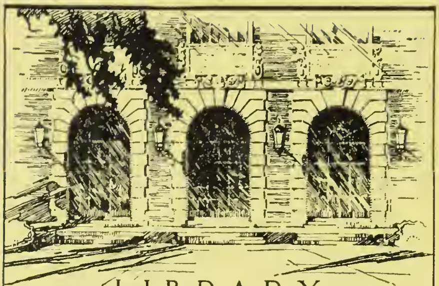

DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

HUGH M. SMITH, Commissioner

FROGS: THEIR NATURAL HISTORY AND UTILIZATION

By A. H. WRIGHT

Cornell University

APPENDIX VI TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1919

Bureau of Fisheries Document No. 888

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FROGS: THEIR NATURAL HISTORY AND UTILIZATION.

By A. H. Wright, *Cornell University.*

INTRODUCTION.

From time to time since Seth Green's day efforts have been made by our best fish-culturists to raise frogs; but in all this period no definite successful mode of procedure has been evolved. Some of these workers became[a] "skeptical" and from "personal study and experience" were made "unbelievers." Others wrote about frog culture in an effort to supply information when they had nothing to give. Still others gave what little they had of value and commented:[b] "We are just as glad as you are that this bullfrog story is finished." Finally, the most serious group[c] announced complete success in "their preliminary experiments," and their efforts were sincerely appreciated by both the public and the culturists; but these experiments were abandoned.

Several writers have taken advantage of the public's intense desire for knowledge on this subject and have perpetrated all sorts of hoaxes and fakes on the credulity of their readers. Periodically some newspapers write of mythical "frog farms" for space fillers. Magazines occasionally accept similar articles, which should never have seen the light, and at present one must needs be on guard against the half-digested, hastily issued, worthless literature which would lead the uninitiated to believe the problem is entirely solved and that frog culture is wholly feasible. Too frequently the public seems to be fed on prettily written, fanciful speculation, and, as a consequence, frog culture receives much undeserved ridicule.

Notwithstanding all this deception and lack of definite procedure and in spite of the fact that little of importance has appeared to encourage it, the public continues to be vitally interested in the possibilities of frog culture. Many a reader of "The Virginian," after the dissertation on the "frawg business," has asked if there is really anything in it. The experiments which were started several years ago at the Pennsylvania State fish hatcheries aroused astonishing and widespread public comment. The commissioner of fisheries of Pennsylvania said:[d]

> The interest was confined not to Pennsylvania alone but extended to nearly all parts of the United States. Newspapers, trade papers, and magazines commented on

[a] Mather, Fred: Modern fish culture in fresh and salt water, pp. 301, 302. New York, 1900.

[b] Dyche, L. L.: Ponds, pond fish, and pond-fish culture, p. 158. State Department of Fish and Game. Kansas. Topeka, 1914.

[c] Report, Department of Fisheries of Pennsylvania from December, 1904, to Nov. 30, 1905, p. 51. Harrisburg, 1906.

[d] Loc. cit. pp. 51, 52.

our work in this direction at considerable lengths, and all approvingly. Letters from private citizens were received from nearly every State in the country asking for further information. These were followed by communications from fish commissions and fish-culturists in the same vein.

In former years, at the sessions of the fishery and fish-cultural societies, frog culture was a frequent topic of inquiry, though not of extended discussion. To-day the U. S. Bureau of Fisheries receives countless inquiries and requests for literature, for information, and for possible sources of breeding stock, and this report is written to supply the information which must precede all careful experimental work on frog culture.

The difficulties encountered in many of the preceding efforts have arisen from lack of knowledge of the natural history of our native species of frogs. Such knowledge is an absolutely necessary premise to intelligent, successful endeavor. Often the best of the previous experimenters were not sure whether they had bullfrog or leopard-frog spawn, and thought that possibly the bullfrog bred twice a year when it breeds but once a year, or considered that bullfrog tadpoles transformed the same year they were hatched or in the following spring, neither of which conditions obtains. A careful critical study of most of the previous efforts reveals uncertainties of this sort, one of the most marked of which is the lack of positively identified stock with which to begin. Here, as in every other farming enterprise, it is necessary to have the seed or stock true to name. Fortified with this precaution and equipped with some of the cardinal points in the life history of the species to be raised, the prospective frog culturist stands a far better chance of success than in a blind "hit-or-miss" endeavor.

COMMERCIAL FROG HUNTING.

SOURCE OF SUPPLY.

The market is yet solely reliant upon the natural supply of frogs. Of this industry, previous to 1900, F. M. Chamberlain, of the U. S. Bureau of Fisheries, remarked as follows:[a]

> The business of taking frogs for market has greatly increased in recent years. It is now carried on in all sections of the United States and is of economic importance in about 15 States, while in nearly all the remaining States and Territories frogs are taken for local or home consumption [in quantities] of which it is impossible to get a statistical account. The States supplying the largest quantities for the markets are California, Missouri, New York, Arkansas, Maryland, Virginia, Ohio, and Indiana. More frogs are taken in New York than in any other State, but on account of their comparatively small size their value is less than in Missouri and California. The Canadian Province of Ontario also yields a rather large supply of market frogs. As ascertained by inquiries of the U. S. Fish Commission, the annual catch in the United States is but little less than 1,000,000, with a gross value to the hunters of about $50,000. The yearly cost of frogs and frog legs to the consumers is not less than $150,000.
>
> The localities in which especially important frog hunting is done are the marshes of the western end of Lake Erie and Lewis and Grand Reservoirs, in Ohio; the marshes of the Sacramento and San Joaquin Rivers, Calif.; the valley of the Kankakee River, Ind.; Oneida Lake, Seneca River, and other waters of northern New York; and the St. Francis River and the sunken lands of the Mississippi River, in Arkansas and Missouri.
>
> * * * The prices received for frogs vary greatly and depend on the condition of the market, the size of the frogs, and the locality. Dressed legs yield the hunters from 12½ to 50 cents a pound, and live frogs from 5 cents to $4 a dozen. In the Kankakee Valley, Ind., for example, the prices received by the hunters are 75 cents a

[a] A manual of fish-culture based on the methods of the U. S. Commission of Fish and Fisheries. Revised edition, pp. 252, 253. U. S. Commission of Fish and Fisheries. Washington, 1900.

dozen for large frogs, 10 cents a dozen for medium-sized frogs, and 5 cents a dozen for small frogs, while in San Francisco the market price is $3 to $4 a dozen.

To the above list of States yielding a considerable supply of frogs in 1900 there should be added Illinois and Minnesota. Of the latter C. H. Townsend writes:[a]

> The most valuable product of these fisheries is the frog, the value of the catch in 1899 constituting nearly one-fourth of the entire fishery yield of the State. The species taken is the "meadow frog," which is quite small, the average weight being between 1 and 2 ounces each. * * * Professional frog catchers are said to make from $5 to $10 per day during the best of the season. Most of the catch is shipped direct to Chicago.
>
> The frog industry in this State was started about 1895, and has grown in importance. In 1899 over $5,000 worth were taken in the vicinity of Minneapolis alone. Litchfield was the next greatest frog-producing center in the State that year. In 1900 this industry had shifted from the latter place to Smith Lake, where one dealer purchased over $5,000 worth during the year.

By the year 1900, then, the following 10 States contributed a large proportion of the market frogs of the country: California, Missouri, New York, Arkansas, Minnesota, Illinois, Maryland, Virginia, Ohio, and Indiana.

In 1908, 250,000 pounds of frogs' legs, with a value of $42,000, were reported for the whole of the United States.[b] The 13 States which furnished this total were:

States.	Quantity.	Value.	States.	Quantity.	Value.
	Pounds.			*Pounds.*	
Missouri	67,000	$11,000	Tennessee	5,000	$1,000
Minnesota	66,000	7,900	Ohio	4,000	600
Louisiana	38,000	4,500	Virginia	3,000	700
Arkansas	27,000	4,000	Iowa	2,500	300
Illinois	25,000	6,800	Delaware	1,900	700
Wisconsin	14,000	2,600	Maryland	1,000	500
North Carolina	5,400	900			

At least 8 of these 13 States are along the Mississippi River, and 6 of them fall wholly within that district. The Mississippi River division contributed 193,000 pounds; the Gulf of Mexico division, 38,000 pounds; the Great Lakes division, 17,000 pounds; and the Atlantic coast division, 11,000 pounds. Thus it is apparent that the Mississippi River States are becoming more important in commercial frog hunting. Before 1900 Missouri and Arkansas were the principal States in this region furnishing frog legs. By 1900 Minnesota and Illinois were added to the list, and by 1908 Louisiana, Wisconsin, Tennessee, and Iowa began to contribute appreciable quotas.

In the previous summation New York does not appear, but in 1915 and 1916 in the Oneida lake region the following is noted:[c]

> [One firm conducted] a gross business of about $15,000 per year in frogs alone. One customer bought between June 1, 1915, and March 1, 1916, $1,687.50 worth of frogs' legs. When sold per hundred, live weight, large and small, the price ranges from 30 cents to $1.50 or averages $1.05. The legs sell per pound, large and small, from 10 to 50 cents, and average 35 cents per pound. An expert can dress between 1,500 and 1,600 frogs per hour, but an average rate is about 1,000 per hour.

[a] Townsend, C. H.: Statistics of the fisheries of the Mississippi River and tributaries. Appendix to Report of the Commissioner, U. S. Commission of Fish and Fisheries for 1901, p. 726. Washington, 1902.
[b] Fisheries of the United States, 1908, pp. 26, 28, 33, et seq. Washington, 1911.
[c] Adams, Chas. C., and Hankinson, T. L.: Notes on Oneida Lake fish and fisheries. Transactions, American Fisheries Society, Vol. XLV, No. 3, June, 1916, p. 163. New York.

METHODS OF CAPTURE.

There are various methods of capturing frogs. The boy's favorite device is the fish pole, with the line baited with red cloth, worms, grasshoppers, or other insects; and this method is yet frequently employed by the market hunter. A more common method, however, is clubbing. Many of us as boys used to choose a good strong club about walking-stick length. With this instrument we skirted the edges of the swamps, lakes, or marshy creeks in the spring or early summer, traversed the clover or hay fields of the uplands in July about cutting time, or hunted in the wet lowlands a little later. Some of the men and boys occasionally put nails in the end of the club, but this more cruel method avails little. The frogs which were killed were put into a bag or strung on a cord by loops tied about their loins. They were dressed immediately after the trip.

[In Minnesota][a] frogs are also taken by sticks and gunny sacks. In using sticks the frogs are usually killed and then sold in a dressed condition for food. Gunny sacks in a wet condition are used in their capture by being thrown over the frogs. Frogs are kept alive for market in gunny sacks placed in running water and covered with hay or straw to keep out the frost.

Some expert froggers are very adept at catching them alive by hand. A frog catcher will hold one hand over or in front of the prey to attract its attention and capture the game by a sudden movement of the other hand.

Several methods are based on the migration of the frogs in the fall or spring. In the central New York region in late September, through October, and even in November, frogs are frequently encountered working their way down the hills toward the swamps around or at either end of some of our Finger Lakes. Many reach the swamp in the fall, and many winter in the ravines and enter the swamps in the spring. In many cases State roads or other similar and partial barriers skirt our lakes—that is, steam railroads, electric railways, etc.—and the frog catchers make use of these. A calcium-carbide can or a barrel placed at the swamp end of a culvert may yield numerous frogs which are traveling down the ravines, and the swamps or ditches dug at the base of the hills and at the swamp's border may give good returns.

[In Minnesota][a] frogs are caught in various ways, but chiefly in pits dug between sloughs and the adjoining high grass. The season for their capture in this manner is usually in the fall, when they are returning to the water. These pits are about 3 feet long, 2 feet wide, and 2 feet deep.

There are many other variations of this pit, posthole, ditch, or excavation method. In Oneida Lake an outgrowth of the pit and can methods is the use of screens.

[This form of capture][b] is used in the fall when the frogs migrate from the fields and swamps toward the lake for hibernation. This migration is not regular, it takes place mostly at night, particularly during warm rains, after a light frost. Taking advantage of this migrating behavior, cheesecloth screens, about 18 inches high, supported by sticks, are placed along the shore to intercept the migrating frogs. At intervals of two or three rods nail kegs, carbide cans, or posthole-like excavations entrap the frogs which, failing to surmount the screen, wander along it and fall into the traps. The frog catcher has only to collect the frogs from those traps. Late in the season one may find various sized frogs, mice, and other small mammals drowned and frozen in these small wells.

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[a] Townsend, C. H.: Loc. cit., p. 726.
[b] Adams, C. C., and Hankinson, T. L.: Loc. cit., pp. 161, 162.

FIG. 1.—GREEN FROG (RANA CLAMITANS). DESIRABLE SPECIES; NATURAL SIZE.

FIG. 2.—"WESTERN BULLFROG" (RANA AURORA). DESIRABLE SPECIES; NATURAL SIZE.

parts are white, with some marbling; in the male the throat is yellow. This species reaches $3\frac{1}{2}$ to 4 inches or more in length and extends in range from the Gulf of Mexico to Hudson Bay, occurring in practically all of eastern North America.

Bullfrog.—The bullfrog (Pl. I) is much larger than the green frog, and the two are often confused. The bullfrog has no ridges down either side of its back. On its upper parts it may vary from yellowish green to a dark brown, while its under parts are yellowish white, with some mottlings. In size it may reach 8 inches, and its range is from eastern North America to the Rockies.

The Southern Bullfrog.—The southern bullfrog is quite similar to the common bullfrog and varies from brownish olive to bone brown or blackish brown above, with some prominent, scattered black spots. The under parts often have a network of black or brown and yellow, one of the most striking ventral colorations of any North American frog. This species has a more pointed snout than the bullfrog, possesses a narrower head (measured at the eardrums), and has all the hind toes except the fourth proportionally longer than the same toes of the bullfrog. Of this form, the author has taken no specimens over 5 or 6 inches in length, while the extreme for the bullfrog may be much more. The known range of the southern bullfrog is in the extreme southeastern United States.

Leopard Frog.—The leopard frog or meadow frog (Pl. III, fig. 1), the most widespread and most common form of North America, has all the under parts white or whitish. On either side of the back is a prominent fold, which is narrower and higher than in the pickerel frog. Between these two main folds sometimes there are other smaller folds. The spots between the two folds are irregular in outline and in position, are not necessarily opposite, and occupy less space than the background color, which varies from bronze to green. The spots below the lateral fold are less regularly placed and never so large as in the pickerel frog. The leopard frog reaches a length of $3\frac{1}{2}$ to 4 inches and is found from the Sierra Nevada Mountains eastward and from the extreme north to Mexico.

The Southern Leopard Frog.—The southern leopard frog is very similar to the common leopard frog and varies from it in a very few characters. It usually has a distinct white spot in the middle of the eardrum, unlike the leopard frog, in which it is generally absent. Then, the head of the southern form is contained 2.5 times, or less than 3 times, in the length of the head and body combined, while the common form has it 3 to 3.5 times. Furthermore, in the southern species the snout is acuminate or pointed and is contained about 1.5 times in the head, while in the other form the snout is less pointed and is contained 2 or more times in the head. This species may reach the size of a common meadow frog and occurs in the southern States.

Pickerel Frog.—The pickerel frog (Pl. III, fig. 2), in life has the under parts of the legs and belly orange yellow. On either side of the back is a broad, low fold of skin. Between these folds there are two regular, more or less opposite, rows of dark, squarish spots, which occupy far more of the back than the light-brown, ground color. Below each back fold the spots are larger and more regular than in the leopard frog. The pickerel frog reaches a length of 3 to $3\frac{1}{2}$ inches and is found from the central plains to the Atlantic seaboard and from the Gulf of Mexico to Hudson Bay.

FIG. 1.—SPADEFOOT (SCAPHIOPUS HOLBROOKII). POSSIBLE SPECIES; NATURAL SIZE.

(After Overton. Mus. Brooklyn Inst. Arts and Sci. Sci. Bull., Vol. 2, No. 3.)

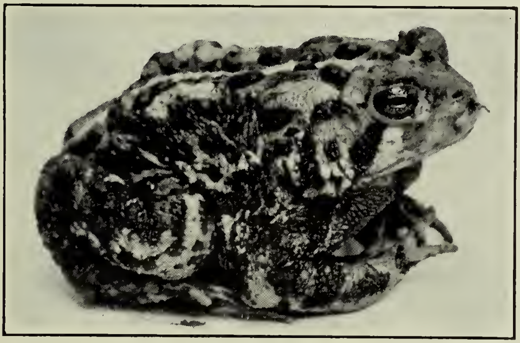

FIG. 2.—COMMON TOAD (BUFO AMERICANUS). POSSIBLE SPECIES; NATURAL SIZE.

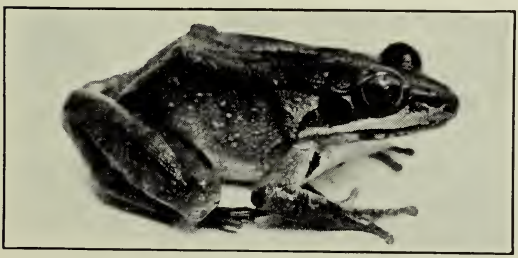

FIG. 3.—WOOD FROG (RANA SYLVATICA). POSSIBLE SPECIES; NATURAL SIZE.

