtail. As we have previously seen, such differentiations may be possible but are extremely difficult to establish in a practical legal form. Furthermore, the enforcement of such a measure would cause very great difficulties.

The first result of such a prohibitive measure probably, not to say certainly, would be the complete cessation of purse seine operations. In our local waters, there would be only one important species for these fishermen to exploit, viz, the bluefin tuna, and, judging from the results of previous years, this fishery is altogether too fluctuating to be depended on. The yellowfin tuna and the bonito appear not to be abundant enough to become objects of large fisheries; moreover, the market for bonito is rather limited.

The round haul boats, on the other hand, would continue fishing, since the round haul operations for barracuda, white sea bass, and yellowtail are of secondary importance to the round haul fishermen. During the winter these boats would be used in the sardine fishery, and during other seasons they could be used profitably for gill netting and hook and line fishing for barracuda, white sea bass, yellowtail, halibut, etc.

The cessation of the purse seine operations would result, temporarily at least, in the loss of the bluefin tuna for human consumption. This fish, which is very important to the canning industry of southern California, can at present be caught only with purse seines.

The yellowtail, which are caught mainly with purse seines and round haul nets and which probably can stand a more intensive fishing than that carried on at the present time, also would be largely lost for human consumption, if the regulation mentioned above were carried out.

Another serious consequence of the cessation of our purse seine industry would be the discontinuation of the present importation into California of large amounts of Mexican barracuda, white sea bass, and yellowtail. In other words, a great percentage of the surplus of the rich fish production in the waters along the extended and very slightly developed coast of Lower California would become unavailable for human consumption. It also would mean that the supply of fish in the fresh fish markets of San Pedro would be vastly reduced during the winter months. Furthermore, the San Diego fish dealers would be relieved of the comparatively low retail prices caused by the San Pedro purse seiners. This probably would favor San Diego as a basis for small boat fishery in neighboring Mexican waters, and so the center of gravity of the fresh fish industry in southern California would tend to shift from San Pedro to San Diego. For many reasons such a change should be weighed carefully from an economic standpoint.

However, the most serious consequence of the cessation of the purse seine operations would be the intensification of the fishing operations in local southern California waters and in the nearest Mexican waters.

With no Mexican purse seine fish available, the wholesale price of fresh fish during the winter months certainly would become decidedly higher than at the present time. Rather small individual catches would be sufficient for a reasonable profit. The advanced wholesale prices certainly would cause an increase in the number of small boats operating. The halibut and the rockfish (rock cod) are among the species which are likely to be especially sought for by these boats. Unfortunately, these two species appear to be overfished at the present time. In any case, there is a general complaint among the fishermen that these fish are becoming scarcer every year, and that the individual catches are becoming smaller. That large yearly catches still are made in the halibut fishery, certainly depends on the high prices; in January 1923, the price per pound of halibut paid to the fishermen at San Pedro was between eighteen and twenty-four cents. (It may be mentioned in this connection that, according to the fishermen, the destruction of the halibut was caused mainly by the drag net operations.) The rockfish banks seem to be very readily depleted, probably because of the slow rate of growth of the rockfish (according to W. F. Thompson of California Fish and Game Commission) and to their great voracity; one often catches two specimens of this fish on the same hook, the one first caught having been swallowed by another.* Furthermore, if the competition of the purse seiners be eliminated during the summer, the number of men gill netting for barracuda probably would increase decidedly. This would intensify the strain on our natural supply of local barracuda, especially since gill netting for this fish is carried on largely during the spawning season (p. 50).

It also should be mentioned that the gill net and the hook and line fishermen probably would be unable to furnish the markets at San Pedro with a sufficient supply of fish except during the summer. Thus the elimination of the purse seiners would be a serious blow to the fresh fish trade and would curtail the available food supply in southern California.

The above discussion shows that the probable results of legislation causing the cessation of our purse seine industry are of such a far reaching and in many respects highly undesirable nature that regulations of this kind should not be passed until the evidence of their necessity is absolutely conclusive, which is not the case at the present time.

D. Regulations permitting the possession of purse seines and round haul nets fit for barracuda, white sea bass, and yellowtail* fishing but prohibiting their use inside the three mile limit of southern California (districts 19 and 20). This alternative is hardly worth a close consideration. First, its enforcement would cause extreme difficulties.

* There seems to be but little doubt that the halibut and the rockfish need protection. An immediate investigation of these fish is needed. Preliminary protective measures are recommended, for instance, a close season during the spawning period.

* There are strong reasons in favor of the assumption that the yellowtail is not being over-fished at the present time. This fish even may be able to stand a more intensive exploitation than the present (p. 72). The reason for considering it in connection with the barracuda and the white sea bass is that these three species are caught at the same localities and with the same gear. To make an exception of the yellowtail probably would not help the fishermen to any considerable extent and certainly would render the enforcement of the proposed measure extremely difficult. In the case of alternative "H", it should be remembered that but small amounts of yellowtail are taken in April and May.

This is evident from the failure of enforcing a similar law with regard to the drag nets. Second, if it were enforced, it certainly would result in the cessation of all purse seine operations, since almost all the barracuda and white sea bass landed are caught inside the three mile limit. For the probable consequences of this cessation, see subheading C. Even were the purse seiners permitted to operate inside the three mile limit for any fish except for barracuda and white sea bass, they probably would not be able to continue their operations with profit.

E. Prohibition of the landing of barracuda, white sea bass, and yellowtail (see foot-note to subheading D) caught with purse seine or with round haul nets, regardless of the source of the product.—This measure probably would be easier to enforce than the last one. If enforced, it certainly would result in the cessation of all purse seine operations. For the probable consequences of this cessation, see subheading C. Even were the yellowtail excluded from the list of protected species, the purse seine operations would be discontinued.

F. Regulations concerning the size of mesh of purse seines and of round haul nets used for barracuda, white sea bass, and yellowtail (see footnote to subheading D).—Many persons consider as desirable the prohibition of the possession of purse seines and round haul nets with mesh so small as to prevent the undersized barracuda from passing through the web. For the consequences of such regulations, see page 79.

G. Closed districts for purse seine and round haul fishing.—This alternative should be given due consideration. If such a district were to be established, the region from Los Coronados Islands to a point half way between Oceanside and Point San Juan undoubtedly is to be recommended, since most of the undersized barracuda are caught in this region. However, the feasibility and desirability of this alternative are highly questionable. It should be remembered that the enforcement of similar regulations in district twenty is very difficult. The difficulties in enforcing the suggested measure undoubtedly would be greater.

H. Close season for barracuda and white sea bass.—In choosing a close season for these two fish, two factors should be kept in mind: (1) the barracuda and the white sea bass should be preserved as much as possible, and (2) the least possible economic loss should be inflicted upon the fishermen. There seems to be but little doubt that, from these viewpoints, the months of April and May are the most desirable. This statement is based on the following reasons: 1. During this period very large catches of local barracuda and white sea bass are landed. In the case of the barracuda it is even the period of the heaviest average monthly local catches (Fig. 11). 2. In the month of April, as a rule, the largest individual catches of local barracuda are made, and most of the undersized barracuda are caught. About the destructiveness of large individual catches and about the destruction of undersized barracuda, see page 48. 3. May probably is the first spawning month of the barracuda and the white sea bass (pp. 36 and 53). 4. In April and May the fresh fish markets often become oversupplied, and so the fish frequently has to be sold at prices which, according to the fishermen, barely, if at all, cover the running expenses. According

to the statement of a person intimately connected with the management of a great number of purse seine boats, such a regulation would not inflict serious damage to the purse seine industry; and this statement has been corroborated by many purse seine fishermen.

In order to facilitate the enforcement of the regulation here discussed, it probably would be best to prohibit, during April and May, not only purse seine and round haul operations for barracuda and white sea bass but the catching of these species with any kind of gear. In other words, during these two months barracuda and white sea bass should not be permitted to be taken or landed in southern California by any kind of boat. Furthermore, the importation of these two species should be prohibited. Such a regulation would not cause serious damage to the gill net industry. In April, 1922, 92.3 per cent of the barracuda sold in the fresh fish markets at San Pedro was landed by purse seiners; for May, 1922, the corresponding value was 63.9 per cent. For white sea bass the corresponding values were 70.6 per cent and 60.5 per cent; see tables 17 and 27. Most of the barracuda and white sea bass, caught by the small boats in May, 1922, was landed during the last two weeks of the month; see tables 18 and 28.

During the close season the fish dealers should be permitted to market barracuda and white sea bass landed and sold in California before April 1 (just as Mexican crawfish is permitted to be marketed in California during the close season). This permission probably would result in relatively high prices paid to the fishermen for these two species during February and March. High prices would increase purse seine operations in Mexican waters during February and March, and thus the purse seiners, to some extent, would be compensated for the losses that they would suffer from a close season. Furthermore, in order to be able to store large quantities of barracuda and white sea bass during the months preceding the close season, the dealers would be forced to improve their cold storage facilities. Such an improvement is highly desirable.

I. Limitation of the number of operating purse seine boats.—The purse seiners depend on large yearly catches, because of the expensiveness of their operations. This makes a limitation of the number of operating purse seine boats highly desirable. However, if legally possible, a regulation of this kind would cause such great difficulties that this alternative reasonably may be disregarded.

Addendum.—It may be mentioned in this connection that there is a decided disinclination among the fishermen to continue the operations in Mexican waters since the establishment of a duty on fresh fish imported from Mexico to the United States. It should be remembered that the expenses of our purse seiners, when operating in Mexican waters, were very high before this import duty was established. As a consequence of this tax, the purse seine operations in southern California waters probably will be intensified.

This law is interpreted somewhat differently at San Pedro and at San Diego. At San Pedro, boats owned by aliens are taxed, regardless of whether or not some members of the crews are citizens, and boats owned by citizens are exempted, no matter if some members of the crews are aliens. At San Diego, the shares of all alien members of the crews are taxed, whether or not the boats are owned by citizens.

7. VI. THE FUTURE DEVELOPMENT OF THE SEA FISHERIES OF SOUTHERN CALIFORNIA IN RELATION TO THE PURSE SEINE INDUSTRY

During the last few decades, the population of southern California, particularly that of Los Angeles County, has undergone an enormous growth, and there is every prospect that it will increase very decidedly in the years to come. This fact makes urgent the solution of the problem as to how the future highly increased demand for fresh fish should be met.

The growth of the population in California has brought about an enormous increase of our fishing industry. Not only does the grand total of fishery products yearly landed in California show an extraordinary rise, but the individual species also have become more and more heavily exploited. Figure 21, which is a reproduction from W. F. Thompson's paper "The Fisheries of California and Their Care," CALIFORNIA FISH AND GAME, volume 8, number 3, gives a good representation of the growth of the fisheries of California as a whole. Figures 13 and 17 show the development of the barracuda and white sea bass fisheries of California. The most outstanding feature of these three graphs is the enormous growth that has occurred since 1916.