WESTERN SPECIES.[a]

The western species are somewhat confusing. At present Camp (1917) recognizes three species, while Cope (1889) held there were four.[b] The three species are *Rana boylii*, the yellow-legged frog; *Rana pretiosa*, the western frog; and *Rana aurora* (both aurora and draytoni), the so-called "western bullfrog."

Yellow-Legged Frog.—The yellow-legged frog has the ear or tympanic region not darker than the rest of the head, possesses no red in its coloration, and has the fold along the upper lip colored like the rest of the body. These creatures are 2½ to 3½ inches in length and occur in California. They have been less used for food because of their skin secretions.

Western Frog.—In the western frog the hind leg, when brought forward along the body, has the inner angle of the bent heel reaching to the eye or nostril, but never beyond. The back and top of the head has prominent, inky-black spots. This species attains a length of 3 to 4 inches and extends from Nevada and northern California throughout Oregon and Washington to Alberta and east into Montana, Wyoming, and Utah.

"Western Bullfrog."—The "western bullfrog" (Pl. II, fig. 2), unlike the western frog (*R. pretiosa*), has no inky spots on the back and top of the head, and the heel reaches to or beyond the nostril. These creatures may have their skin very smooth (*aurora*) or roughened (*draytoni*), have the lateral folds of the back indistinct (*aurora*) or prominent (*draytoni*), possess unspotted or dotted backs (*aurora*) or have regularly placed, light, centered spots (*draytoni*), be medium, 3 inches long (*aurora*), or large, 4 inches (*draytoni*). The "western bullfrog" extends from Puget Sound to Lower California.

These last two forms, the western frog and the "western bullfrog," usually have the tympanic region darker than the rest of the head, red often present in the coloration, and the fold along the upper lip usually white or lighter than the rest of the head.

POSSIBLE MARKETABLE SPECIES (PL. IV).

There are several species of true frogs which are smaller, such as the wood frog and its relative, the northern wood frog; the mink frog (*Rana septentrionalis*) of extreme northeastern United States and Canada; the carpenter frog (*R. virgatipes*) of New Jersey and the Carolinas; or the local and rare gopher frog (*R. æsopus*) of Florida. It will, doubtless, never become feasible to use these species in frog culture.

The *wood frog* (Pl. IV, fig. 3) is either light or reddish brown above, with a darker brown streak or mask on either side of the head. Underneath it is a glistening white. The *northern wood frog* is like the wood frog; but the length of the hind leg to the heel does not exceed the combined length of the head and body, while in the

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[a] The author is indebted to Charles Lewis Camp's "Notes on the systematic status of the toads and frogs of California" (University of California Publications in Zoology, vol. 17, No. 9, pp. 115–125, Feb. 3, 1917, University of California Press, Berkeley) for most of what follows on the western forms. The author also has specimens from the Pacific coast collected by Profs. J. C. Bradley, W. A. Hilton, A. C. Chandler, and the writer.

[b] Cope, E. D.: The Batrachia of North America. U. S. National Museum Bulletin No. 34, 432–447. Washington, 1889.

wood frog it does. The *mink frog*, like the bullfrog, has no fold of skin on either side of the back, one joint of the fourth toe is free of web, and the male has the eardrum larger than the eye. This form is small, the body being from 2 to 3 inches in length. The mink frog is light olive with irregular spottings on the posterior back and sides, with the hind legs spotted or banded. The *carpenter frog* has no lateral folds, two joints of the fourth toe are free, and the animal is brownish, with four yellowish or golden-brown, longitudinal stripes on the back. The under parts are yellowish white, with alternating dark and light stripes on the hind legs. The *gopher frog*, unlike the pickerel and leopard frogs, has a hind leg to heel length shorter than the total length of the head and body and has its spotted dorsal skin also quite warty.

The *spadefoots* (Pl. IV, fig. 1),[a] with vertical pupils and sharp spades on their hind feet, are almost large enough to be of value in the market, but are uncertain in habits. The *toads* (Pl. IV, fig. 2), with parotoid glands just back of the eye and with warty skins, may some day serve as food, though a greater prejudice will have to be overcome than in the case of the frogs.

UNDESIRABLE SPECIES.

The tree frogs, with no parotoid gland back of the eye and with disks on the fingers and toes, comprise most of this class. The males of these creatures can always be told from true-frog males, because the area under the chin is always colored darker or differently from the rest of the under parts, while true frogs rarely have such a coloration. Rarely a male green frog or other species may have a yellow or another color under the chin, but it is not sharply indicated, as in the tree frogs, and does not appear discolored.

Common among these tree frogs are some with small disks and a length of 1 inch or less; namely the *cricket frog* (*Acris gryllus*) with a triangle between its eyes, webbed feet, and prominent, alternating, dark and light longitudinal bands on the back of the thighs; and the *swamp cricket frog* (Pseudacris) with webs small or absent and with a more or less smooth skin.

The tree frogs proper, with large disks, are several in number, of which the peeper, the tree toad, the Carolina tree frog, the Florida tree frog, the Pacific tree frog, and the southern tree frog are most common. None reach much beyond 2 or, at the most, $2\frac{1}{2}$ inches in length. The brownish and smooth *peeper* (*Hyla crucifer*) (Pl. XXII, fig. 16), is recognized by an X-shaped mark on its back. The *tree toad* (*H. versicolor*) (Pl. XI, fig. 3) of the eastern United States is grayish brown or green; is rough of skin; and has a light spot below the eye and a network of dark and yellow on the posterior part of the thighs, while its relative of the southwest (*H. arenicolor*) has no network on the thighs. The tree toad of the piney woods (*H. femoralis*) has the posterior surface of the thighs, with round yellowish or white spots, but not a reticulation or network. The *Carolina tree frog* (*H. cinerea*) is grass-green above, with a straw-colored stripe along the side of the head and body, while *H. evittata* of Maryland and Virginia has no such stripe. The green of Anderson's tree

[a] See footnote, p. 22.

toad (*H. andersonii*) is bounded beneath by a white line and this by a purplish brown or purple color. The *Florida tree frog* (*H. gratiosa*) of Florida and Georgia, the largest (2½ inches long) of all our tree frogs, has many roundish spots on its dorsal surfaces and very large disks. The *Pacific tree frog* (*Hyla regilla*) and the *southern tree frog* (*H. squirella*) have the thighs with no particular color pattern, are not pure green on the back, like the Carolina tree frog, and have the body not so slim as in this form. One occurs on the Pacific coast and the other in our southern States.

Our *narrow-mouthed toads*, unlike the true frogs, have no teeth in the upper jaw, are never 2 inches in length, have the eardrum hidden, and possess a peculiar fold of skin on the top of the head.

CULTURE OF FROGS.

BREEDING HABITS.

Those frogs which appear in the early spring usually begin croaking at once and proceed to pair and ovulate with little or no intervals between appearance and egg laying, while those which appear last wait for longer periods between emergence and croaking and between croaking and ovulation. It has been much in vogue to say of many species that they breed "in early spring," but many of our forms of which this has been said do not breed until summer. The males in many cases resort to the breeding grounds before the females, and the females may wait until their eggs are ripe before they enter the water. Or, as is the case with some toads, the two may meet on the trip to the water and become mated before the destination is reached. The croaking or mating male seizes the first female within reach and maintains his embrace until the eggs are laid. Sometimes in gregarious species six or eight males strive for one female, and often the female is killed. Fertilization comes exactly at the extrusion of the eggs or slightly after it.

At first no envelopes about the eggs are apparent and the egg mass may feel soft and sticky. After a few minutes this substance absorbs water, and each egg then is revealed to be a spherical body closely surrounded by a membrane and by one or two jellylike envelopes. (See fig. 1.) Some eggs have only the inner envelope present. This gelatinous substance comes from the oviduct and forms, when swollen, the egg capsules, tubes, bands, films, or masses to which we are so accustomed. The egg masses (Pls. XIII to XIX) are spherical in the wood frog, the pickerel frog, and in some of the other true frogs; plinthlike in the leopard frog and southern leopard frog; a spiral in the various toads; a surface film in the green frog, bullfrog, and tree toad; and a submerged film or mass in the swamp cricket frog. In the peeper and cricket frog the eggs are separate. The wood, pickerel, and leopard frogs lay their whole complement in a short time; the film form of the green frog, bullfrog, and tree frog takes longer, the first two maintaining the same position and the latter moving about during the process. With the toads and spadefoots some time is consumed in laying their spirals or bands. In the peeper several hours may transpire before the eggs are all laid.

DEVELOPMENT AND TRANSFORMATION.

The eggs hatch in from 3 or 4 to 25 days, depending on the temperature conditions. At hatching, the larvæ have a distinct neck, with a prominent head and body. The tail is very small or absent. On the ventral side of the head is an invagination or depression which is to be the mouth. Behind this comes the ventral adhesive disk or disks, which help the little creature to attach itself to the egg mass or to hang itself upon some plants. In front of the mouth are two deep, dark pits which later become the nostrils. On either side of the head appear swellings which become the external gills. The eyes do not yet appear.

As development goes on the external gills appear as branched organs, two or three on a side; the eye shows as a ring beneath the skin; and the tail grows and presents a middle muscular portion where the muscle segments clearly show. This middle part supports a thin, waferlike tail fin the parts of which are called, respectively, the lower and upper crests. The nasal pit shifts in position and becomes the nostril, and the vent opens. The mouth appears, and dependence on the yolk of the belly ceases. Soon the external gills begin to disappear, a lateral flap or fold of skin connects the head with the body, and the neck region disappears. Beneath this fold internal gills develop. On the left side, the lateral flap does not close completely, but leaves an opening, the spiracle. The water passes into the mouth over the internal gills and out this hole on the left side. On the mouth a membranous, fringed lip, with upper and lower portion, comes into being. At the portal are horny jaws or mandibles. On the upper and lower portions are rows of horny teeth. The eye is no longer a covered pigmented ring, but is now at the surface. The intestine has become much elongated and coiled. The buds of the hind limbs begin to appear. The fore limbs start to develop beneath the skin. When the hind limbs have reached considerable size the left arm comes out through the spiracle and the right arm breaks through the skin.

The process of transformation is now on. The tail crests decrease in size, and the creature begins to live on its tail; that is, absorbs it. The gills vanish, and the lungs begin to serve as the sole respiratory organs, if the skin be not considered. The eye assumes eyelids. The tadpole mouth fringe, with its horny jaws and horny teeth, is discarded, and a true frog mouth begins to appear. The long intestine becomes wonderfully shortened, and the small frog, with a vestige of a tail, is ready to leave the water. This process is termed transformation or metamorphosis.

SELECTION OF STOCK.

Most of the inquiries which the Bureau receives center about possible literature concerning frog culture or about the supply of breeding-frog stock, frogs either unmated or mated, eggs, or tadpoles. At the present time no supply bureau or hatchery can offer certified eggs or tadpoles of a particular species, and rarely can mated pairs be supplied. Some of the dealers in zoological supplies and some hatcheries can furnish frogs and might at certain seasons offer to furnish mated pairs. But such, which are paired in captivity, would

FIG. 1.—HABITAT OF THE LEOPARD FROG; A LARGE CAT-TAIL AND SEDGY SWAMP.

FIG. 2.—HABITAT OF THE PICKEREL FROG; THE BACKWATER OF AN UPLAND STREAM.

FIG. 1.—HABITAT OF THE GREEN FROG; A PERMANENT POND (FOREGROUND) NEAR A STREAM (BACKGROUND).

FIG. 2.—HABITAT OF THE BULLFROG; A MILL POND FILLED WITH STUMPS, FALLEN TREES, ETC.

usually be undesirable; they might lay in transit, break the embrace en route, or never lay at all, as is generally the rule. A more extended discussion of the five or six groups of stock follows: (1) Individual frogs; (2) mated pairs; (3) eggs; (4) tadpoles; and (5) transition stages.

INDIVIDUAL FROGS.

In many ways it might appear that the easiest and most certain method of securing stock would be to begin with the individual frogs. To be sure, they are to be found throughout the active period of the year—that is, from the early thaws of spring to the hard frosts of fall—but one must know their breeding season or he may carry them almost a year before the first eggs are secured. If the material come from a supply bureau, there is no certainty as to the period of previous captivity, the amount of freedom the frogs had in such quarters, etc. Frequently it has been found that with the leopard frog, green frog, and bullfrog the males were first captured and the females taken later, sometimes two or three weeks afterwards. To hold the males in captivity or in close quarters tends to reduce their breeding potentiality. Or, if females be captured just before breeding and be brought into the hatchery to await the subsequent capture of impulsive breeding males, the chances are that in rare cases the female may lay without the male, or that, by the time a pair or pairs are mated in the laboratory or hatchery, one or the other member may be weakened, and the pair may continue in the embrace several weeks until the death of one or both individuals. In most cases such a mated pair proves unfruitful. Over and over again has the writer taken gravid females and mated them with captive males or with males subsequently taken, and in almost every instance no eggs were laid or, if so, they were frequently infertile.

If, however, the experimenter has a good pond or water inclosure, with more or less natural conditions, he might stock it with individual frogs and not encounter the above difficulties so inherent in confining frogs in close quarters. If the prospective culturist wishes to start with the individual frogs, he must choose or determine what species he prefers or what his region offers. At present the four principal eastern species for the frog market are the leopard frog, the pickerel frog, the green frog, and the bullfrog.

If the leopard frog be chosen, the person who purposes to breed this species can usually secure enough frogs from the swampy marshlands (Pl. V, fig. 1), or backwaters and overflow ponds of streams in his own neighborhood. The leopard or spring frog appears from its hibernation in the muddy bottoms of our marshes and ponds when the streams have just freed themselves of ice and the lowlands are overflowing. When the temperature of the water reaches 41 to 50°, they may confidently be expected to appear in numbers.[a] From the middle of March to the middle of April is the period in which to expect them to appear for breeding. In early spring, whenever a low guttural croaking is heard in swampy stretches, it is that of the leopard frog. The croak is wholly unlike the shrill notes of the peeper and swamp cricket frog or the short

[a] The dates of first appearance, spawning, etc., of the commercial species were determined for the latitude of Ithaca, N. Y., but might well apply for northeastern United States if not for all of northern United States.

rattlelike note of the wood frog, all three of which are frogs too small to be considered commercially.

In the shallow water, along the edges of swamps, or on the banks of dead streams or backwaters one can find many leopard frogs. In the early spring—in fact, at all times during the breeding period—they can best be taken at night with an electric flashlight or acetylene lamp, lantern, or jack of any kind. Later in the spring the frogs are more easily captured during the day. To be sure that the captor has individuals of both sexes, he must be able to distinguish them. The male of a leopard frog has the thumb of the fore foot much enlarged on the inner edge and has a vocal sac between each ear and shoulder. These vocal sacs can be demonstrated by seizing the frog around the waist just in front of the hind limbs and alternately squeezing and relaxing the pressure. In this way a male will inflate the sacs. The ripe females are very gravid and swollen and have no vocal sacs and no enlarged thumbs. It seems advisable to have an equal, or preferably greater, number of males than females to insure all the females being mated. It seems to be the condition at the sexual congresses of this species that the males exceed the females in number. Of course there is some evidence that a male may mate the second time in a season, but this is not fully established. Frequently the author has put his captives in close quarters to obtain quick matings and then placed the pairs in the pond or inclosure meant for the breeding purposes. To keep them mated more than two or three days at the most in the laboratory or hatchery may result in a long embrace, and this defeats the purpose of the operation. If the culturist plans to begin with adult breeders, he can secure individuals of this species without great difficulty, because it is so gregarious at the time of the breeding assemblies; he will have a little more difficulty in locating the smaller gregarious breeder, the pickerel frog, and doubtless even a lesser measure of success in the case of the more solitary green frogs and bullfrogs.

It is yet a doubtful question whether the pickerel frog will become as important a commercial form as the leopard frog, green frog, or bullfrog. It is slightly smaller than the leopard frog, and the acrid secretion of its skin may militate against its availability. Whoever wishes to experiment with it will not find it in exactly the same habitat as the leopard frog. The leopard frog is essentially a frog (in its greatest abundance) of the cat-tail swamps, sedgy marshes (Pl. V, fig. 1), and grassy overflows (Pl. VII, fig. 1), while the pickerel frog is more often found in sphagnum bogs, marl ponds, cold streams, in the shallows of mill ponds, or in the quiet waters of bayous (Pl. V, fig. 2), away from the currents of our clear streams. It usually appears from hibernation about the same time as the toad and later than the leopard frog. When the air temperatures approach 48 to 58°, pickerel frogs begin to appear and become numerous at 58 to 67°. They hibernate in the water, and when it reaches 45 to 53° they come out of their winter sleep. In point of time this outcoming occurs between March 19 and April 25. The croak of the male is low and grating, and usually to the tyro this will be a poor guide for their capture. The male is usually smaller, darker in color, and with the thumbs enlarged, as in the males of the leopard frog.

FIG. 1.—HABITAT OF THE LEOPARD FROG AND TOAD; AN OVERFLOW AREA OF A STREAM. DRIES UP IN MIDSUMMER.

FIG. 2.—HABITAT OF THE TOAD AND PEEPER; A SHALLOW MEADOW POND WHICH DRIES UP IN MIDSUMMER.

FIG. 1.—HABITAT OF THE WOOD FROG; A WOODLAND POND.

FIG. 2.—HABITAT OF THE MINK FROG; A BEAVER POND FILLED WITH WATER LILIES, DORSET, ONTARIO.