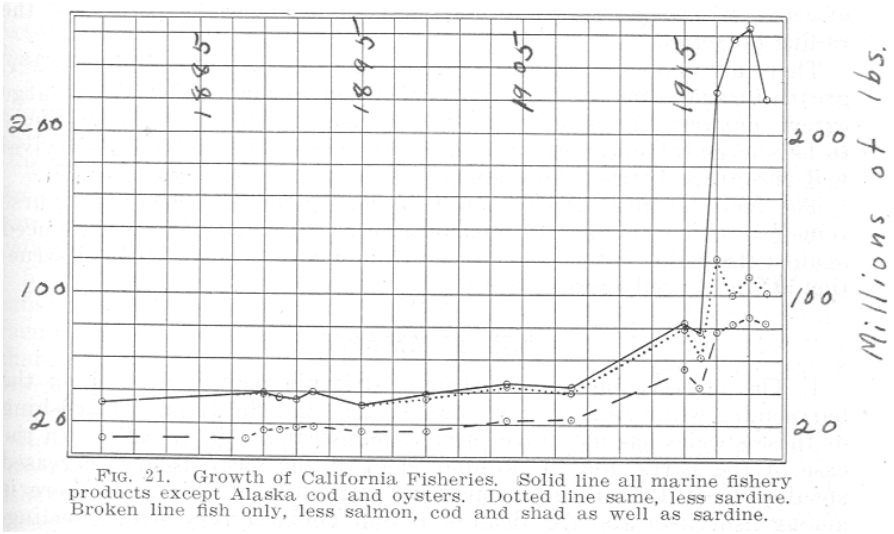

FIG. 21. Growth of California Fisheries. Solid line all marine fishery products except Alaska cod and oysters. Dotted line same, less sardine. Broken line fish only, less salmon, cod and shad as well as sardine.

FIG. 21. Growth of California Fisheries. Solid line all marine fishery products except Alaska cod and oysters. Dotted line same, less sardine. Broken line fish only, less salmon, cod and shad as well as sardine

Can our local fisheries develop much more without endangering the natural supply? This question probably must be answered in the negative. It is evident by now to most persons well conversant with the problems connected with our fishing industry that our natural supply of local fish is very limited. of the more important species sold to the fresh fish markets, two or three probably are being over-fished at the present time. These fish are the barracuda, the California halibut and the rockfish (rock cod). Furthermore, a rather limited development of the local white sea bass operations probably very soon would endanger this fish. See Table 2 and figure 3, and the discussion of this problem in the next chapter.

In order to meet the future highly increased demand for fresh fish, southern California, to a very large extent, must reply upon an extensive exploitation of distant fishing grounds. In other words, the development of our sea fisheries probably will be the same as that of the sea fisheries of most European countries.

The exploitation of distant fishing grounds implies the existence of a fleet of large, seagoing fishing vessels, economical in operation, and fit to carry big loads of fish (on ice, or otherwise preserved) long distances. For a rational development of our sea fisheries will be needed vessels, large, speedy, and economical enough to operate with profit as far away as the Gulf of California and along the west coast of Central America.

At the present time, southern California has no vessels approaching this type more closely than the purse seine boats. These are the only ones which, on a large scale, undertake fishing expeditions to distant waters, *i. e.*, along the whole west coast of Lower California. The purse seine fleet provides our best hope for the future development of our fishing industry according to the principles outlined above. A great number of the present purse seine boats have a considerable cruising radius and carrying capacity, and there are signs of further development in these respects as well as with regard to economy of operation. For instance, the reduction of the cost of operation by the installment of crude oil engines probably will imply a considerable increase of the radius of action.

There are among our present purse seine boats vessels of high power, great storage capacity, and economical operation, which, to a large extent, answer the requirements of the future. These vessels are likely to be successful under the present economic crisis, and their survival will encourage further development of the principles they embody.

The facts outlined above should be kept in mind, when the "purse seine" problem is under consideration. They should be balanced against the rather intangible damage done by these boats in the destruction of undersized barracuda.

8. VII. SUMMARY

1. The purse seiners of southern California mainly depend on the barracuda, white sea bass, yellowtail, and bluefin tuna. Overfishing of these species has not as yet been demonstrated scientifically. In the case of the barracuda the annual yield of the local fishery increased steadily from 1916 to 1921 inclusive. In spite of this fact, there is among fishermen and fish dealers at San Pedro a very strong feeling, almost amounting to conviction, that the natural supply of local barracuda begins to show decided indications of decrease. As to the white sea bass, only a few fishermen and dealers at San Pedro complain about increasing scarcity, and some persons even maintain that 1922 was a year of unusual abundance. However, it seems rather likely that this fishery has practically reached its climax. The annual yield of the local fishery for white sea bass increased steadily from 1916 to 1920 inclusive, but 1921 showed a slight decrease, when compared with 1920. There are no complaints about increasing scarcity of yellowtail and bluefin tuna, and we have good reasons to assume that these species are not being overfished at present. Indeed, the yellowtail

fishery probably can be developed considerably, without endangering the natural supply. The decrease in the annual yields of these two species during the last few years (written in 1922) was certainly not caused by depletion but by market conditions and natural fluctuations.

2. The main objection to the purse seine method in southern California is its destructiveness to undersized barracuda. This objection probably is largely justified, but the data available are not sufficient to form the basis for drastic legislative measures against this method. Not only the purse seiners but also the round haul fishermen destroy large quantities of undersized barracuda. The question is still open whether or not the purse seiners and the round haul fishermen by killing undersized barracuda are more destructive to this species than the gill netters, who catch very large quantities of spawning fish and thus eliminate countless numbers of potential barracuda. Gill netting for this fish is almost limited to the spawning period. The purse seiners, on the other hand, operate throughout the whole year.

3. Most undersized barracuda are destroyed in very large individual catches containing small fish among the legal sizes. Such catches, which therefore should be avoided, occur mainly in April and in the region from Los Coronados Islands to a point about half way between Oceanside and Point San Juan.

It is a fact not generally appreciated that all marine fisheries are extremely wasteful and that they can not be carried on under modern market conditions without being so (p. 15).

4. While of the barracuda large quantities of undersized fish are caught and destroyed by purse seiners and round haul fishermen, only negligible amounts of small white sea bass are marketed. Small yellowtail hardly ever are seen in the fresh fish markets of San Pedro. Small white sea bass are caught by purse seiners as well as by round haul fishermen. There is no indication that, in the white sea bass and yellowtail fisheries, purse seines are more destructive than other gear.

5. The failure of the bluefin tuna fishery in 1921 and 1922 may cause an increase in the number of purse seine boats fishing for barracuda, white sea bass, and yellowtail during the summer. Such a change in the purse seine fishery would decidedly increase the risk of overfishing the last three species.

6. Most of the purse seines used for barracuda, white sea bass, and yellowtail are made largely from webbing of 2½-inch mesh. This size of mesh seems to be advisable both from the standpoint of the fishermen and the principle of conservation, since the undersized barracuda gill less readily in this kind of webbing. The cleaning of the seine from gilled barracuda means unprofitable work for the fishermen, and a large percentage of the gilled fish probably is killed by the rough treatment.

7. Purse seine operations in southern California are probably not destructive to the "feeding grounds" of the commercial fish, *i. e.*, to the bottom fauna and flora of the fishing grounds.

8. Because of their ability to catch the bluefin tuna, the purse seiners are of great importance to the canneries. The purse seiners are of vital importance to the fresh fish markets as a source of supply of barracuda, white sea bass, and yellowtail, three species on which the fresh fish trade of southern California mainly depends. During the winter, when only small quantities of barracuda are caught in

local waters, these men import large amounts of this fish from Mexico. The gill netters can furnish the markets with a sufficient supply of barracuda only during the summer, from the middle of May to the middle of August. From January 1 to July 1, 1922, of the total amounts of barracuda, white sea bass, and yellowtail sold to the fresh fish markets at San Pedro, the purse seiners landed 70.4 per cent, 47.2 per cent, and 73.2 per cent, respectively.

9. Great fluctuations in the daily supply of barracuda, white sea bass, and yellowtail are characteristic of the periods during which the fresh fish markets depend mainly on the small boats for their supply of these fish as well as during the purse seine periods. In other words, the opinion is not tenable that only the purse seiners by their large individual catches bring about oversupply. The recurrent oversupply, especially of barracuda, causes much fish to be spoiled and unsettles the fresh fish trade.

10. The prices of barracuda, white sea bass, and yellowtail paid to the fishermen by the fresh fish markets at San Pedro are strikingly variable. These variations are largely due to the fact that these markets become oversupplied very easily because of lack of sufficient cold storage facilities.

11. For this and other reasons, the purse seine industry of southern California is nearly in a bankrupt condition. Other fisheries, especially the gill net fishery for barracuda, also suffer from this condition.

12. The purse seine and round haul fisheries for barracuda, white sea bass, and yellowtail are so similar that legislative regulations aiming at one of them also should include the other.

13. Conclusive proofs of overfishing will require a thorough-going analysis of the commercial catches of a number of consecutive years. If protective measures are not passed until such proofs are available, the barracuda and the white sea bass fisheries probably will suffer. It is highly desirable that these two species be protected as soon as possible.

14. The probable results of legislation causing the cessation of our purse seine industry are far reaching and in many respects of a highly undesirable nature. Such regulations, therefore, should not be passed until the evidence of their necessity is absolutely conclusive, which is not the case at the present time.

15. Among the various possible measures to protect the barracuda and the white sea bass, the closing of a season certainly is the one to be recommended. Such a measure would not cause the cessation of the purse seine industry. For many reasons, the closing of April and May should be first considered. In order to facilitate the enforcement of this regulation, it probably would be best to prohibit, during these two months, not only purse seine and round haul operations for barracuda and white sea bass but the catching of these two species with any kind of gear. In other words, barracuda and white sea bass should not be permitted to be taken or landed in southern California by any kind of boat.

16. A permission to market, during the close season, barracuda and white sea bass landed and sold in California before April 1 probably would cause relatively high prices of these fish during the period preceding the close season. The fishermen would thus be partly compensated for the losses they would suffer from a close season. Furthermore, such a regulation probably would cause the fish dealers to

improve their cold storage facilities. Such an improvement is highly desirable.

17. The import duty on fresh fish from Mexico is detrimental. It will probably cause an intensification of the purse seine operations in southern California waters.

18. The future demand for fresh fish in southern California probably will be much greater than the present. In order to satisfy this increased demand, it will be necessary to rely to a large extent on the exploitation of distant fishing grounds. Fishing in distant waters implies the existance of a fleet of large seagoing vessels, economical in operation and fit to carry big loads of fish (on ice, or otherwise preserved) long distances. At the present time, there are in southern California no vessels approaching this type more nearly than the purse seine boats. These are the only ones which, on a large scale, undertake fishing operations to distant waters (along the whole coast of Lower California).

19. It is impossible as yet to furnish the legislative body of California with adequate and scientific information on questions which are rooted in the biology and life history of the barracuda, white sea bass, and yellowtail. It is a deplorable fact that exhaustive investigations along these lines, which by their nature will require considerable time and painstaking and devoted work, have not yet been begun.

9. VIII. RECOMMENDATIONS ON THE FISHING INDUSTRY OF SOUTHERN CALIFORNIA

1. Purse seining for barracuda, white sea bass, and yellowtail should be permitted in districts 19 and 20A of southern California, until it has been proven scientifically that the purse seines are more destructive than other gear which could advantageously replace them.

2. No limits should be established for the size of mesh of purse seines.

3. The present weight limit of three pounds for the barracuda should be replaced by a length limit of 25 inches.

4. No size limit should be established for white sea bass and yellowtail.

5. April and May should be made a close season for barracuda and white sea bass. During these two months the barracuda and white sea bass should not be permitted to be taken or landed in southern California with any kind of gear, nor should they be imported. During the close season the fish dealers should be permitted to market barracuda and white sea bass landed and sold in California before April 1.