The green frog is one of the solitary species. In habitat it is not as restricted as the bullfrog. Both occur in swamps, and in our deeper, larger ponds and reservoirs. In the smaller ponds and pools only the green frog is present. In fact, along watercourses there is hardly a small pond (Pl. VI, fig. 1) which can not claim a green frog. In the swamps only does the leopard frog exceed it in abundance. The latter often inhabits the less permanent situations; the green frog usually chooses more permanent, deeper bodies of water. The green frog starts to appear when the air reaches 54 to 61° and quite commonly at 61 to 69°. It also, like the leopard frog, pickerel frog, and bullfrog, hibernates in the water and awakens when the temperature of the water reaches 46 to 58°. It most assuredly is not "the first species heard in the spring." In fact, it does not begin to croak until a month after its first appearance. Then its low-pitched, short "bass-viol" note is very distinctive. The male of the green frog also has enlarged thumbs, and, in addition, has a yellow throat and a tympanum larger than the eye, while the female has a tympanum only equal in size to the eye. This species, being solitary, would be hard to secure alive in sufficient quantities for breeding purposes unless more effort were expended on its capture than it was actually worth. Wherever they are common, as in big mill ponds and small lakes, one might take enough to determine if the green frog be the species most desired. They are best taken at night.

Finally, in the East, the bullfrog appears to be the most desirable because of its size. One commonly associates the bullfrog with marshy bayous, buttonbush swamps, mill ponds (Pl. VI., fig. 2), or lakes. They are not, however, as restricted in habitat as some texts might lead the reader to infer. The author has found them along both upland and lowland streams, in clear brooks which fed cold, marly, sphagnum ponds, and along watercourses laden with such marshy vegetation as lizard's-tail, marsh cress, arrowhead, pickerel weed, and swamp loosestrife. Rarely they have appeared in small numbers in temporary or very small ponds, a more logical home for the green frog. Such distribution can ordinarily be explained by the loss or draining of a former mill pond or reservoir habitat near by, and such records are more accidental than normal. These frogs seem to prefer mill ponds, hydraulic lakes, reservoirs, and kindred bodies of water. The author's best collecting grounds were a clear, glacial lake in a New England kettle hole, with a slight suggestion of the sphagnous flora about it; a pond in a clear trout brook; a large reservoir for a hydraulic laboratory; a disused mill pond; and a wooded lake whose shifting water level had made a fringe of overhanging dead trees, floating logs, and submerged roots and limbs. In every case the shores were more or less wooded, but more important are two factors: Shallows where the species can transform; and brush, stumps whose roots are at the edge of the pond or overturned and driftwood along the banks.

When the bullfrog comes out, at least seven of the species which appear in the spring are entirely or almost finished with their spawning. The bullfrog is such a wary form that in some years its presence is not suspected until June, when croaking begins. When the air reaches 68 to 75° (certainly 76 to 79°), the appearance of the bullfrogs may be expected, provided the temperature of the water bottoms is 57 to 64° or averages 64 to 69°. They are the last frogs to appear and come out from May 11 to June 4. They begin to croak about two or three weeks after emergence from hibernation.

When croaking begins, the males often take certain perches in which they keep a proprietary interest. About one pond the author once located seven such places, each with its possessor, only once finding two in one place. The characteristics of the stands can best be described by presenting the following list of positions occupied by certain frogs in one pond: The first was on a board in water filled with brush; another was perched on a log among brush beneath a float of a boathouse; the third was on the bank among some limbs extending into the water; the fourth was by an overturned stump whose roots were partly out of the water and partly submerged; the fifth was among some driftwood along the shore; the sixth was a stationary float; and the last was at the base of a tree fallen into the pond. At these stands one could have had good success in capturing the frogs at night. This habit of maintaining perches obtains more particularly when the species is not especially numerous in a pond or lake. When, however, the numbers of males about a lake are numerous enough to make their night croaking seem a real chorus, and when they are abundant among the fallen logs and brush of the swampy borders of lakes, it is not likely that any one individual holds a favorite site to the exclusion of the others. In such places one can easily take, in an hour or so, 30 or 40 adults with the aid of either flash light or acetylene light.

If one wishes to secure them by day he may adopt the device of the familiar red flannel on a hook or ordinary fish bait. At the breeding season one occasionally finds them in grassy situations. Here they lie on the surface of the water. One has only to wade among them to capture them by hand. At first they may become frightened, but soon they reappear. Whenever bullfrogs are hard to find or scarce in certain bad seasons let the collector search out a former mill pond whose dam is gone, and in the temporary small ponds remaining he can frequently find the frogs in their circumscribed quarters.

The males have the first finger enlarged (Pl. XII, fig. 4) and enlarged tympana. They begin croaking 15 to 30 days before actual spawning takes place. In some ponds the males are very much in evidence. In one lake, when the bullfrogs were laying freely, as many as 10 males were found within a space of 8 feet. Here among the dead branches of overhanging elderberry bushes (Pl. XIII, fig. 1) they were hidden because of the dense mat made by the shrubs. At this time in midday the author had no difficulty in capturing, by hand, in half an hour, some 25 males, while only three or four females were observed. This was in the middle of June. Later in the season the females appear more in evidence. Doubtless these easy captures of a supposedly shy form were naturally due to the fact that it was their breeding season. The author is, however, coming to believe that this species is as easy of capture as any other large frog. Even after a bullfrog has left the water's surface one may capture it while it is swimming beneath the water, for it is very slow as compared with some of the other

FIG. 1.—HABITAT OF COUCH'S AND HAMMOND'S SPADEFOOTS AND OF TWO TOADS (BUFO WOODHOUSII AND BUFO COMPACTILIS), SIERRA BLANCA, TEX.

FIG. 2.—HABITAT OF THE SOUTHERN BULLFROG; OVERFLOWED AREA AND TANGLED SWAMP OF A CLEAR SOUTHERN STREAM, THEODORE, ALA.

FIG. 1.—HABITAT OF THE CRICKET FROG; A SHALLOW GRASSY AND SEDGY MEADOW POOL, DINWIDDIE, VA.

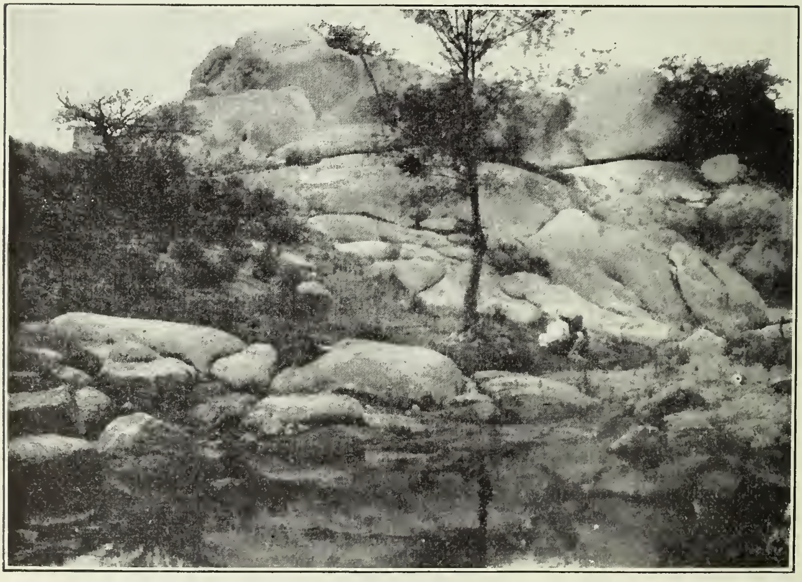


FIG. 2.—HABITAT OF THE DESERT TREE TOAD (HYLA ARENICOLOR) AND OF A TOAD (BUFO PUNCTATUS); A ROCKY CREEK IN A DESERT MOUNTAIN PASS, DRAGOON, TEXAS PASS, ARIZ.

forms. If one wish to stock his inclosure or ponds with adults, let him do it by the first of July, or preferably by June 1.

The southern bullfrog is one of the common forms of the deep-wooded swamps and of the water-lily-filled watercourses of such areas and is often called the swamp bullfrog. Equally frequent is it in the vast, open, swampy stretches or "prairies" of the Everglade, Okefinokee, and other famous southern swamps. The bright green and yellow of the under parts make it very conspicuous when in hand. Often these creatures will not dive until within an oar's length, but in the main this species is a shy form. Occasionally the author has taken them when visiting trap lanterns in aquatic situations.

The southern leopard frog is similar to the common leopard frog in habitat, mating, and general habits.

MATED PAIRS (PLS. XI AND XII).

Some articles on frog culture advocate stocking the suitable waters with a sufficient number of mated pairs of mature frogs. To the writer the main consideration in using individual breeders or mated pairs is that it positively proves to the beginner the identity of the species with which he is stocking his waters. Heretofore the most creditable published attempts with eggs or tadpoles taken afield leaves one with the impression that the experimenter was not absolutely sure whether he had good or worthless species. If mated pairs be the starting point, avoid pairs mated in captivity by some one other than yourself, for you do not know their period of captivity. If mated by the person concerned within one or two days after being taken in the field, return them to the out-of-door environment at once. The only sure source of fertile pairs is the field-mated pairs. The writer finds that in at least nine different species of frogs the pairs captured afield usually remain mated, no matter how long the journey to the laboratory or hatchery or pond, however roughly handled, or however hot the glass jar (not advisable) became from sun exposure. If they broke apart on the trip, they soon resumed mating and seldom released their hold when transferred from aquarium to aquarium or from pond to pond.

When mated pairs are secured in the field, one can reasonably expect them to lay the following night or the next day unless the temperature of the water drops suddenly. Rarely a pair may wait several days before ovulation. The prospective frog breeder can identify his material by the mode of embrace. All of the four principal commercial eastern frogs belong to the true-frog (Rana) group, in which the male holds the female behind the forearm with his hands appressed to the breast of the female (Pl. XI, figs. 1 and 2). This is the so-called pectoral embrace, and any mated pair with pectoral embrace found after April 25 is almost positively one of the four principal marketable eastern species. Before April 25 the wood frog pairs might be taken; but if the characters of this species already described are remembered, no mistake will be made.

Desirable species.—Of the four principal marketable eastern species, the mating of the leopard frog is easily the most familiar. This species is not restricted to night courtship, although most of it occurs at this time, and more mated pairs can be secured at night with a light than in the daytime. One can frequently observe the mating behavior of this species during the day, if he can discover a spot where the species has already begun ovulation. The author has taken most of his mated pairs under such conditions. Before they are mated the males may be heard croaking at the surface. Occasionally when wading through an area in which eggs are numerous, one hears croaks which at first puzzle him; they come from the mated and mating frogs beneath the water and often reveal the position of the game on the bottom. At such times, one finds several males and gravid females about and under sticks. More rarely, the pairs appear at the surface. The period of mating begins April 1 or before, but the bulk of it does not come until the middle of April; it continues for about three weeks, extending to the first or middle of May.

Like the leopard frog, the pickerel frog is gregarious at the breeding time and often gathers in small, restricted areas for egg laying. This facilitates its capture. The beginning of mating usually comes the last week in April, the earliest record being April 5, the average April 23. This species mates by day or night. The author has seen very vigorous matings at all times of day. Often, within a small area 6 feet square or less, one can find 12 to 15 pickerel frogs mating or pairs in egg-laying positions. The mating places are often, but not always, in shallows. Along one shore, within a short stretch, the author has counted 20 or more frogs actively mating, to say nothing of those in the water. In one instance, in a space 3 feet square, were 21 unmated males, 5 mated pairs, and 8 fresh egg masses (representing 16 more frogs). Usually with most of the frogs, mated pairs, captured in the field, laid the night of the same day of their capture, but the rule did not always hold true with the pickerel frog; in fact, it seemed the exception. To find pairs of pickerel frogs which had mated in the laboratory waiting two or three days before ovulation was not surprising, but frequently pairs from the field waited from two to five days before laying. In two instances in different years (one, in an early season, the other in a late season) the eggs were laid after remaining in the embrace a week. In 1912 a pair continued in the embrace two weeks before ovulation. This delayed deposition makes the pickerel frog less desirable than the leopard frog.

The green frog is a solitary species. This habit makes it difficult to capture mated pairs in the field. One might better begin with the eggs or tadpoles or adult breeders. The mating is more active at night than by day. It does not begin before the latter part of May. With captive individuals it has been noted as early as May 22. The interval between first croaking and actual mating may be considerable. In his night collecting the author not infrequently located places where a male might be found croaking several nights in succession. Egg masses have subsequently been recorded in such spots so often that it has been found a good plan to keep such localities in mind when searching for eggs by day or night. About such masses the original or other males are afterwards frequently found for varying periods. In fact, many have been captured in this way.

The bullfrog is as shy as the green frog, and only about places where they are abundant could one ever hope to capture an appreciable number of pairs.

FIG. 1.—GREEN FROGS. EARDRUM NORMAL IN FEMALE, ENLARGED IN MALE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 2.—LEOPARD FROGS. PECTORAL EMBRACE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 3.—TREE TOADS. AXILLARY EMBRACE.
(After Wright, Carnegie Publ. No. 197.)

FIG. 4.—COUCH'S SPADEFOOTS. INGUINAL EMBRACE.

FIG. 1.—WOOD FROG. CONCAVE WEB OF FEMALE.

FIG. 2.—WOOD FROG. CONVEX WEB OF MALE.

FIG. 3.—BULLFROG. FOREFINGER OF FEMALE NOT SWOLLEN.

FIG. 4.—BULLFROG. FOREFINGER OF MALE VERY MUCH SWOLLEN.

The author found the southern bullfrog at the breeding season in the swampy tangles of buttonbushes and white alders, where the water was waist deep and the bushes 8 to 12 feet high. In southern Alabama he recorded croaking males as not uncommon in overflowed areas and swamps (Pl. IX, fig. 2) of clear streams, especially if overgrown with a thick mat of cat briars (smilax) and arrow arums. In the main their croakings consist of four or five notes and are wholly unlike the call of the northern bullfrog. To some people there is something of the human voice in their call; to others it sounds like an alligator. If the ventriloquial males be in tangles they are hard to discover. These croaking males may also occur along the deep-wooded, overflowed banks of southern rivers. The males have the eardrums enlarged (see green frog, Pl. XI, fig. 1) and the first finger swollen. (See bullfrog, Pl. XII, fig. 4.)

Possible Species.—At all seasons, except the breeding time, the wood frog is silent and retiring. In water at the spring congress they are difficult of approach. At ordinary approach the best one can hope for is only a series of surface ripples. Such assemblies may not last more than a day or so each year. Anywhere from 50 to 200 males have thus been observed floating at the surface. The scene resembles a small toad assembly, in which there is the same scrabbling and zeal of mating. They disappear simultaneously on seeing anyone, and on going through the pond a minute later one would wonder where the 200 males could be, to say nothing of the females. At the approach of the breeding season the males have the thumb much swollen and the webbing in the hind feet with margin convex, not concave, as in the females at all seasons and in males at other seasons of the year (Pl. XII, figs. 1 and 2). The period of mating has begun in some years as early as the middle of March and may rarely extend to May 1. The species is customarily at the height of sexual ardor the last week of March or the first week in April. They mate to some extent by day, but more frequently during the night.

In the common toad the males are noticeably smaller than the females, have dark throats, and at the breeding season possess dark-brown excrescences on the inner upper side of the first two fingers (rarely on the inner edge of third finger) and on the inner carpal tubercle. Both sexes repair to the water about the same time. The migrations begin early in April, but the toads have been recorded migrating to breeding localities as late as June 14, by which date many of the early breeders are leaving or have left the ponds.

The males far outnumber the females, and the furious actions incident to the first meetings of the two sexes, or following the arrivals of other toads, are long sustained and exhausting. The male embraces the female by digging its forearms into the axilla of the female, the fore fingers of the male being folded up. (See tree toad, Pl. XI, fig. 3). In this way it is clearly seen how the dorsal horny excrescences of the first three fingers of the male come into use.

In the west and southwest six species of toads may continue to breed as late as July or August, dependent on the rains, and in each species the male has the same kind of excrescences on the fingers and the same form of embrace as already described for the common toad. Because of their greater size two of these six might be of more commercial importance than our common toad. They are *Bufo woodhousii* and *B. alvarius*.

The hermit spadefoot toad[a] appears suddenly after prolonged rains in April and May or sometimes June or July. At the breeding season it is fond of sprawling out on the surface of the water as a wood frog does; and it is from this position that it croaks. This species gathers in large breeding assemblies like toads, and the matings are as spirited. The male seizes the female just ahead of the hind legs (inguinal fashion), a form of embrace not known in any other American forms except in the narrow-mouthed toads and possibly *Ascaphus truei* of Washington.

The same form of embrace (Pl. XI, fig. 4) and dependence on rains seems to hold true of Couch's and Hammond's spadefoots of the southwest and west, where the writer has observed their breeding habits. In these regions, after long droughts, these creatures and other species of toads at night almost literally pour down from the mountains or in the desert to any temporary streams (Pl. IX, fig. 1), pools, or "tanks," and their strange choruses can sometimes be heard from one-half to a mile away. The croaks of the Couch's spadefoot are given from the edges of swift-flowing, temporary streams or ponds and resemble the mewing of a cat. The males of Hammond's spadefoot float more or less on the surface of the water and, like the hermit spadefoot, dip the posterior portion of the body as they croak. Sometimes when both species are breeding in the same place at the same time cross embraces between the species ensue.