6. It should be lawful to market game fish, caught accidentally during purse seine and round haul operations, if this is feasible from an administrative standpoint.

7. The present duty on fresh fish imported from Mexico should be removed.

8. No measures should be adopted which would increase the present strain on the natural supply of halibut and rockfish.

9. Thorough-going investigations on the life history and biology of the barracuda, white sea bass, and yellowtail, and on the economic importance of these species should be begun as soon as possible. An investigation on the amount of undersized barracuda destroyed by purse seines and other gear should be undertaken during the months of March, April, and May.

APPENDIX

Description of the Purse Seine

In contrast to the Italian round haul nets or "lampara" and to the Japanese round haul nets* used in California, the purse seines are of a simple structure. There are two kinds of purse seines used in California, viz., those for "white fish," *i. e.,* for barracuda, white sea bass, and yellowtail, and those for "tuna." Both kinds are built on the same plan and differ only in details.

In the following, first the different parts of the purse seines and the manner in which they are put together will be described. Afterwards (on page 93) a general description of the finished net will be given.

1. Description of the parts and the building of the purse seine.

Web: The web has the shape of a long, shallow curtain and is made up of three to seven, generally four or five, horizontal strips. In most purse seines all the strips are rectangular and of the same length. Thus the whole seine, before the "hanging" (see page 90), is rectangular. In a few purse seines the strips are made a little shorter progressively from the top to the bottom, i. e., the top strip is made the longest, the bottom strip the shortest, and the middle strips of intermediate lengths. When strips of different lengths are sewn together, the rows of meshes, in most cases, are made to hang vertically throughout the whole seine just as in the seines with strips of equal length.

Before the strips are sewn together, they are always tarred (not tanned as in the case of most of the other nets used in California). In tarring, the small mesh web always shrinks somewhat more than the large mesh web. Furthermore, even the tarred web shrinks somewhat during the first months of fishing; and here again the small mesh web shrinks a little more than the web of large mesh. When two strips of different size of mesh are to be sewn together, the builder of the seine therefore must know in each particular case how much should be gathered, or, as the fishermen say, "taken up," on the edge of the small mesh strip in order that the web may "hang" well. The middle points of the two strips must be opposite each other; at the ends of the seine the free edges of the strips must meet; and between these fixed points the "take up" must be uniform.

The length and depth of the web are fairly variable in the different seines, as is shown in the following table.

	Length	*Depth*
Tuna seines	About 240–320 fathoms	About 23–34 fathoms
"White fish seines"	About 200–250 fathoms	About 12–24 fathoms

In most of the tuna seines the web is about 250 to 290 fathoms long and 25 to 30 fathoms deep; in most of the "white fish" seines it is about 200 to 240 fathoms long and 14 to 19 fathoms deep. As a rule, the seines are deeper the longer they are. The depths given above refer to stretched and untarred web. The depths of the finished seines suspended in the water are about one quarter less.

The reason the tuna seines are made longer and deeper than the "white fish" seines is that most of the bluefin tuna are caught in

* These nets are described by Elmer Higgins and H. B. Holmes in CALIFORNIA FISH AND GAME, volume 7, number 4, October, 1921.

deep water, while the "white fish" are taken mostly in rather shallow water. Furthermore, when disturbed in cold weather, the bluefin tuna are inclined to "sound," i. e., to go down into deeper water, which makes them very difficult to catch (see p. 75). The reason the purse seines are not made still longer and deeper is that the larger the seines, the more difficult they are to handle, and an increase in the time required for pursing the seine increases the chance for the fish to escape. Moreover, deep purse seines are very inconvenient in shallow water as they are apt to get caught and torn on snags (to "snag" in the fishermen's terminology).

In most of the "white fish" seines 2½ or 2¾-inch mesh, stretched web, is used in all the top strips and 4 to 5-inch mesh, stretched web, in the bottom strip. The bottom strip is generally about 25 to 50 meshes deep, sometimes as much as 75 to 100 meshes deep. In some "white fish" seines 3 to 3½-inch mesh are used in the top strips. For example, one seine had the following combination of strips: top strip, 3-inch mesh, 200 meshes deep; second strip, 2¾-inch mesh, 200 meshes; third strip, 2½-inch mesh, 75 meshes; bottom strip, 4½-inch mesh, 50 meshes. In another seine the corresponding figures were 2½-inch (100 meshes), 3½-inch (100 meshes), 3½-inch (100 meshes), 3½-inch (100 meshes), and 4-inch (100 meshes). Small meshes, 2½ inches, are preferred by most fishermen, since small, "undersized" barracuda (1½ to 2½ pounds) do not gill so readily in this kind of web.