Undesirable Species.—In the undesirable species such as tree frogs, like the peeper and tree toad (Hyla), the cricket frog (Acris), and the swamp cricket frog (Pseudacris), the mating embrace is axillary (Pl. XI, fig. 3), and any mated pair with such a form of embrace is an undesirable species, unless it be the possible form, the toad. The narrow-mouthed toads (Gastrophryne) have the inguinal form (Pl. XI, fig. 4) of embrace, and no desirable form normally mates in this way. The possible form, the hermit spadefoot (Scaphiopus) does mate in this manner, and sometimes a weakened male toad (Bufo) with normal axillary embrace or a weakened male frog (Rana) with normal pectoral embrace may seize a female just ahead of the hind legs (inguinal fashion) in lieu of the normal embrace.

EGGS.

Several experimenters have suggested that to rear frogs for the market one could best start with eggs easily procured in nature. This apparent ease, however, has often led people to work with undesirable stock; and even some of the experimenters themselves have not been absolutely sure to which species of frogs the eggs belonged. With certain precautions as to the identity of the material, it is a convenient point at which to begin the work. It is, however, highly essential that one know the undesirable frogs and their eggs—the tree frogs, swamp cricket frog, peeper, cricket frog, and the large tree frogs; the narrow-mouthed toad; and the oak toad; and also the possible forms—the wood frog, other smaller frogs, the toad, and the spadefoot.

Desirable Species.—In the early spring the leopard frog is the second true frog to begin ovulation. It prefers cat-tail swamps

[a] Overton, Frank: Long Island fauna and flora. The frogs and toads. Museum, Brooklyn Institute of Arts and Sciences. Science Bulletin, vol. 2, No. 3, pp. 28-30. The author wishes to thank Dr. Overton and the Brooklyn Museum for the generous loan of Pl. IV, fig. 1, and Pl. XVIII, fig. 4.

FIG. 1.—A SURFACE FILM OF BULLFROG EGGS ATTACHED TO THE TIPS OF ELDERBERRY BUSHES.

FIG. 2.—AN EGG AREA OF LEOPARD-FROG EGGS, THE EGG MASSES ON THE BOTTOM OR ATTACHED TO VEGETATION.

(After Wright, Carnegie Publ. No. 197.)

FIG. 3.—A SURFACE FILM OF GREEN-FROG EGGS AMONG VEGETATION.

(After Wright, Carnegie Publ. No. 197.)

(Pl. V, fig. 1), marshy expanses of other types, grassy overflows (Pl. VII, fig. 1), and shallow, dead streams. In other situations than these it breeds sparingly. In some places it begins laying before April 1, and the period of ovulation may extend to May 15. In general, when the air temperature reaches 43 to 48°, and certainly when it averages 51 to 55°, the leopard frog begins spawning. The temperature of the water varies from 43 to 45° at the beginning of breeding to 50 to 65° at its crest. The leopard frog may lay at any time of day, even at noon, but more frequently it spawns at night. Leopard frogs have a tendency to congregate in large numbers and often 40 or more bunches of eggs are recorded within small circumscribed areas (Pl. XIII, fig. 2). At such times, when an area is approached, the mated pairs often seek cover under the bunches which have already been laid.

The egg masses of the leopard frog may be attached to submerged cat-tails, twigs, sticks, grass, etc., or as often may rest on the bottom unattached. Several times the water's surface has been observed to be so low that the tops of the bunches appeared at the surface. The bunches of eggs occur in the open, unprotected, marshy expanses, or in overflows where the edges and bottoms have plenty of grass. One will often find the egg masses interspersed with algæ and dead leaves, which so fill the shallows that the bottom can not be seen. As a rule, the leopard frog tends to seek shallower water and more swampy localities than the wood frog. The egg mass at ovulation is 1 or 2 inches in diameter. After it has expanded it is plinthlike or flat, the greater diameter varying from 3 to 6 inches, the smaller from 2 to 3 inches (Pl. XIV, fig. 2). The eggs of this species might be confused with those of the wood frog, which lays during the same period. The differences between the two are elaborated under the wood frog (p. 28). Under normal field conditions the eggs hatch in from 13 to 20 days.

The southern leopard frog, as well as the northern leopard frog, breeds normally in the spring, and hence is called the "spring frog," but occasionally its breeding period may extend until July 4, or later, after the first eggs of the species are hatched and the tadpoles transformed.

The egg mass of the southern leopard frog is plinthlike (Pl. XVIII, fig. 2), and the individual eggs are hardly distinguishable from those of the northern form. These masses may occur attached to vegetation along the quiet side shallows of streams or unattached upon the bottoms of pools, or they may be laid in swampy situations.

The pickerel frog, as far as the recorded situations show, seeks clear water, and, in the main, is usually found in the upper stretches of our clear streams. It frequents ponds heavily laden with dead leaves of quiet backwaters (Pl. V, fig. 2). The eggs are frequently found in the shallows of mill ponds, rocky holes of ravines, or lowland pools of wide, meandering streams. The bulk of egg laying occurs during the last week in April and the first week of May. Usually the period extends from April 23 to May 15. One may expect this species to begin laying when the temperature of the air reaches 50 to 61° and most certainly when 65 to 69° are recorded, provided the temperature of the water is 51 to 64°.

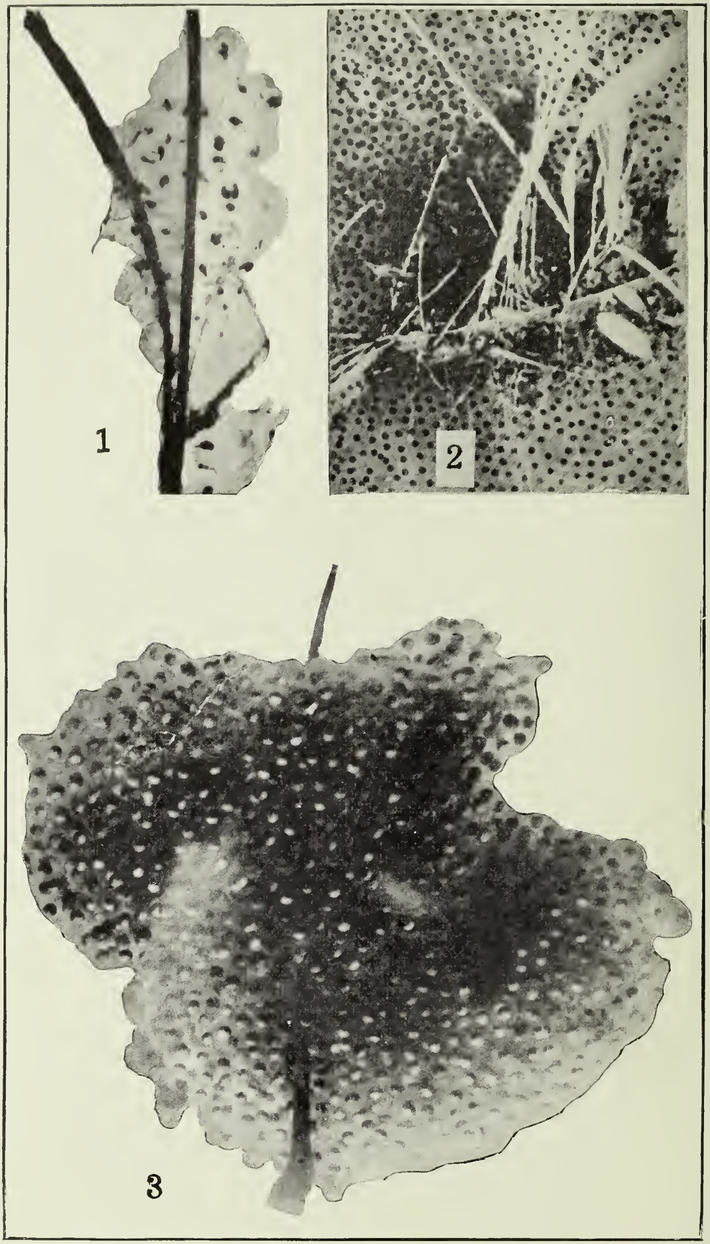
The eggs of the pickerel frog are almost invariably submerged and attached to sticks, twigs, or tufts of grass stems. The species usually seeks the shallows for egg laying, although not exclusively. Almost every year some egg masses are found in the middle of ponds where the water is 3 feet deep or more. It tends to lay in special areas (Pl. XVII, fig. 3), as do the wood frog and the leopard frog. At one time, in an area 3 by 3 feet, 18 bunches were deposited. In another spot of the same dimensions 31 bunches were found. All of these areas gave excellent illustrations of the placing of bunches one upon another. The greatest number of bunches observed upon one support was a case in which 7 were noted. Quite frequently on one tuft of grass, or on a stick, one finds one or more bunches of eggs of the spotted salamander, a bunch of leopard frogs' eggs, and as many as two bunches of pickerel frogs' eggs immediately above them—seldom below, because laid later. At the time of deposition a bunch may be 1 to 2 inches in diameter, but it soon expands to 3½ or 4 inches. It is usually firm and globular (Pl. XV, fig. 3). The egg complement of the pickerel frog may be from 2,000 to 3,000. The bright yellow or orange lower and the brown upper halves of the eggs of the pickerel frog make them the most easily distinguishable of all our true frogs' eggs. In nature the eggs may hatch within 11 to 21 days.

The green frog begins ovulation in the late spring or early summer, the extreme dates being May 23 and August 10. When the air temperature reaches 65 to 74°, or the temperature of the water surfaces 68 to 76°, the green frog may be expected to begin breeding. Surface temperatures are probably very influential in controlling the breeding habit, because of the position of the eggs after they are laid. When the air temperature reaches 80°, the species breeds commonly. During June and the first part of July the eggs of this form are very common; thereafter they diminish in numbers until the last of July or the first of August, when a few stragglers deposit the last eggs of the breeding season. This species lays mainly at night, but the author has twice seen it laying during the day.

The mass of the green frogs' eggs floats on the surface of the water. The typical form (Pl. XV, fig. 2) is a disklike film of a single layer of eggs, loosely attached or free. The eggs have the upper halves black and the lower halves white or creamy white. They may be found in the middle of the pond, where it is filled with a cover of algæ at the surface, or with hornwort, water milfoil, Chara, Nitella, or similar water plants, which make a mat of vegetation from the bottom to the surface, or where isolated patches of grass, water plantain, etc., grow in the middle of a pond. Usually, without such conditions, the masses occur about the edges of the pond (Pl. XIII, fig. 3), attached to grass, smartweed, etc., either growing in or extending into the water. In 100 or more cases hardly an exception to the surface deposition has been noted, but a few apparent exceptions have occurred. One egg complement was found in a somewhat scattered mass on leaves and twigs partially submerged. In another instance some of the complement was at the surface and the rest in water 4 to 6 inches deep. Inasmuch as such masses were found some time after deposition, a rise in the level of the pond could easily have brought about this anomalous condition. Another variation in the location of the egg mass is occasionally recorded. The mass may be attached to grass stems, the point of

FIGS. 1 AND 2.—FORM OF EGG MASSES.

1, Egg masses of wood frog, both masses globular; 2, egg mass of the leopard frog, mass plinthlike, not globular. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 3.—FORM OF EGG MASSES.

1, Egg mass of the swamp cricket frog, several such bunches laid by one female; 2, egg mass of green frog, a surface film among vegetation; 3, egg masses of the pickerel frog, globular mass, frequently in tiers. (After Wright, Carnegie Publ. No. 197.)

attachment being some 4 or 5 inches below the surface of the water. This attachment serves as the apex of an inverted cone, and the base of the cone spreads out on the surface of the water. This also may be due to a rise in the level of the water. Rarely a mass more than a foot square is recorded. Some of these masses may be composite. In a certain pond, where numerous frogs had laid, two bunches had been placed so close together as to make a film 15 by 10 inches. In another case a mass just as large was secured, and the evidences of its double nature were even more evident than in the preceding instance.

For several years small isolated packets of eggs were found on the water's surface, distributed in the manner of tree toads' eggs, but without their individual characteristics. They could not have been those of the swamp cricket frogs' eggs, for this species lays very early in the spring. At last it was discovered that, as egg development went on, the egg masses of the green frog often lost their circular disklike form, assumed irregular shapes, and separated into small masses of 25 or more eggs, a natural process due to the jelly becoming loose as hatching approached. But the egg packets observed were composed of fresh eggs. In those instances the wind or strong currents, or both, caused them to float away from the original mass.

The bullfrog begins egg laying at air temperatures of 71 to 72°, or at water temperatures of 66 to 71°. On the average, however, breeding comes at an air temperature of 80° and at a water temperature of 70 to 71°. The bullfrog lays the last of June or in July. The author's breeding record for this frog extends from June 16 to July 10. Doubtless it begins earlier some years or extends beyond July 10 in belated seasons. The writer has taken females with ripe ova the last of July. Ovulation usually occurs at night, at which time the species is most active. The bullfrog is a solitary form, yet at the height of breeding a mill pond (Pl. VI, fig 2) may have a dozen or more pairs in it, and some lakes may be well enough supplied with them to furnish the famed bullfrog choruses of June and July.

Usually the egg masses of the bullfrog are found among brush or under similar cover (Pl. XVI, fig. 1). The disk form so prevalent in the egg masses of the green frog obtains with this species as well. In one instance the egg mass covered a space of 2 by 2½ feet, or 5 square feet; in a second case, 2 by 2 feet; and in a third, 2 by 1½ feet. The size of these masses is a sufficient criterion for identification, since it is very unusual to find an egg mass of the green frog which covers a square foot. The first of these three egg films was deposited upon a mass of driftwood and brush, which was at the surface; the second was found among some fresh white branches that extended into the water from the edge of the pond. In rare cases the masses become stringlike, due to shifting water levels. One such mass was found attached to the roots of an overturned stump in shallow water and another in brush beneath a boathouse float. Sometimes bullfrogs lay their films in midpond around stumps, or attach the surface egg film to the tips of overhanging bushes which extend into the water (Pl. XIII, fig. 1). The winds often break these films into pieces and distribute them along the shores of the lake or pond. The mass is glutinous and is not firm and hard, as in the wood-frog, leopard-frog, and pickerel-frog eggs, which are laid earlier in the season. In the last of June and through July only one other common frog is breeding; namely, the green frog. The green frogs usually deposit their eggs upon vegetation. They lay on or among grass, water plants, and algæ, or along grassy edges of ponds, while the bullfrog almost invariably lays in brush. The egg complements of the two species are also different in size. The green frog seldom lays more than 3,500 or 4,000 eggs, while the bullfrog may lay from 10,000 to 20,000. Usually, the egg of the bullfrog has not the distinct middle envelope of jelly which is found in the green frog's egg (fig. 1, *F* and *D*). Furthermore, this middle envelope in the eggs of the green frog often is elliptical, and not round, as in the eggs of the leopard and pickerel frogs (fig. 1, *G* and *B*). In nature, the eggs hatch in four days or less.

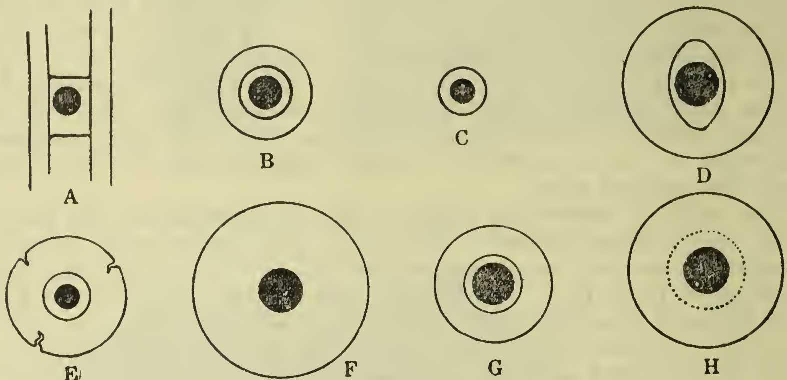


Fig. 1.—Individual Eggs (three times natural size).

A. Egg of common toad in two jelly envelopes or tubes, the inner of which is divided by cross partitions. *B*. Egg of pickerel frog. Inner envelope and egg proper of same size as egg of leopard frog (*G*) but outer envelope smaller. *C*. Egg of peeper. The one envelope and the egg proper together appear the duplicate of the egg of the tree toad (*E*) when it is stripped of its outer envelope. *D*. Egg of green frog. Unlike the egg of the bullfrog, it has an inner envelope. *E*. Egg of tree toad. The outer envelope often ragged in outline. *F*. Egg of bullfrog. Unlike the other four frogs, it has no inner envelope. *G*. Egg of leopard frog. Egg proper black and white, not brown and orange as in pickeral frog (*B*). *H*. Egg of wood frog. It has the largest egg proper of these eight species and larger envelopes than the confusing pickerel-frog (*B*) and leopard-frog (*G*) eggs. (After Wright, Carnegie publication No. 197.)

The eggs of the southern bullfrog are not known, and we are not very familiar with its breeding habits. In Georgia, Florida, and Alabama the writer has chanced upon this species in full croaking season in June and July. This species is reputed to lay small eggs in large masses on or at the surface of the water in the early summer, and if this be true the habits of this form are closely similar to those of the northern bullfrog.