In the tuna seines the size of mesh is more variable than in the "white fish" seines. Mesh varying from 2½ to 15 inches has been seen. These sizes are found in different combinations; however, the largest sized meshes (from about 10 to 15 inches) are found only in the bottom strip. One tuna seine had a combination of strips of 4½, 3, 4, and 10-inch mesh in order from the top to the bottom. In some other tuna seines the corresponding figures were: (1) top strip, 3½-inch mesh, 150 meshes deep; second strip, 5-inch mesh, 100 meshes; third strip, 6-inch mesh, 50 meshes; fourth strip, 3-inch, 100 meshes; fifth strip, 3-inch, 100 meshes; bottom strip, 4-inch, 100 meshes. (2) top strip, 5-inch, 100 meshes; second strip, 5-inch, 100 meshes; third strip, 5-inch, 100 meshes; fourth strip, 4½-inch, 100 meshes; bottom strip, 6-inch, 50 meshes. (3) top strip, 3-inch, 200 meshes; second strip, 6-inch, 100 meshes; third strip, 9-inch, 100 meshes; bottom strip, 15-inch, 12 meshes. Some fishermen favor the following combination of strips from the top to the bottom: 2½–4, 4–5, 5–8, and 6–10-inch mesh. Others prefer to have 2½ to 3½ inch mesh in most of the top strips; they prefer this small mesh web because of its strength, although its density makes the seine very heavy in the water. As examples of the last mentioned type of tuna seines, the following combinations may be given: (1) 2½, 3, 2½, 2½, 2½, 3½, and 4-inch mesh (100 meshes of 4-inch mesh), in order from the top to the bottom; (2) 2¾, 2¾, 2¾, 5, and 5-inch mesh (100 meshes of 5-inch mesh). As will be seen from the figures given in this paragraph, there is a great variety in the size of mesh of the tuna seines. There is no standardized usage. When building his seine, the fisherman applies his own ideas and experiments with different combinations, a circumstance that probably will make for the development and perfection of this gear. Furthermore, when building a new tuna seine, the fishermen, for reasons of economy, often have to use one or more old strips of a "white fish" seine.

The web of a purse seine is made of cotton seine twine, in most cases medium-laid, in some cases hard-laid. The following numbers of medium-laid twine are mostly used in the "white fish" seines:

Size of Mesh	*Number of Twine*
2½–2¾ inch	15–21 (mostly 18)
3 –3½ inch	18–21
4 –5 inch	21–27

In the tuna seines the following numbers are used:

Size of Mesh	*Number of Twine*
2½–2¾ inch	18–21
3 –3¾ inch	24–27
4 –5 inch	33–42
6 –7 inch	42–48
8 –15 inch	42–60

The "bunt" or "bailing-piece" of the "white fish" seine (see p. 95), *i. e.*, the portion of the seine into which the bulk of the catch is crowded before the landing, sometimes has stronger twine than the remainder of the seine.

Almost all the purse seine web sold and used in southern California is manufactured in the United States.

"Hangings:" The free edges of the web of a purse seine are fastened to two ropes, sometimes called the "hangings."* The upper edge is fastened to the "cork line," which is buoyed with numerous corks. At each of the two upper corners of the web the cork line is made into a free loop, which is about three-fourths of a fathom long or somewhat shorter (see Fig. 22). Below the loops this rope is fastened to the end edges of the web, generally only part way down. The portions of this rope below the loops are not furnished with corks; sometimes they are called the "up and down" lines, but most of the fishermen have no technical name for them. The lower edge of the web is fastened to the "lead line," which is weighted with numerous sinkers or leads. At the ends of the seine the lead line is fastened to the up and down lines, often by means of a short rope of intermediate thickness fastened to the lower portions of the end edges of the web. In addition to their floating and ballasting the seine, the cork line and the lead line serve as reinforcement for the edges of the web and take much of the strain in the hauling of the seine.

As far as my experience goes, the hangings are always untarred manila. Before the web is hung, the ropes are soaked in water so as to get rid of kinks.

In some seines the whole cork line, including the up and down lines, is twenty-one thread manila. In other cases, especially in the large seines, the middle portion of this rope is twenty-one thread manila, and forty to sixty fathoms at each end of the seine and the up and down lines are twenty-seven to twenty-nine thread manila. The lead line generally is twelve to fifteen thread manila.

Some fishermen make the new cork line almost as long as the web and make allowance only for the influence of the corks on the length

* See "The Fisheries and Fishery Industries of the United States" by G. Brown Goode, Washington, 1887, section V, page 254, footnote.

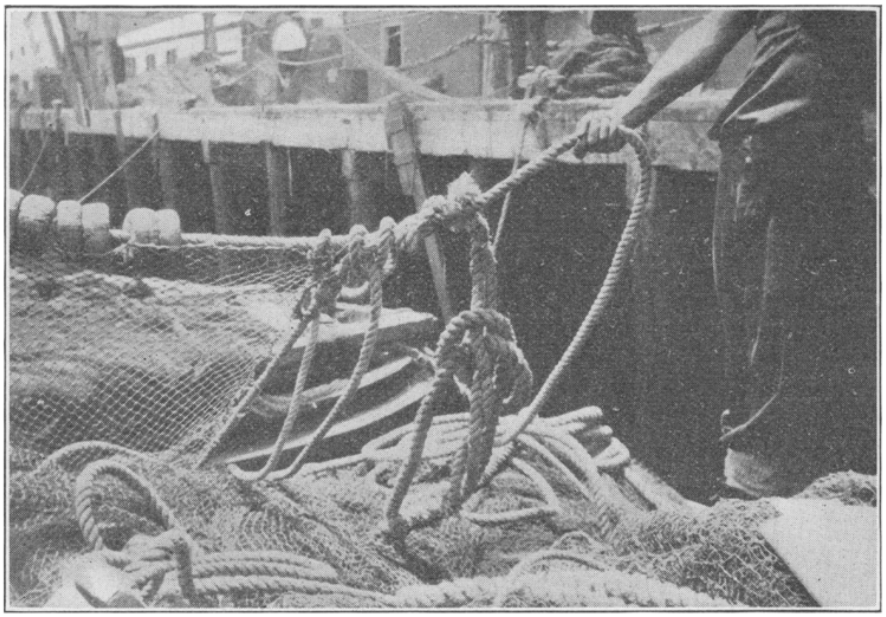

FIG. 22. The skiff end of a purse seine. The cork rope and the brail line are fastened to the place where the cork line and the up and down line meet. The purse line is fastened to the middle of the end loop. The man holds the seine by the skiff line.

FIG. 22. The skiff end of a purse seine. The cork rope and the brail line are fastened to the place where the cork line and the up and down line meet. The purse line is fastened to the middle of the end loop. The man holds the seine by the skiff line

of the rope. Most of them, however, make the web somewhat longer than the cork line. The new cork line always shrinks somewhat more in the water than does the web which makes the web "hang full."

The lead line is made about ten to twelve per cent, in most cases ten per cent, shorter than the cork line. As the bottom strip in most cases is of about the same length as the top strip, it is necessary to "take up" more web along the lead line than along the cork line. It should be remembered, however, that the light lead line shrinks somewhat less in the water than does the heavy cork line. The "take up" is uniform along the lead line as well as along the cork line.

The up and down lines are made considerably shorter than the corresponding web; generally they are about half as long (stretched web), but the ratio is somewhat variable. The "take up" along these ropes which is uniform therefore is quite considerable.

In hanging the web to the cork line and to the up and down lines medium-laid cotton seine twine numbers 42–48 is used in most seines; along the lead line numbers 36–48 of the same twine is used.

In the hanging of the seine, *i. e.*, in the fastening of the web to the ropes and in fastening the strips of web together, the skill of the net builder is tested. As has been shown in the previous paragraphs, many factors must be taken into account in order to make the seine hang well. Webs of different sized meshes and of different qualities, and ropes of different sizes and qualities shrink to a different extent. The age of the material also must be considered. When trying their seines, the fishermen fairly often find the "hang" to be unsatisfactory. In such a case the seine must be hung over again, because the fishing capacity of a seine depends largely on the "hang."

Corks and leads: As previously mentioned, the cork line is buoyed with numerous corks. The number of corks is somewhat different in the various seines, but it is always sufficient to keep the seine floating with the cork line at the surface of the water. In most seines there are fourteen to nineteen corks to a fathom. Generally the corks are of about the same shape and size, and almost evenly distributed along the whole cork line; however, slight differences in their distribution have been found. The corks in the middle of the seine are not distinguished from the others by size or by color. The corks are discshaped, generally six inches wide and two inches thick, and have a hole in the middle for the cork line. Wooden floats are never used.

The sinkers or leads are uniformly distributed along the whole lead line. They weigh about four ounces each, are oval in shape, and have a hole through the long axis for the rope. In most seines there are about fifteen to twenty-two leads to a fathom.

Devices for pursing the seine: Uniformly distributed along the entire lead line is a series of large rings, the "purse rings," through which runs a heavy rope, the "purse line." The purse rings are attached to the lead line by means of "bridle lines;" these are of fifteen thread untarred manila, and each one is about 2#–2# fathoms long. Each purse ring is tied to the center of its bridle line, the two ends of which are tied to the lead line at a distance from each other of about two fathoms. In some seines one purse ring at each end of the lead line is tied to one end of a short rope, the other end of which is fastened to the lead line (Fig. 23). The distances between the bridle lines are about two fathoms. The purse rings are about six to seven inches in diameter and about half an inch thick, in most cases they are made of galvanized iron. The purse line is of untarred manila and generally about three inches in circumference. For the sake of convenience, it always is divided into two or three parts of about equal length; these are fastened together by two links and a "figure eight." The ends of the purse line are tied to the free loops at the upper corners of the seine (Fig. 22).

Devices for lifting up the ends of the lead line to the cork line: In order to lift up the ends of the lead line to the cork line, a procedure usually called "brailing," the fishermen have a series of rings, the "brail rings," along each of the two up and down lines, and through each of these series of rings runs a rope, the "brail line," mostly of twenty-one to twenty-seven thread untarred manila. One end of the brail line is fastened to the up and down line at a point about ½–1½ fathoms from the lead line; the other end is tied to the base of the loop at the end of the cork line (Fig. 22). The brail rings are about 1½–2 inches in diameter, one-fourth of an inch thick, and made of galvanized iron. In most seines they are fastened directly to the up and down lines, *i. e.*, without any bridle lines, and at a distance from each other of three-fourths to one and a half fathoms.

"Skiff line," "haul line," and "cork rope:" The end of the seine which is near the skiff when the seine is being laid out (Fig. 23) is called the "skiff end," the other end is called the "haul end" or the "hauling end."

To the base of the loop formed by the cork line at the upper corner of the skiff end of the seine is fastened an eight to twelve fathom long

rope of untarred manila. This rope, which is called the "skiff line," generally is about 2½–3 inches in circumference. For the sake of convenience in throwing the skiff line from the skiff to the purse seine boat, five to six fathoms of a lighter rope (usually of twenty-one thread untarred manila) is spliced to the free end of the skiff line.

To the end of the loop formed by the cork line at the upper corner of the haul end of the seine is fastened a 60–125, generally 80–100, fathoms long rope, the "haul line." Old purse lines often are used for haul lines.

At the skiff end of the seine there is another rope, sometimes called the "cork rope." It is about eight to twelve fathoms long and of twenty-one to twenty-seven thread untarred manila. One of its ends is fastened to the cork line near the base of the loop, its other end is tied to the cork line at a point about six to nine fathoms from the loop. It is used to pull the skiff end of the seine up to the side of the purse seine boat.

The loops formed by the cork line at the ends of the seine: As has been mentioned before, the purse line, the skiff line, and the haul line are tied to the two loops formed by the cork line at the upper corners of the seine. Each of these loops generally is tied together at two places and thus is divided into three loops or links; the two links nearest to the web are rather small, and the end link is large (Fig. 22). To the link nearest to the web the skiff line and the haul line are tied and to the middle link the purse line is tied; however, sometimes the positions of these ropes is reversed.