Possible Species.—The hermit spadefoot toad is one of the most erratic and transient of our toads or frogs. It suddenly appears after a shower, and egg laying is soon over after an ear-splitting chorus of croaking lasting a few days. Breeding usually occurs in April but occasionally persists until August. This species breeds in quiet pools and ponds (Pl. VII, fig. 2). The eggs are enveloped in a gelatinous band (Pl. XVIII, fig. 4), the cross section of which includes several eggs. In the common toads the eggs occur in one

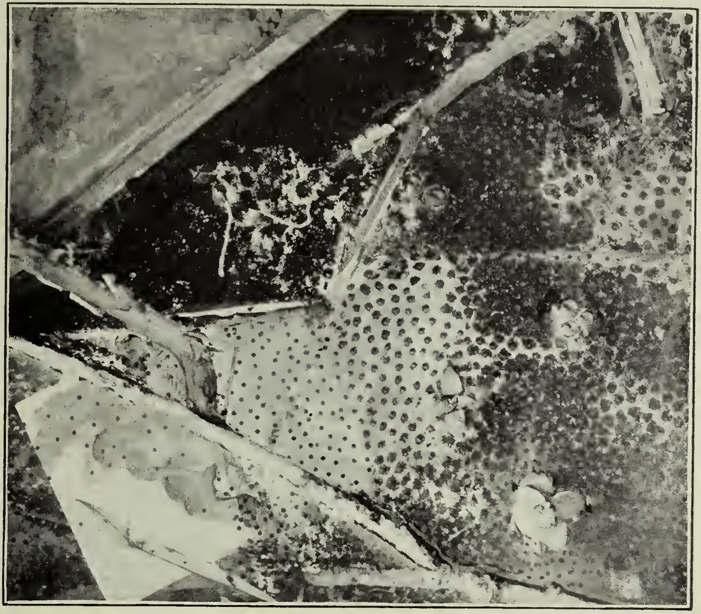


FIG. 1.—EGG MASS OF BULLFROG; A SURFACE FILM 18 INCHES IN DIAMETER LAID AMONG DEAD STICKS AND OLD BOARDS.

(After Wright, Carnegie Publ. No. 197.)

FIG. 2.—A SURFACE PACKET OF TREE-TOAD EGGS ATTACHED TO A POND-WEED LEAF.

(After Wright, Carnegie Publ. No. 197.)

FIG. 1.—COMMON TOAD EGG STRINGS CURLED ABOUT VEGETATION.
(After Wright, Carnegie Publ. No. 197.)

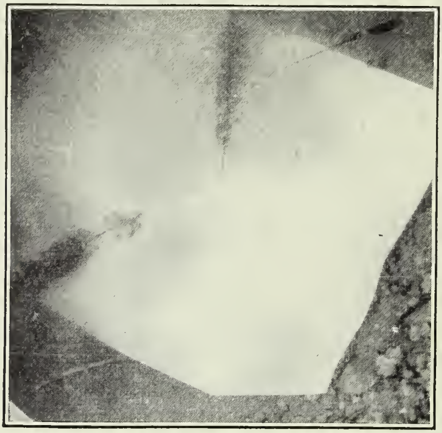


FIG. 2.—THE STALKED EGGS OF THE DESERT TREE TOAD (?).

FIG. 3.—AN EGG AREA OF THE PICKEREL FROG AND TWO MATED PAIRS; EGG MASSES ATTACHED TO VEGETATION AND STICKS ON THE BOTTOM.

(After Wright, Carnegie Publ. No. 197.)

or two lines or files within one jelly tube. The eggs of the spadefoot usually hatch in a very short period.

While the hermit spadefoot lays eggs in bands like the European forms of this family, the spadefoots of the Southwest—namely, Couch's and Hammond's spadefoots—may strew them on the bottom of the ponds. These eggs may be singly placed or be in more or less agglutinated masses usually one egg deep and may be laid as late as mid-August. This peculiar arrangement of the egg complements may be due to the absence of suitable vegetation, since Strecker[a] has seen Couch's spadefoots lay egg bands which became attached to grass, etc.

The life histories of several smaller true frogs are unknown. These, including Cope's frog, the yellow-legged frog, and *Rana onca*, are too small to be considered.

The wood frog usually chooses still water for spawning, rarely backwaters or bayous of streams. It prefers the leaf-laden ponds (Pl. VIII, fig. 1) and transient pools of wooded districts, though not wholly restricted to such localities. Occasionally the author has seen the frogs migrating to swampy cat-tail stretches for spawning and has both observed and heard them in such situations. Two of his best collecting spots were a grassy pool and a high upland pond, both of which were out in the open and ordinarily dried up in midsummer. In wooded districts he has found them even using pools no more than 1½ by 4 feet in area. When the air temperatures average 53 to 58°, one may go out with some expectation of finding the wood frogs spawning, provided the water temperature is at least 41 to 48°. Spawning reaches its height usually at about 53 to 60°. The average date of spawning is about April 4; the author's earliest record is March 19; his latest first record, April 14. In general, wood frogs spawn most frequently in the first half of April, though occasionally earlier or later, depending on the season. In some years, when spring opens early, as the last of March, the spawning begins with a rush, and the species may be practically through laying within from four to six days after the beginning of ovulation. Most of the egg complements are laid at night, yet the author has frequent instances in which the eggs were laid during the day, both in the laboratory and in the field. In the laboratory, they have been observed to lay throughout the day; in the field, there have been numerous indications that eggs were laid during the day. This species is gregarious at the breeding season. Where the first bunch of eggs of the season is laid, one is quite certain to find other wood frogs depositing their complements later. In this way the whole egg content of a large pond may frequently be massed in a small limited area (Pl. XVIII, fig. 3).

The eggs of the wood frog may be deposited either near the edges or in the middle of the pond. They are usually attached to grass stems, weed stalks, twigs, or brush; but, in rare cases, they may rest free on the bottom. In this species the egg bunches tend to be attached more frequently than in the case of the leopard frog. In rare cases, wood-frog and leopard-frog masses are found on the same twig. The egg mass, at the time of laying, may be an inch in diameter. Within one-half hour to two hours it assumes a diameter

[a] Strecker, J. L.: Notes on the life history of *Scaphiopus couchii* Baird. Proceedings, Biological Society of Washington, Vol. XXI, p. 203. Washington, 1908.

of 2 or 3 inches. Freshly laid masses are always of a very bluish tinge. The eggs are usually found in shallow water, 6 inches to 2 or 3 feet deep, though occasionally eggs have been in water of a greater depth. The eggs of the wood frog are to be confused only with those of the leopard frog. In the former, the egg mass is globose (Pl. XIV, fig. 1); in the latter it is plinthlike. In the leopard-frog egg, the middle envelope is evident to the naked eye, which is not true of the wood-frog egg (fig. 1, *G* and *H*). The eggs of the wood frog are free, and the outer envelope of each egg keeps its spherical form more exactly than in the case of the leopard frog, where the eggs are closer together and both they and the outer envelopes smaller. The eggs of the wood frog are 3.6 to 5.5 mm. from each other, while in the leopard frog the eggs are 2.6 to 3.6 mm. apart. The two egg masses can be separated easily in the field by inverting the mass, thus revealing the lower side of each egg. In the eggs of the leopard frog the whiteness of the egg mass becomes very apparent, but in those of the wood frog the general effect is not decidedly that of whiteness, because of the evident encroachment of the black of the upper half upon the lower side.

The northern wood frog doubtless has breeding habits similar to those of the eastern wood frog.

The life history of the common toad will serve well enough as an example of the life histories of our more common toads. At the spawning season hundreds of pairs may be recorded laying at one time; and in one instance 10 pairs were secured within an area 1½ feet square. Any water hole, ditch, or transient pool may contain one or more toads at this season. They seemingly prefer the shallower waters and are apparently not particular whether it be grassy (Pl. VII, fig. 2), weedy, or swampy (Pl. VII, fig. 1), or whether the bottom be free or covered with fresh or dead vegetation. So long as water is at hand, their main desideratum is met. In choice of a breeding spot, then, the toad is easily suited and will use a greater variety of localities than any other anuran. This species may begin spawning when the temperature of the air is 50 to 51°, but the crest of the breeding season is reached at about 70°. Spawning may begin when the water temperature is as low as 51° but reaches a maximum when the water temperature is about 56 to 66°. The toad begins ovulation about April 23, the earliest examples recorded being April 5. The crest of ovulation comes about April 30. Thereafter the number of spawning pairs diminishes. By May 15 or 20 the bulk of the laying is about completed, and by May 20 or 25 nearly all the toads' eggs are hatched. In June there are a few stragglers. In rare instances the species lays through July. So, spawning in this species occasionally extends far beyond the transformation time of the first-hatched toad tadpoles of the season. Egg laying takes place both by day and by night. The female toad lays from 4,000 to 7,000 eggs. The eggs are laid ordinarily in quiet water; it may be shallow, but not always so. The eggs are found in pools and ponds, artificial or natural, in marshes, backwaters, ditches, etc. The strings may rest merely on the bottom or be twined about vegetation or sticks which happen to be near at hand (Pl. XVII, fig. 1). The eggs are laid in long, spiral tubes of jelly (Pl. XIX, fig. 2). Each egg, with its quadrangular envelope, is incased in two tubes of jelly, one tube within the other. (See fig. 1, *A*.) The hatching period is

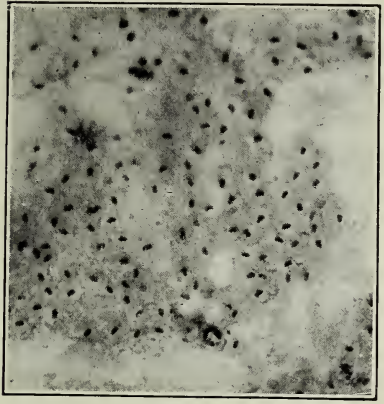


FIG. 1.—A SURFACE FILM OF TREE-TOAD EGGS.

FIG. 2.—A PLINTHLIKE EGG MASS OF THE SOUTHERN LEOPARD FROG.

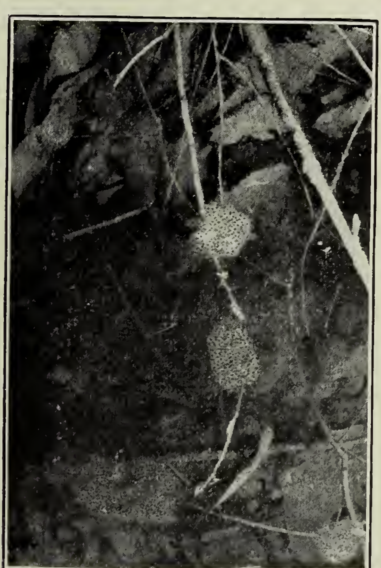


FIG. 3.—AN EGG AREA OF THE WOOD FROG, THE EGG MASSES ATTACHED TO STICKS.

(After Wright, Carnegie Publ. No. 197.)

FIG. 4.—AN EGG BAND OF THE SPADEFOOT ATTACHED TO VEGETATION.

(After Overton. Mus. Brooklyn Inst. Arts & Sci. Sci. Bull., Vol. 2, No. 3.)

FIG. 1.—EGGS OF PEEPERS LAID IN THE AQUARIUM.

(After Wright, Carnegie Publ. No. 197.)

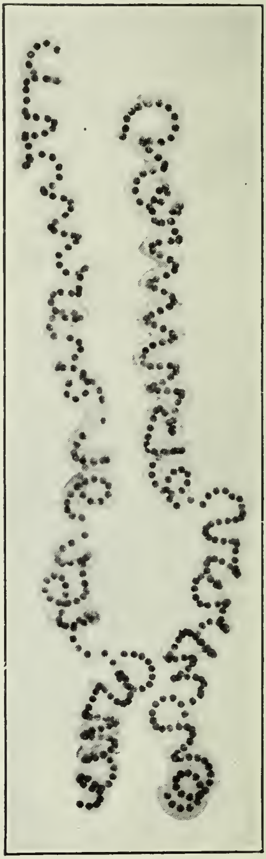


FIG. 2.—TWO EGG STRINGS OF THE TOAD; A STRING FROM EACH OVIDUCT.

(After Wright, Carnegie Publ. No. 197.)

very short. In general the eggs hatch within from three to five days. In colder seasons, the eggs may not hatch until 8 to 12 days have passed.

UNDESIRABLE SPECIES.—The swamp cricket frog, one of the first to appear in the spring, lays small bunches of eggs attached to sticks, leaf stems (Pl. XV, fig. 1), etc., in every transient pool, pond, or ditch, as well as in the swamps. In each bunch are 20 to 100 eggs. Usually the bunches are beneath the surface, but the mass is seldom over 1 to 1½ inches in diameter. The eggs, however, are black on the upper half and white on the lower half. Besides, the largest individual eggs of this species may be as large as the smallest green frog or bullfrog eggs, which, however, are not laid until summer. Furthermore, the smallness of the mass enables one to distinguish the swamp cricket-frog eggs from any of the desirable frog-egg stock.

The peeper, together with the swamp cricket frog, makes up the shrill chorus from our swampy situations in early spring. They often occur in the same situations as the leopard frog, but the eggs of the peeper (fig. 1, *C*) are laid separately (Pl. XIX, fig. 1), do not occur in masses, and are hard to find. Hence there is little danger of their confusion with those of the leopard frog, though laid at the same time.

The cricket frog is one of the first forms to appear in the spring and according to several authors breeds in March, April, and May or even later. Abbott [a] says the small masses of eggs are attached to blades of coarse grass along ditches in the meadows. The writer recently found them breeding actively on June 1. They had chosen a shallow (1 to 4 inches deep), grassy meadow pool (Pl. X, fig. 1). The eggs were attached singly to sedge stems or were strewn singly on the bottom. In one or two instances three or four eggs were close together. Many of the eggs were in water not more than an inch in depth.

The larger tree frogs, like the common tree toad, Carolina tree frog, and the pine wood's tree frog, lay their eggs from the very last of May to July. The color of the eggs is brown on the upper half and cream or yellowish on the lower half. On the criterion of color alone they might possibly be confused with those of the pickerel frog, which deposits eggs, the upper halves of which are brown and the lower yellow or orange. The latter species, however, lays its eggs from April 20 to May 20 before the tree frogs begin. Besides, its egg masses are spherical, 2 or more inches in diameter, and are found beneath the surface of the water. These tree frogs lay at the same period that the green frog and the bullfrog do and, as do these, lay their eggs in films on the water (Pls. XVI, fig. 2, and XVIII, fig. 1). But the bullfrog and green-frog eggs occur in large films 2 to 8 inches in diameter, while the tree-frog films are seldom over 1½ inches. Occasionally, the large egg films of the bullfrog and green frog break up into smaller films, but then they can be distinguished from the tree frogs by the fact that the egg is black above and white below.

The narrow-mouthed toad is a form whose life history is not wholly understood. Brimley [b] holds that it breeds from May to August, and

[a] Abbott, C. C.: Notes on the habits of the "Savannah Cricket Frog." American Naturalist, Vol. XVI, No. 9, p. 707, 1882.

[b] Brimley, C. S.: Batrachia found at Raleigh, N. C. American Naturalist, Vol. XXX, p. 501. Philadelphia, 1896.

the author's limited experience with the species suggests that the eggs are usually laid during the spring or early summer. Deckert[a] found their eggs on August 28. The eggs were "laid in oblong, jelly-like sheets or flat masses about 1½ inches long and 1 inch wide. The egg masses contain about 100 to 150 eggs."

The oak toad breeds in May and June, most of the egg laying doubtless occurring before June 15. The egg string is laid in warm, shallow ponds, and many of these eggs or the subsequent tadpoles are dried up by the rapid evaporation of the very transient breeding pools. The egg string or file is a small edition of the southern toad's egg string, the former being much smaller in diameter than the latter. A female oak toad may deposit 500 to 600 eggs, while a common toad produces 4,000 or more. The eggs of the oak toad are slightly smaller than those of the common toad.

TADPOLES (PL. XX).

For the average layman the tadpole might prove the easiest starting point in attempting frog culture: Individual breeders must be secured just before mating; to take mated pairs is more difficult; the egg period is short and the chances of finding eggs restricted by time and the expertness of the seeker; but the tadpoles of some of the best species may be had at almost any time, the green frog remaining a year in the tadpole stage and the bullfrog two years. There are a few cardinal considerations to be borne in mind: Any large tadpole of the eastern United States found in the spring before May 1 is, so far as we now know, either a green frog or a bullfrog tadpole. Usually tadpoles taken after September 1, and almost surely after October 1, must be of the green-frog or the bullfrog species. Throughout the summer, when the other tadpoles are present, if a tadpole be at least 2 inches or more in length, it is generally either that of a leopard frog, pickerel frog, or bullfrog, all desirable species. In proportion to their size, these commercial frogs have smaller eggs than the smaller species of frogs, and, consequently, the period of tadpole development and growth to adult form may also consume more time both actually and relatively.

Desirable Species.—The tadpoles of the leopard frog transform during the same season in which the eggs are laid. The eggs are relatively larger and the size at transformation is smaller than in the green frog and the bullfrog. Usually 71 to 111 days elapse between egg laying and the change to small frogs, or 60 to 80 days elapse between the hatching of the eggs and transformation. The tadpoles of the leopard frog are very seldom found after August 15. The distinctive marks are: Crests of the tail (not muscular portion) conspicuously lighter than the body, almost transparent, and marked with widely scattered fine spots or specks; belly deep cream color with bronzy iridescence; greatest length, 3 to 3.4 inches. (See Pl. XX, fig. 4.)