2. General description of the finished purse seine.

The purse seine is built like a long shallow curtain without any bag in the middle. Its upper edge is buoyed with numerous corks on a strong rope, the cork line, to keep the seine floating with the cork line at the surface of the water. The cork line continues along the end edges of the seine, and at each of the two upper corners of the seine it is made into a free loop; the vertical parts of the cork line have no corks and are called the up and down lines. The lower edge of the seine is weighted with numerous leads on a light rope, called the lead line. The lead line is about ten per cent shorter than the cork line which is advantageous in two respects, viz., it decreases the time required for pursing and it bags the bottom strips of the seine; when the corralled fish swim down along the web, this bagging directs them toward the middle of the seine. Uniformly distributed along the entire length of the lead line are a great number of rings, the purse rings, which are attached to the lead line by means of short ropes, the bridle lines. Through these rings runs a heavy rope, the purse line, the ends of which are tied to the two loops formed by the cork line. The pulling in of the purse line closes the bottom of the seine. Along each of the up and down lines is a series of rings, through which runs a rope, the brail line. The brail line is used to lift up the lead line to the cork line; one of its ends is fastened to the up and down line at a point about ½–1½ fathoms from the lead line; the other end is tied to the base of the loop formed by the cork line. Tied to the skiff end loop of the cork line is a heavy rope, the skiff line, which is about eight to twelve fathoms long; by means of this rope the seine, when being laid out, is attached to the skiff. A similar rope, the haul

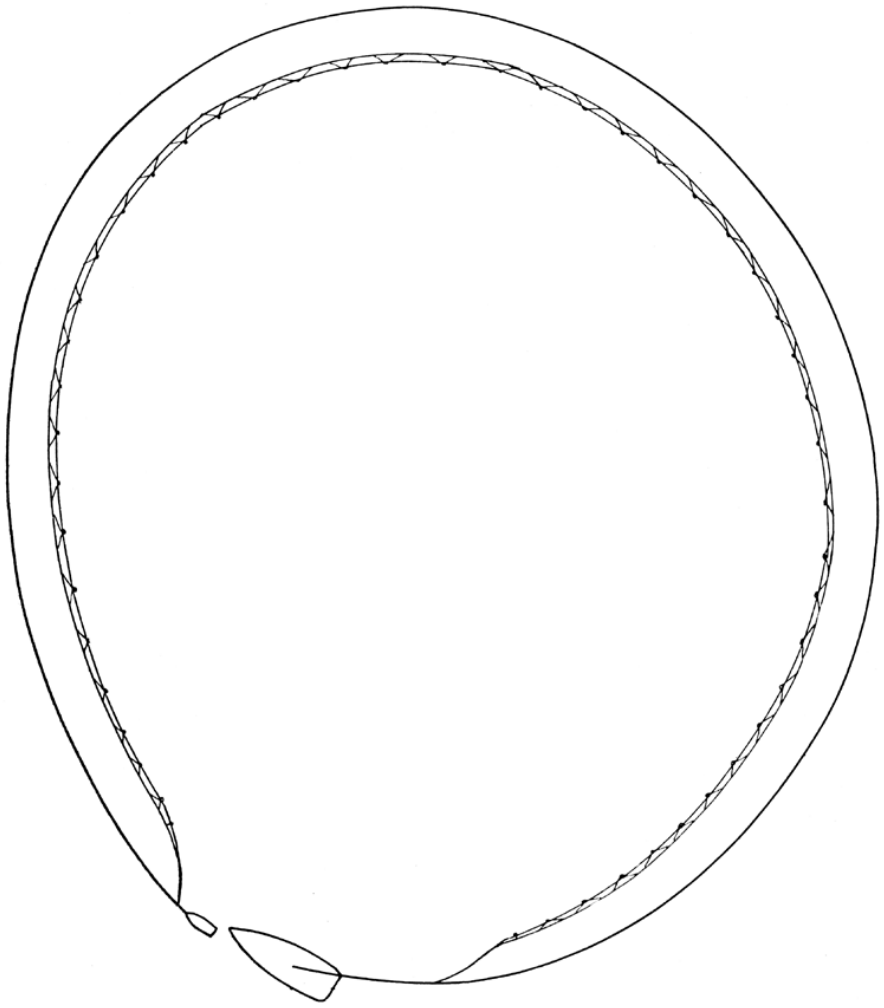

FIG. 23. Diagram showing a bird's-eye view of the purse seine. The purse seine boat (the large wedge) has just reached the skiff (the small wedge) after having completed the encircling movement. Boats and seine proportionate size.

FIG. 23. Diagram showing a bird's-eye view of the purse seine. The purse seine boat (the large wedge) has just reached the skiff (the small wedge) after having completed the encircling movement. Boats and seine proportionate size

line, generally 80–100 fathoms long, is tied to the haul end loop of the cork line. The haul line is used to pull the haul end of the laid-out seine to the side of the purse seine boat. At the skiff end of the seine is another rope, the cork rope, which is about eight to twelve fathoms long; one end of this rope is tied to the base of the loop formed by the cork line, the other end is tied to the cork line at a point about six to nine fathoms from the loop. By means of the cork rope the skiff end of the laid-out seine is pulled to the side of the purse seine boat.

The purse seine is piled on the turntable in the stern of the purse seine boat. The free end of its skiff line is tied to a skiff which is towed behind the purse seine boat. When a school of fish is to be surrounded, the skiff is released while the purse seine boat runs at full speed, and its weight drags the skiff end of the net into the water.

As soon as the seine has been laid in a huge circle around the school and the ends of the seine have been brought up to the side of the boat, the ends of the purse line are untied, and the bottom of the seine is closed with all possible speed by the pulling in of the purse line; this procedure, which is called "pursing," is done with winches. After the pursing is completed, the seine is hauled in by hand from the haul end and placed on the turntable, until the catch is concentrated in the "bunt," *i. e.*, the skiff end of the seine, from where it is landed on the purse seine boat by means of a dip net.

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