The pickerel-frog tadpoles change into frogs the same season the eggs are laid. The developmental period from the egg to transformation consumes from 87 to 100 days; the period from egg hatching to transformation 76 to 85 days. The distinctive marks of the tadpole are: Tail crests not transparent or translucent, as in the leopard frog, but opaque, very dark, sometimes almost purplish

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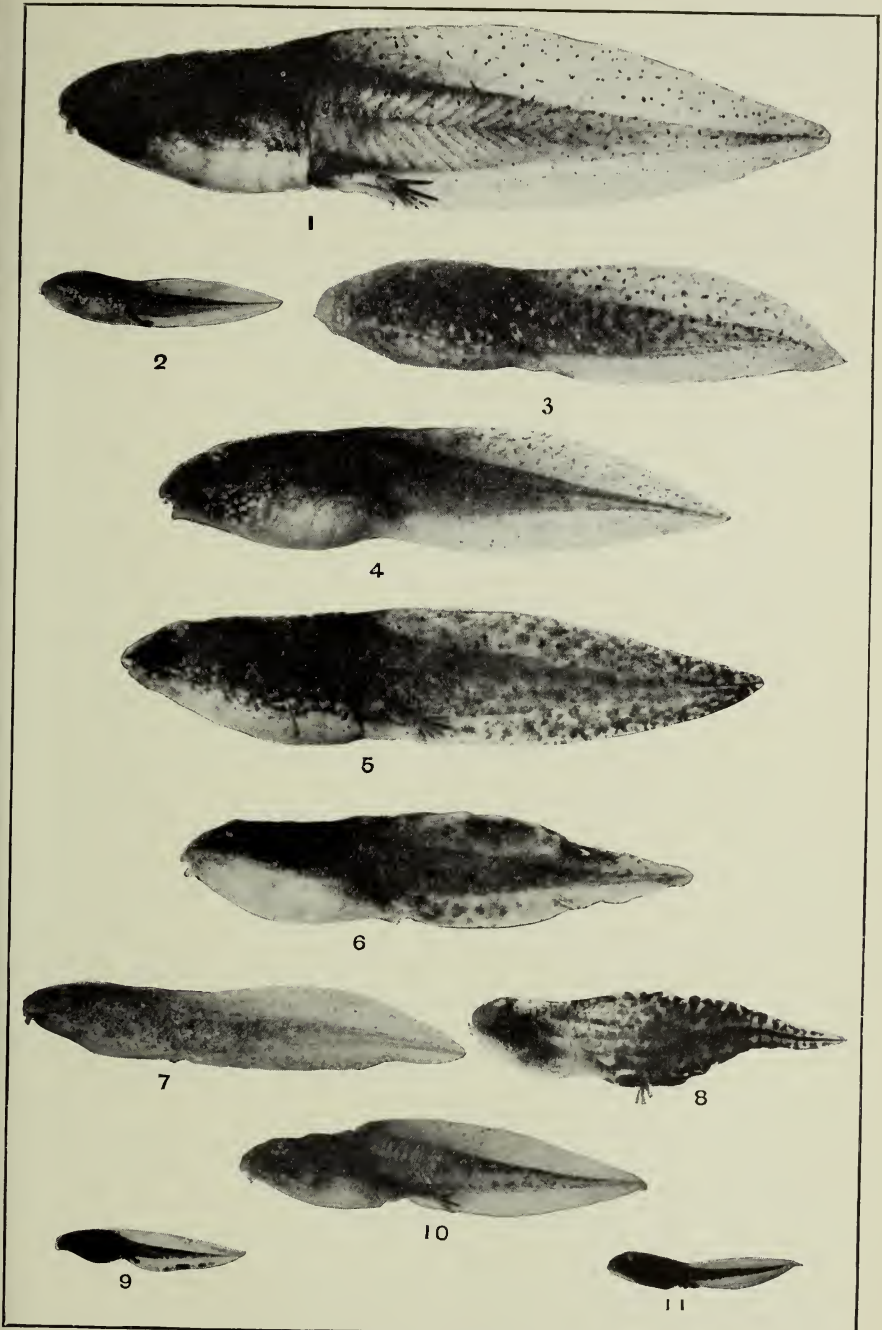
[a] Deckert, R. F.: Further notes on the Salientia of Jacksonville, Fla. Copeia, No. 9, p. 1, 1914.



FIGS. 1 TO 11.—MATURE TADPOLES, NATURAL SIZES.

1, 2-year-old bullfrog tadpole; 2, 3 to 5 months old bullfrog tadpole; 3, 1-year-old bullfrog tadpole; 4, leopard-frog tadpole; 5, 1-year-old green-frog tadpole; 6, pickerel-frog tadpole; 7, 3 to 6 months old green-frog tadpole; 8, tree-toad tadpole; 9, peeper tadpole; 10, wood-frog tadpole; 11, common toad tadpole. (After Wright, Carnegie Publ. No. 197.)

black, and usually marked with aggregate spots or blotches somewhat like the green-frog tadpole. In the pickerel-frog and leopard-frog tadpoles, in spite of the coppery iridescence on the belly, the elongate intestine shows through the skin, while in the green-frog tadpole the deep cream color hides the view of the intestine. The pickerel-frog tadpoles never reach 3 inches in length. (See Pl. XX, fig. 6.)

The green-frog tadpole requires one year for growth before it becomes a small fully formed frog. The same factors operate for this extension of time as in the case of the bullfrog tadpole. The tadpole of the green frog, however, has to attain a size slightly more than one-half that of the mature bullfrog tadpole, and the larval or tadpole period is, therefore, one-half as long. The distinctive marks are: Tail greenish, mottled with brown; belly deep cream color with very little or no iridescence; no round black spots; never over 3½ inches in length. (See Pl. XX, figs. 5 and 7.)

The bullfrog tadpole requires two years or more for growth before it transforms or becomes a frog in form. This long period of development results from several causes, among which are these: The eggs are relatively small and are laid late in the season; and the larvæ or tadpoles are hatched in an immature state and have to grow to a comparatively large size before they change into small bullfrogs; that is, the mature bullfrog tadpole may be three times as long as a wood-frog tadpole or twice that of a pickerel-frog or leopard-frog tadpole. Any tadpole over 3½ inches in length will prove to be that of a bullfrog. The distinctive marks are: Belly of a straw or maize yellow color; the body and the tail (except the lower crest of fin) with regular round black spots; and fine yellow dots all over the body. (See Pl. XX, figs. 1, 2, and 3.)

Possible Species.—With the exception of the toad, the tadpoles of several possible forms are not well enough known to describe positively. The toad tadpoles seldom reach more than from 1 to 1¼ inches in length. The small size required enables the tadpole to develop quickly into the toad form. The period of development from the egg to transformation is from 50 to 65 days; from the hatching to transformation, 41 to 60 days. The distinctive marks of the tadpole are: Body very dark or black (not greenish) in appearance; crests of the tail cloudy transparent or milky translucent and not high; tail tip often more or less rounded. (See Pl. XX, fig. 11.)

The tadpole of the wood frog develops in one season; usually the period of development from the eggs to transformation extends over about 90 days, though the range may be from 61 to 115 days. The tadpole period and breeding time of the wood frog coincide with those of the leopard frog. The tadpole of the wood frog never becomes more than 2 inches long. Like that of the leopard frog the belly of the wood frog has a bronzy iridescence, but it is more pinkish in the latter along the upper-jaw region, while the wood-frog tadpole has a cream-colored line; finally, the mouth of the tadpole of the wood frog has three rows of teeth on the upper jaw and four rows on the lower jaw, while all the desirable species have two rows of teeth on the upper jaw and three on the lower. (See Pl. XX, fig. 10.)

Undesirable Species.—Some of the more frequent tadpoles which should be avoided are those of the narrow-mouthed toad, the tree toad, the peeper, the swamp cricket frog, and the cricket frog.

The narrow-mouthed toad, so far as known, transforms the same season during which the eggs are laid. This period was formerly considered to be 90 to 100 days, but Deckert's[a] captives required only 16 days from hatching to transformation, an amazingly short period. The largest of the tadpoles of this species reach a length of 1⅗ inches and are very easily distinguished from those of other species. The body is very flat, and the depth of it is contained 1½ times in the width, while other tadpoles have round bodies; there is no spiracle; there are no horny-edged mandibles, and the lower lip of ordinary tadpoles is not present, while the upper has either a faint row of teeth or none at all. The color of the tadpole is quite conspicuous. On the back and sides it is a uniform brown or olive black. Along the middle of the muscular part of the tail there is a bright, clear, white band one-fourth to one-half inch long. Along either side of the belly there is a similar white line, and most of the belly is of this clear white. All in all, it is our most remarkable tadpole.

The known tree-frog tadpoles of this country, with the exception of the peeper, have the two rows of teeth on the upper lip and two on the lower, thus differing from the desirable frogs which have two rows on the upper and three on the lower. Furthermore, the upper tail crest (this is also true of the peeper tree frog) extends onto the back almost to between the eyes, which are lateral, visible both from the back and belly. In the tree-frog tadpoles the eyes are not visible from the lower side of the animal, and the tail crest seldom reaches onto the back beyond the vertical of the spiracle.

The common tree-toad tadpole takes about 50 or 60 days for development from the egg to the transformed tree toad. Sometimes the period may be no longer than 45 days or, in other cases, as great as 65 days. These tadpoles can be distinguished at once by their long tails, which are 2.2 to 3.5 times the length of the body and scarlet or orange vermilion in color, with black blotches more prominent near the margins of the crests. The belly is conspicuously of a white or light cream color, slightly iridescent, and the intestine does not show through. These tadpoles reach a length of 2 inches. (See Pl. XX, fig. 8.)

The peeper tadpole may have the rows of teeth two and two, as in American tree frogs in general, or some of the tadpoles may have a small third goateelike row on the edge of the lower lip. The peeper tadpole transforms about 90 or 100 days after egg laying and never exceeds 1.3 inches in length. The tail is only 1.4 to 2.1 times the length of the body. The tail crests are clear and usually heavily pigmented with purplish black blotches near the outer edges. (See Pl. XX, fig. 9.)

The swamp cricket frog spends about 75 to 100 days in passing from the egg to transformation. The tadpole is the darkest in color of any tree-frog tadpole; the body is brownish black all over, and the back and the upper two-thirds of the muscular part of the tail have the same color. The lower third of the muscular portion of the tail is whitish. The tail crests are transparent and practically unspotted, a character which is distinctive in an adult tadpole. The rows of teeth are 2–2, or 2–2 with a slight suggestion of a third lower row.

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[a] Deckert, R. F.: Loc. cit., pp. 1, 2.

The tadpole of the cricket frog develops in about the same length of time as that of the peeper. The tadpoles of the former transform the same season the eggs are laid and seldom exceed $1\frac{1}{2}$ inches in length. They are larger than peeper tadpoles, have the crests blotched like tree-toad tadpoles, but have not the scarlet color of these creatures. The conspicuous character is the arrangement of coloration on the muscular part of the tail. There are four long bands—the first a brown band from body to tip of the tail; above this a cream white band, followed by another brown band to tail tip; and this surmounted by another short cream white band. There are two rows of teeth on the upper lip and three complete rows on the lower, as in the case of some of the frogs.

TRANSITION STAGES (PLS. XXI AND XXII).

Many of the attempts at frog culture have consisted in carrying eggs through hatching or even in carrying tadpoles through to transformation; but the efforts have ended at the latter stage. In nature, there is always considerable loss of tadpoles particularly just before transformation, and hitherto, in captivity, the same trouble has often been encountered. Some culturists might, therefore, prefer to begin their first efforts with the transformed frogs which have passed the critical stage, and thus avoid this large percentage of loss of stock. In many ways it is easier than gathering mated pairs or eggs and ought to be almost as successful as the capture with a seine of tadpoles or of individual adults at breeding time. At the approach of the transformation the tadpoles continually remain in the shallows. To be forehanded, a person might pull a minnow seine along such an area, particularly if it be somewhat or quite weedy, and obtain four-legged stages with the stumps of the tail remaining. These complete the tail absorption in a few days and are often easier of capture than the spry small frogs along the bank. If one try to make the captures immediately after transformation is wholly completed, he will have considerable success with leopard frogs and pickerel frogs and often secure 50 to 100 frogs at one time. The aquatic forms, the small green frogs and bullfrogs, however, immediately leap into the water at one's approach and never start landward through the vegetation, as the young leopard frogs and pickerel frogs so commonly do.

Desirable Species.—All of the four principal desirable species for the frog market (the leopard frog, the pickerel frog, the green frog, and the bullfrog) transform at an average size of 1 to 2 inches, while all the possible or undesirable species usually transform at sizes below that of 1 inch. Of course, the danger comes in the layman mistaking a growing undesirable form for a transformed frog of a desirable species; but if he thoroughly learns the cardinal characters of the four adult commercial frogs no error should occur, for the young frogs are sufficient replicas or duplicates of the adults to make their identification easy.

Most of the leopard-frog tadpoles change to small frogs in July, although a few may wait until August before complete transformation. The average range of dates extends from June 30 to July 25, with the bulk of the transformations occurring in mid-July, the latest ones recorded being on August 6. At the approach of transformation the young come out into the open shallows or rest at the edges of the ponds in the thick mats of vegetation. If the season has been very rainy and the mortality consequently low, a region may have almost a plague of small frogs. Then temporary ditches, holes, and transient diggings are filled with these creatures migrating from the water over the land, and these constitute the so-called rain of frogs. This shows the apparent ease with which young transformed leopard frogs can be captured at such rare occasions with pitfalls, but ordinarily the operation is less easy. If the pond about which the frogs are transforming have a heavy growth of vegetation the frogs prove

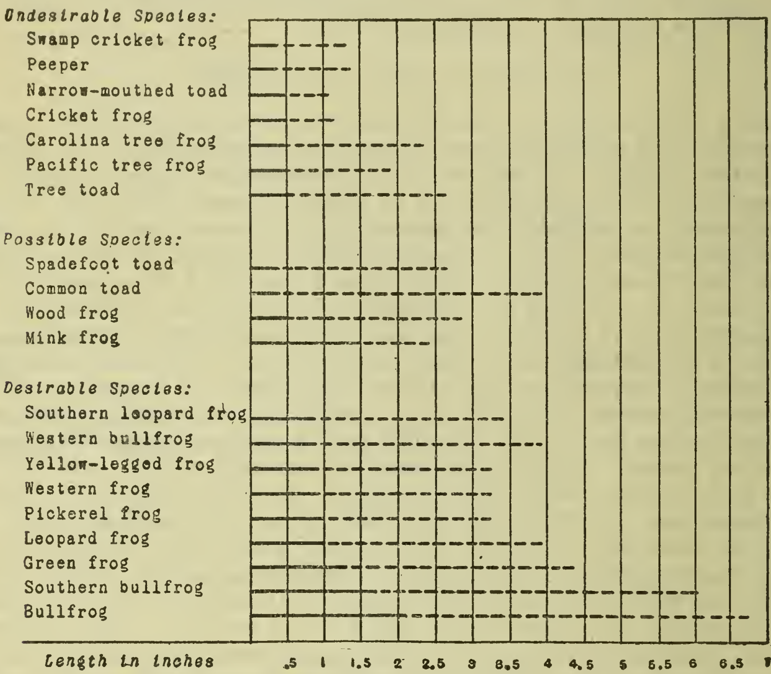
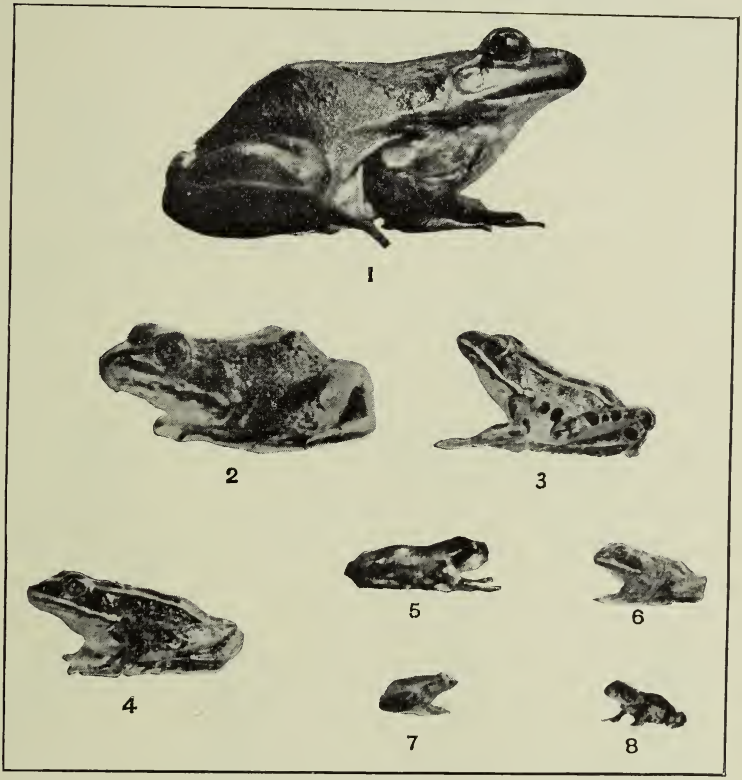


FIG. 2.—Transformation and adult sizes of frogs. Length of continuous line equals the transformation size. Length of continuous and broken lines gives adult size. Adult size determined by largest adult in author's collection.

difficult of capture and are quickly lost in the weeds; therefore, the sure method is to seine the swampy area or pond just before the final stage is reached. At transformation a young leopard frog is, on the average, 1 inch long, the range of size being 0.75 to 1.25 inches. (See fig. 2 and Pls. XXI, fig. 4, and XXII, fig. 6.)

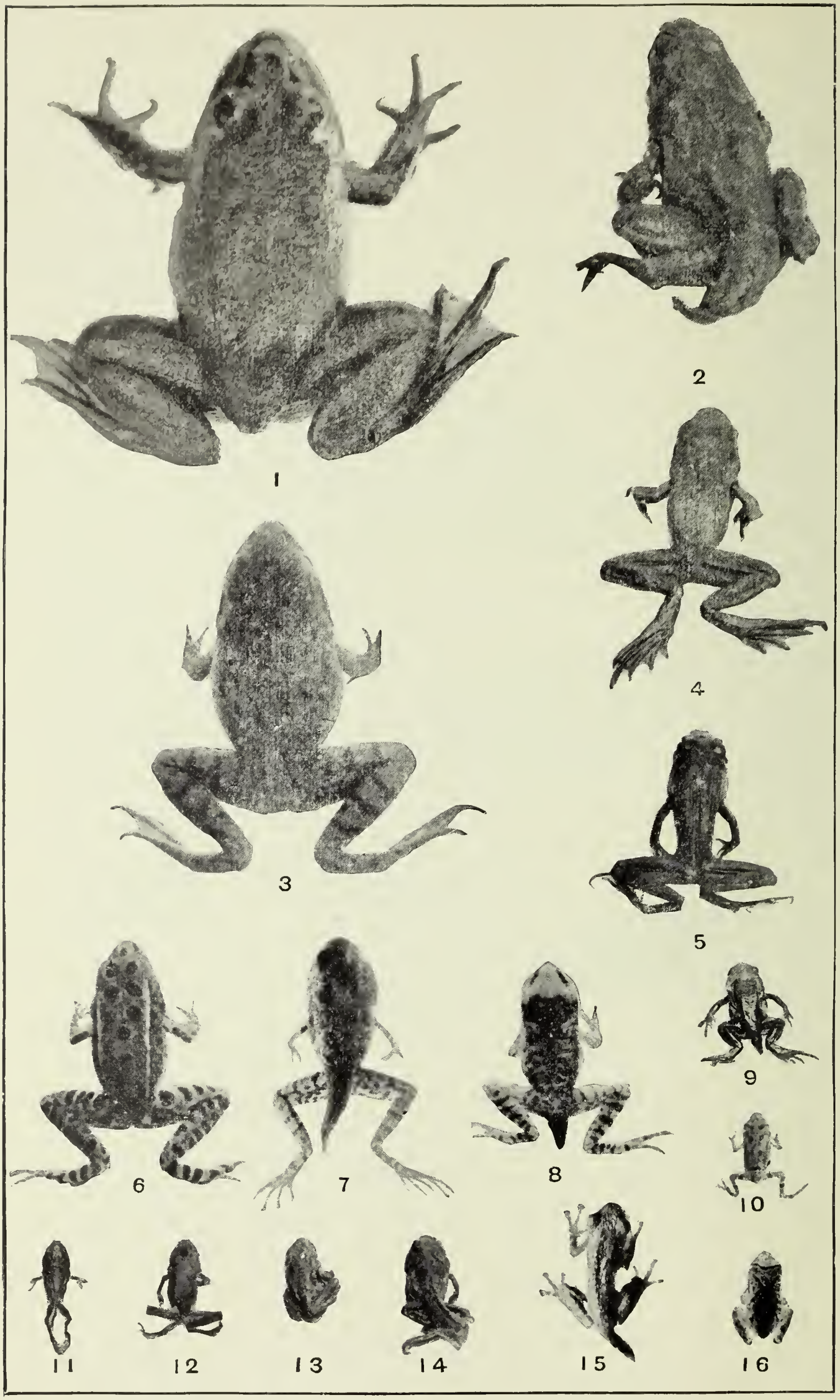
The southern leopard frog transforms during the last of June and in July. The transformed frogs range from 0.75 to 1 inch in length, the average being seven-eighths of an inch. (See fig. 2 and Pl. XXII, fig. 5.)

The pickerel-frog tadpoles may begin to transform the last week in July, but by far the greater number of larvæ transform in August. Occasionally some tadpoles do not transform until September 1 or rarely until October 1. The length at transformation averages 1 inch, and the range of size is 0.75 to 1.1 inches. What has been said



FIGS. 1 TO 8.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, green frog; 3, pickerel frog; 4, leopard frog; 5, tree toad; 6, wood frog, 7, peeper; 8, common toad. (After Wright, Carnegie Publ. No. 197.)



FIGS. 1 TO 16.—TRANSFORMATION SIZES, NATURAL SIZES.

1, Bullfrog; 2, mink frog; 3, green frog; 4, western frog; 5, southern leopard frog; 6, leopard frog; 7, pickerel frog; 8, wood frog; 9, narrow-mouthed toad; 10, common toad; 11, spadefoot toad; 12, Pacific tree frog; 13, swamp-cricket frog; 14, cricket frog; 15, tree toad; 16, peeper. (Photos of 2, 4, 5, 9, 11, 12, 13, 14 from spirit specimens.)

of the leopard frog is more or less true of the pickerel frog. A capital place to secure transformed and half-grown pickerel frogs is along the banks of the headwaters of our clear streams. (See fig. 2 and Pls. XXI, fig. 3, and XXII, fig. 7.)

The newly transformed green frogs vary in length from 1.1 to 1.5 inches, the average being 1.3 inches. Most of the transformations occur in the latter part of June and throughout July. Usually, by the first of August transformation for this species is largely, but not wholly, completed. In a species which lays from the last of May to the middle of August, or later, it is evident that some transformations may occur at any time within the same limits. This form spends one winter in the tadpole stage and is a year old before it changes to the frog form. Of all the commercial forms, this has proved the hardest to collect in numbers at the transformation stage. The long period of transformation, the smallness of some of the ponds and of their green-frog tadpole content, and the shyness of the species make it more difficult to secure a quantity of young green frogs than a similar number of young bullfrogs. It does not seem at present a convenient starting point in the culture of the green frog. (See fig. 2 and Pls. XXI, fig. 2, and XXII, fig. 3.)

The bullfrog tadpole spends two winters as a tadpole. Inasmuch as the eggs are small and deposited late in the season (usually the last of June or in July), the tadpoles are small when winter arrives. The whole of the next season is consumed in growth, and it is not until another winter is passed that the larvæ begin to approach transformation, which usually comes in July—that is, two years after egg deposition. More rarely does the tadpole spend a third winter before transformation. According to all of our data, transformation occurs in July or later. An average of the first dates recorded places the beginning of transformation at July 15, The species evidently does not begin transformation before July 1, and the period of transformation often extends to August 15. In one year, when first recorded on July 30, tadpoles were found which would require two weeks more before transformation. In another year several were found transforming on August 20, and a few other tadpoles which appeared as if they might transform in October or November or during the next season were found. The mature tadpoles begin to come out in the shallow water in early summer. Here they hide in the Chara, Nitella, hornwort, water milfoil, etc., or they rest beneath the lily pads, pond weeds, and other surface plants. Another favorite place of transformation is among the pickerel weed, arrowhead, and water plantain, which afford an overhead cover. Occasionally, around ponds where shallows are absent, stumps of trees, fallen logs, and trees fringe the edge, and their roots extend out into the water. These are favorite transformation sites for the species. At this period they are present in hundreds, or even thousands. The transformed individuals present a spirited sight as one approaches. They are shy, and long before one gets within range start skipping over the vegetation, giving the alarm note so characteristic of the species when surprised. Equally interesting is it when they occupy perches along the stumpy edges of deep ponds. It seems as if a wave of little bullfrogs keeps going before one as he skirts the pond. Inasmuch as this species requires two years to mature, it might naturally be expected that with varying conditions the tadpoles would be of diverse sizes at transformation, due to inequalities of growth. This supposition is borne out by observation. In none of the species under consideration is there such a range of size at transformation as in the bullfrog, which at this period varies from 1.7 to 2.35 inches in length, with an average of 2.1 inches. (See fig. 2 and Pls. XXI, fig. 1, and XXII, fig. 1.)

Some of the southern bullfrog tadpoles may transform in the very last of May, and the minimum transformation size recorded is $1\frac{3}{4}$ inches. (See fig. 2.)

Possible Species.—The toad tadpole is among the first of the season to transform. When transformation is taking place, the shores of some ponds are black with myriads of little toads, their numbers being particularly noticeable when they leave the shores and cross near-by roads and streets. Transformation begins the last of June and may continue into August and rarely into September. The author's earliest record of transformation is June 8. The average date is June 21. The size at transformation is small, ranging from 0.3 to 0.5 inch in length, the average being 0.4 inch. (See fig. 2 and Pls. XXI, fig. 8, and XXII, fig. 10.)

The wood frog usually begins transformation about July 1. The transformation may begin as early as June 8 or extend to August 1, and the transformation size varies from 0.5 to 0.85 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 6, and XXII,fig. 8.)

The hermit spadefoot toad transforms from June to August and ranges in size from 0.3 to 0.5 of an inch at the time of transformation. (See fig. 2 and Pl. XXII, fig. 11.)

Undesirable Species.—The undesirable forms, when full grown, are small and the young transformed frogs are also small of size, none of them ranging over 0.8 of an inch and most of them having an average size of 0.3 to 0.7 of an inch.

The narrow-mouthed toad tadpole may transform from the middle of June to September or October. The average size at transformation is 0.5 of an inch. (See fig. 2 and Pl. XXII, fig. 9.) The tree toad transforms largely during the last of July and the first of August. The size at transformation varies from 0.5 to 0.8 of an inch, the average being 0.6 of an inch. (See fig. 2 and Pls. XXI, fig. 5, and XXII, fig. 15.) The peeper tadpole usually begins to transform as early as July 1, although the average date is July 6. The range of transformation is from June 12 to August 1, and the range of size is 0.35 to 0.55 of an inch, the average being 0.4 of an inch. (See fig. 2 and Pls. XXI, fig. 7, and XXII, fig. 16.) The swamp cricket frog usually has finished transformation by July 1 and may transform as early as June 1. At transformation the frog is 0.3 to 0.5 of an inch in length. (See fig 2 and Pl. XXII, fig. 13.) The cricket frog transforms from June 1 to July if the eggs be laid early, or in August if the eggs be laid in June. At transformation it averages a greater length than the swamp cricket frog, being 0.5 of an inch in length. (See fig. 2 and Pl. XXII, fig. 14.)

RATE OF GROWTH.

The rate of growth from transformation to the full-grown adult condition (fig. 2) is very important. If a frog requires a long period to reach adult estate, then such a factor is one item which militates against the species as a desirable frog for cultural purposes; and other favorable factors must counterbalance if the species is to be kept in the preferred list. If, in nature, two years are required for the bullfrog to pass through the tadpole stage and five or six years more to reach a length of 6 inches, in order to make its cultivation worth while, the dangers and enemies to which it is subjected during those seven or eight years must be overcome or reduced, or else the numbers of bullfrogs must be increased by careful handling to allow for the great losses in the course of their growth. Through many years the growth of our food fishes has been observed at our numerous fish hatcheries, but there is next to nothing in the literature of this country concerning the growth of frogs. Some authors have assumed that if, just previous to hibernation in the fall or at the outcoming in the spring, the collector found three or four groups of different sizes, these groups had been hatched in as many succeeding years. There are, however, great variations. A species which laid from May to August might, in the following August, include some frogs $1\frac{1}{3}$ of a year old and some 1 year old. For growth studies it is imperative that not only the average and range of transformation size, but also the time of transformation, be known; for example, a small frog little beyond the transformation size if found in May must be almost a year old, because rarely, if ever, does any frog transform earlier than June. The results which the writer presents in the following table are merely tentative conclusions based only on measurements of frogs of all sizes collected at random over a period of 10 years.

Estimated Sizes, Range, and Average of Certain Frogs at Yearly Intervals of Growth, Shown in Inches.

	Transformation.		1 year old.		2 years old.		3 years old.		4 years old.	
	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.	Range.	Average.
Pickerel frog	0.75–1.1	1.0	1.1 –1.75	1.5	1.75–2.1	1.875	2.1 –2.45	2.3	2.45–2.75	2.6
Leopard frog	.72–1.25	1.0	1.25–1.75	1.5	1.75–2.2	2.0	2.2 –2.5	2.35	2.5 –3.0	2.7
Green frog	1.1 –1.5	1.3	1.5 –2.05	1.8	2.05–2.6	2.25	2.6 –3.15	2.85	3.15–3.85	3.5
Bullfrog	1.7 –2.35	2.1	2.35–2.85	2.6	2.85–3.6	3.25	3.6 –4.4	4.0	4.4 –5.2	4.75
Wood frog	.5 –0.84	.62	.84–1.15	1.0	1.15–1.59	1.375	1.59–2.05	1.8	2.05–2.55	2.25
Tree toad	.56–0.81	.62	.81–1.15	1.0	1.15–1.6	1.375	1.6 –2.0	1.8	....	......

In most of these forms the frog reaches the breeding condition in four years, and in the case of the pickerel frog, leopard frog, and green frog some individuals may possibly breed when 3 years old. The bullfrogs which reach 7 or 8 inches in length must require seven or eight years for such a growth. In all the forms, a growth of an inch a year is unusual, the normal rate being from 0.35 to 0.75 of an inch a year. The wood frog reaches maturity in four years, and the tree toad in three years. In both, the rate of growth is apparently about 0.35 inch a year.

FOOD.

The food problem is one of the crucial questions in the feasibility of frog culture. No very systematic seasonal study of the food of our frogs has ever been undertaken and successfully completed. The toad has been quite thoroughly studied throughout its feeding season.[a] The best food investigation of any of our frogs (*Rana pipiens*) covers a very short feeding period from August 8 to 22,[b] while the food of the bullfrog has aroused interest and some attention because of some of its bizarre tendencies. As a consequence, the food of the tadpoles, transformed frogs, and adults of our commoner species can not be spoken of as positively as would become scientific parlance. A summary of what has appeared will have to suffice until comparative studies which are in progress are forthcoming.

FOOD OF TADPOLES.

In the earlier days armchair scientists held that the food of a tadpole had to be almost or quite wholly vegetable in nature, because of the elongate intestine the creature possessed; but even casual observers have noted with what avidity tadpoles assemble around a dead fish. The taxidermist knows very well to what a bone-clean condition tadpoles reduce carcasses of mammals, birds, or cold-blooded vertebrates. Several experimenters in frog culture have maintained that they could raise tadpoles on dressed submerged fish or on liver, a well-known fish food. These animal tendencies in the diet of an apparent vegetarian extend even to the devouring of their own kind under stress of unusual circumstances. It must, however, be remembered that most of this animal food, if not all of it, is dead and immobile. Seldom do they prey on larger aquatic animals or even on the smaller forms, unless these incidentally occur in the food stream which is mainly vegetable in character. Their animal-feeding proclivities are mainly those of scavengers, and it is therefore hardly correct to call them carnivorous or omnivorous, as has been done by some. Up to the present time there has been no serious extended examination of the food of tadpoles, because of the enormity of the task and on account of the previous uncertainty of the identification of the frog species to which they belonged.

FOOD OF TRANSITION STAGES.

This period when the tadpole changes to a small frog is a critical time in the life history of any individual frog and is in many ways the most important point of attention for the frog culturist. The creature makes a complete change of form, becomes truly carnivorous, spends some of its life on the banks or in the fields, and therefore can not be expected to adjust itself in an instant to a new existence. Dr. Philip A. Munz, who is studying the food of transforming and transformed frogs, presents the following preliminary and provisional summary from his examinations:

> Thus far a fairly representative series of each of the following species of Rana has been studied: *R. catesbeiana*, the bullfrog; *R. clamitans*, the green frog; *R. sylvatica*, the wood frog; and *R. palustris*, the pickerel frog. In each species the same general tendencies are evident:

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[a] Kirkland, A. H.: The habits, food and economic value of the American toad. Hatch Experiment Station of the Massachusetts Agricultural College, Bulletin 46, April, 1897, Amherst, Mass.; also, Usefulness of the American toad, U. S. Department of Agriculture, Farmers' Bulletin No. 196. Washington, 1904.
Garman, H.: Kentucky Experiment Station Bulletin No. 91. 1901.
Hodge, C. F.: Nature study leaflet. Worcester, Mass., 1898.

[b] Drake, Carl J.: The food of *Rana pipiens* Schreber. Ohio Naturalist, March, 1914, Vol. XIV, No. 5, pp. 267–269. Columbus.

(1) The larval alimentary canal is very long, but slightly differentiated in its various portions and filled with ooze and silt scraped up from the objects in the pond and containing many species of diatoms, blue-green and green algæ of filamentous and nonfilamentous forms, small pieces of green plant tissue, and bits of fibers and other nondecaying material found in ooze. As yet I have found no tadpoles containing animal tissue, but as is generally known, they nibble off small pieces of flesh when it is available. Insects, mites, spiders, etc., are quite universally absent from the larval food; even the small water crustacea are rarely met with.

(2) After the fore and hind legs are both in evidence and the horny plates of the tadpole mouth are shed, the tail is gradually shortened and the alimentary canal shortens to become dilated anteriorly and posteriorly, forming the stomach and the rectum, the latter communicating with the cloaca. During this time there is practically no food taken in, although the fat in the body cavity is scarcely reduced in amount; evidently the material available as the result of the absorption of the tail is sufficient. The epidermis is evidently shed often during the absorption of the tail; for in many cases, especially in the bullfrog which is large enough for it to be more apparent, epidermis is present in the alimentary canal; this tendency to swallow the cast epidermis seems quite universal. Occasionally a few algal filaments seem to become entangled in it and are then present in the stomach contents.

(3) After the tail is reduced to a mere remnant with a length of 1 to 2 millimeters (0.4 to 0.8 of an inch) and the mouth has increased to several times its former size, the alimentary canal has become from one-sixth to one-tenth of its larval length, and the young frog again begins feeding, now taking mostly animal food. The range of forms consumed is very great, each species of frog apparently eating anything alive and moving and yet small enough to swallow. Crustacea, Isopoda, Acarina, Arachnida, and almost every group of Insecta have been found. The forms fed upon are not aquatic to any extent, but feeding is done largely above and near the water. Naturally such life as is to be found on or near the ground is most available and the stomach content is largely ground beetles, plant lice, springtails (Collembola), leaf hoppers, snout beetles, spiders, mites, sow bugs, ants, and small flies. Of the molluscs, snails are occasionally met with, and of the vertebrates only a few have been observed, such as young frogs and toads in young bullfrogs.

The differences in selection of food may come under two categories: (*a*) Those due to the size of the species of frog—the bullfrog, for example—can and does eat much larger forms than can the smaller species, and yet it also takes the smallest mites; and (*b*) those due to the location and nature of the ponds from which the specimens were taken; for in different locations are to be found different food materials. But as yet I have been able to observe no difference in the range of insects or other forms eaten by each species,

By way of summary, then, the tadpole is largely herbivorous; the transforming individual does but little or no feeding, and the young frog is carnivorous, eating plant and inorganic materials perhaps as a matter of accident while seizing insects or other prey.

FOOD OF ADULTS.

Growing and adult frogs are carnivorous. To be sure, they may accidentally take in vegetation or mineral matter, but this is an incident to their pursuit of moving prey or synchronous with the swallowing of their own cast skins. If their prey remains quiet it may escape. If our frogs pursued their prey in the water as do fishes there would be no particular need for a tongue, and some of the most aquatic frogs of the world have little or no tongue as a consequence. Practically all of the frogs of the United States are possessed of a good, thick, adhesive protrusible tongue, which is fastened at its forward end. The posterior end of the tongue can be shot forward and then quickly retracted with the prey affixed or held.

It must be remembered that our frogs do not pursue their prey beneath the water; therefore it becomes evident that practically all food prehension for our species takes place at or above the water's surface, on the shores of bodies of water, on the banks of streams, in the meadows, or in some cases in the trees. Some remain in favorable position and capture the passing prey; others hop toward their prey until within range; still others occasionally stalk their prey; and a fourth group, like the tree frogs, may at times leap into mid-air for their game.

The tongue is the main organ of prehension, but the forefeet are often used in a ludicrous manner to help in forcing into the mouth a difficult or cumbersome object. If one tries to force food or other objects into the mouth of a captive frog, however, the same feet may often be employed to prevent the operation.

A general summary of the various food elements as thus far determined by previous authors follows.

Vegetable matter.—What Kirkland [a] found true for the toad obtains more or less for our species of true frogs. He held that—

> Vegetable material formed less than 1 per cent and from its character appears to have been taken by accident and can not be properly considered as food. Since the toad takes the greater part of its food from the ground by means of its large, fleshy tongue, nothing can be more natural than that a small quantity of vegetable detritus should be swept into the mouth along with the insects on which the animal feeds. The most common vegetable substance found in the stomachs is grass, both dry and fresh. Bits of rotten wood, broken acorn shells, seeds of the linden (*Tilea americana*) and maple (*Acer saccharinum*) and bits of apple parings have also been detected. All these vegetable substances were usually associated with a large quantity of ants and other terrestrial insects.

Possibly the more aquatic frogs, like the bullfrog and green frog, might take more vegetable matter than the more terrestrial leopard frog or wood frog. The former have a feeding ground where the algal carpet of the water's surface may be the alighting ground for the prey, or where the wet, broken vegetation of the shore may be the hiding ground of numerous insects.

Mineral matter.—Of this habit Kirkland writes the following: [a]

> The mineral matter found in the stomach forms slightly more than 1 per cent of the total contents and consists of gravel, sand, and, in a few cases, coal ashes. When a large piece of gravel is swallowed it is regurgitated; this I have proven by experiments on toads in confinement. Otherwise the gravel passes through the alimentary canal and may be found in the castings. Since the toad does not masticate its food, but depends on the stomach for the whole process of trituration, it is probable that the gravel when present assists in grinding the strongly chitinized bodies of beetles, etc., yet in the majority of the toads examined there was no gravel present in the alimentary canal, although many of the stomachs contained finely ground beetles. A proper inference from the above is that gravel is not essential to digestion in the toad, and the writer inclines to the opinion that, as in the case of the vegetable matter, the presence of gravel in the stomachs is the result of accident rather than of design.

Animal Matter.—No doubt, in the case of our four principal commercial species this element constitutes from 97 to 98 per cent of the food, as in the toad.

Mollusks.—Mollusca are seldom eaten by the wood frog and pickerel frog and constitute about 1 per cent of the food of the toad and about 3 per cent of that of the leopard frog. Mollusca no doubt enter to an appreciable extent into the diet of the more aquatic forms of anurans. Surface [b] found the green frog alone had eaten mollusks to any extent, while Dyche [c] found 12 of his 30 bullfrogs had eaten snails, one having 9 in its stomach.

Worms.—These enter into the nocturnal toad's diet more than into that of any other species and constitute 1 per cent of its diet. Worms

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[a] Kirkland, A. H.: Loc. cit., pp. 13-14.

[b] Surface, H. A.: Bi-Monthly Zoological Bulletin. Division of Zoology, Pennsylvania Department of Agriculture. Vol. III, Nos. 3 and 4. 1913.

[c] Dyche, L. L.: Ponds, pond fish, and pond-fish culture, pp. 150-153. State Department of Fish and Game, Kansas. Topeka, 1914.

have been recorded in the food of the leopard frog but are rare in the food of the other four common species of frog.

Spiders.—Spiders and their relatives are eaten by the smaller forms like the cricket frog, swamp cricket frog, peeper, and tree toad, as well as by all of the larger forms. "Spiders occur in the stomachs of the toad in all months, but form only 2 per cent of the total food."[a] In the case of the leopard frog, according to Drake,[b] they constitute 27 per cent of the food of the species and are, next to beetles, the largest single item, while in the wood frog, pickerel frog, green frog, and bullfrog, spiders form 8 to 12 per cent of the food of these forms.

Crustaceans.—The smaller forms, like the cricket frog, swamp cricket frog, peeper, and tree toad, very rarely, if ever, eat small crayfish, and only in very shallow water or in pools which are drying up do the leopard frogs attempt an extensive diet of crayfish. There are no records of these creatures being used as food by the pickerel frog, wood frog, or toad, the two latter being quite terrestrial. The more aquatic creatures—that is, the green frog and the bullfrog—eat them, the first to the amount of 4 or 5 per cent, while the last, being larger, makes them 20 or 25 per cent of its whole diet. The opposite condition obtains in the case of the sow bugs, since the bullfrog does not eat them and the green frog very seldom, while the more terrestrial leopard frog may make sow bugs 4 or 5 per cent of its food. These creatures form 2 per cent of the toad's food, and the pickerel frog also occasionally eats them.

Myriapods.—"Myriapods [according to Kirkland [a]] form a constant article of diet for the toads. * * * These creatures form 10 per cent of the food for the season." They constitute 1 or 2 per cent of the food of the leopard frog, 4 or 5 per cent of the food of the pickerel frog, and 5 or 6 per cent of the food of the green frog.

Insects.—Insects are the main food reliance for frogs, tree frogs, and toads. Five orders, possibly a sixth (Diptera), enter largely into their dietary list. The five principal orders are Coleoptera, Lepidoptera, Hymenoptera, Hemiptera, and Orthoptera. The evidence serves again to prove that these amphibians get most, if not all, of their food above the water or outside of it.

Coleoptera, mainly ground, lamellicorn, and click beetles, and weevils constitute 27 per cent of the food of the toad, while in the animal food of the leopard frog beetles form 33 per cent of the whole, the principal groups being ground, tiger, and snout beetles. In the food of the wood frog, pickerel frog, and green frog the proportion is equally large, while in the diet of the bullfrog the beetle element is surprisingly large; no doubt, water beetles of the surface enter into the food of the bullfrog more than into that of the other species of frog.

Lepidopterous (moths and butterflies) larvæ prove very tempting morsels to toads and make up 28 per cent of their food, while this order constitutes 13 per cent of the leopard frog's diet, about 15 to 17 per cent of that of the wood frog, pickerel frog, and green frog, and only about 5 or 6 per cent of that of the bullfrog.

Hymenoptera form an appreciable part (19 per cent) of the food of the terrestrial forms like the toad. In the diet of the smaller tree frogs and of the young of the larger forms, hymenoptera (ants, etc.),

[a] Kirkland, A. H.: Loc. cit., p. 15. [b] Drake, Carl J.: Loc. cit., p. 265.

together with flies, replace the beetles of the adults. In the food of the wood frog and of the pickerel frog this order of insects constitutes 4 per cent, or less, and is a negligible factor in the green frog's and bullfrog's diet.

Orthoptera: Roaches, crickets, and grasshoppers make up a prominent part of the food of the adult leopard, wood, and green frogs, while mole crickets not infrequently enter into the diet of the bullfrog. Orthoptera furnish 3 per cent of the animal food of the toad.

Hemiptera: Bugs enter but slightly into the food of the wood frog and bullfrog, form less than one-half per cent of the food of the toad, 4 per cent or less of the leopard frog's diet, 8 per cent of that of the green frog, and 12 per cent or more of that of the pickerel frog.

Diptera: Flies and their relatives form 1½ per cent of the food of the leopard frog and one-half per cent of that of the toad. They are rather a negligible factor in the food of the large forms, while in such creatures as the cricket frog they may play a prominent rôle.

Vertebrates.—Vertebrates enter but seldom into the diet of any but the largest forms, such as the bullfrog. Dyche[a] records the finding of bullheads, crappies, sunfish, goldfish, bullfrog, and other frog tadpoles in the stomachs of bullfrogs. There are extant records of unusual food, like young ducklings, sparrows, mice, snakes, and young newly hatched alligators, in the food of this same species. The other frogs are too small of maw to essay the devouring of any vertebrates.

ENEMIES.

No article is more sought for or more relished as a food by a diversity of animals from fish to man than frogs. The latter's defense consists in concealment and in the possession of poison glands in the skin, neither of which means is aggressive in its nature. Insects and plants may prove a more constant fare, but to any fair-sized animal a frog diet is one of the preferable menus, if obtainable.

Invertebrates: One would naturally think the insect and small animal life of the inland waters was a negligible factor in the reduction of the number of frogs, tree toads, and toads. But for the tender early larval stages and even for the more mature tadpoles these are very serious foes. Anyone who has collected a miscellaneous mass of aquatic life and put it all in one jar knows from dear and sad experience that these small creatures of the water often prey upon and kill the confined tadpoles and small frogs. In the open, especially at night, has the writer seen adult peepers and swamp cricket frogs or their tadpoles in the fatal grip of giant water bugs. Other aquatic bugs, like the well-known Zaitha, walking sticks, and, not least, the back swimmers, make life precarious for tadpoles or miserable for adult frogs in the water. The water beetles, especially their larvæ (water tigers) and dragonfly nymphs also take their heavy toll of tadpole lives. Many of the smaller, almost microscopic, crustaceans, like daphnia and others, are reputed to be incessant enemies covering the whole bodies of the tadpoles. Some of the larger crustacea, like the crayfish, may possibly take the live tadpoles, but it can not be definitely stated that they do. Mosquitoes, gnats, etc., pester frogs and tree frogs when out of the water, but in general little is known of this matter, because it usually happens at night when man is seldom observant.

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[a] Dyche, L. L.: Loc. cit., pp. 150–153.

Fishes.—Fish which are almost wholly restricted to the same habitat as frogs might be considered the most serious foe of the early aquatic stages of the frogs and toads. It is very doubtful, however, if their depredations compare with those of the aquatic snakes. In the quiet waters where tadpoles frequently resort the worst depredators are the members of the pike family. From the lunge down to the little grass pike is a series of forms which revel in frogs and their tadpoles. Equally appreciative of small frogs and tadpoles are basses, but some of the larger, like the smallmouthed bass, are not abundant in the habitat of frogs. Forms of the quiet water, like the largemouthed bass and sometimes the rock bass and others of similar habits and of equally large maws, feed on them. The omnivorous catfishes sometimes eat the young tadpoles, the growing frogs and the trouts especially do. The horned dace and some of the larger voracious minnows occasionally eat the newly hatched larvæ of frogs.

Amphibians.—The aquatic salamanders, like the newt, frequently pull off eggs from a frog's egg mass for food. The larger forms, like the mudpuppy (Necturus) and hellbender (Cryptobranchus), may eat frog's eggs or larvæ if favorably situated. Among frogs there are several species whose adults do not stop at fratricide or cannibalism. In fact, it is one of the factors which has led some frog culturists to abandon bullfrogs, which will feed on anything from insects to small alligators, not even sparing their own progeny.

Reptiles.—In this group we find some of the most inveterate and merciless foes of frogs. In the southern States an archenemy is the alligator. Among the turtles the snapping turtles lie in wait for frogs and their tadpoles, while the more alert and active soft-shelled turtles may at times pursue them. The equally vicious musk turtle also is a foe of the frog. The spotted and painted turtles and some of the other "sliders" or so-called terrapins are said to feed on tadpoles, but of this the writer has no first-hand evidence.

The snakes, both aquatic and semiaquatic, are the worst pests the frog has to meet. Among the cold-blooded vertebrates there is no more relentless preying of one thing upon another than the persistent hunting by day or, better, by night of a ribbon snake or water snake for frogs. In fact, frogs are, par excellence, the food of the aquatic snakes. Several of the semiaquatic garters eat or prefer true frogs, cricket and swamp cricket frogs. The very aquatic water snakes (Tropidonotus) of several species, are the worst offenders and at times feed exclusively on frogs. The rainbow and red-bellied (Farancia) snakes also feed on frogs or their tadpoles. On the land the spreading adder is the main enemy. The black snake and garter snakes are quite partial to them, and the pilot snake, copperhead, or ground rattlesnake do not scorn them.

Birds.—Whoever plans to raise frogs must beware of several of our largest and most distinctive forms of birds. The herons and bitterns are the most serious frog eaters. Their long legs and toes equip them for wading, and their long necks and bills are adapted either for a silent waiting game or a slow, stalking search. They frequent the shallows where the tadpoles and transforming frogs are abundant. The great blue heron, the little green heron, the little blue heron, and some of the less familiar forms of the South wait long periods or slowly patrol in the open stretches of lakes, ponds, and streams for their game. The bitterns inhabit the cover of the marshes and stalk their prey. Among the hawks, the various species of kites feed upon frogs, but because of their rarity are a negligible factor. The marsh hawks eat some frogs. The despised Cooper's hawk rarely takes to a frog diet, while the red-shouldered hawk and sometimes the broad-winged hawk eagerly seek frogs. Into the diet of owls frogs seldom enter, the barred owl most frequently being the depredator. W. B. Barrows [a] found that no food occurs more regularly in the crow's stomach than frogs and toads. In April to July it is the largest live animal item, except insects, in the crow's diet. Of the kingfisher frogs need to beware, though they are seldom seen with frogs or tadpoles, fish being the usual fare. Bronzed grackles eat frogs but rarely. The totipalmate birds, like the snakebird, cormorant, and pelican, are largely fish eaters, but they, no doubt, pursue and capture some frogs. Several ducks are reputed to eat frogs, and one, the hooded merganser, is often called the "frog duck." It would also be well to bear in mind the charge that domestic ducks eat the tadpoles and occasionally the transformed and transforming stages.

Mammals.—In this country the four-footed mammals which eat frogs are very few. Most of these belong to the weasel tribe. The skunk enjoys a good frog when he can catch it, and the mink quite frequently varies his diet with them. The weasels are occasional depredators, but are not comparable to the house or brown rat, which tries anything and everything it can catch. The muskrat is a nuisance in any pond and should be held with suspicion, as should the raccoon. Some individual domestic cats have been known to develop a fondness for frogs, and particularly for tadpoles.

Man is not content with cleaning up and draining the "frog holes" or swampy stretches, but he kills the frogs at all seasons. Few, if any, of our State legislatures see fit to protect them and establish open and closed seasons. As a result, they are taken mainly when they congregate for breeding purposes, and such a toll hardly accords with the ideas of conservation held at the present day.

Nine-tenths of the wild supply is secured at the breeding season or just before breeding. Such a profligate expenditure can not long escape our attention. As thoughtless youths many of us often counted our strings of 100, and some of us hunted them regardless of the season.

In the eastern United States the four important commercial forms should not be killed in the wild state before the following dates:

Leopard frog	May 1, or, better, May 15.
Pickerel frog	May 10, or, better, May 20.
Bullfrog	July 1, or, better, July 15.
Green frog	July 15, or, better, August 1.

[a] Barrows, W. B., and Schwarz, E. A.: The common crow of the United States. U. S. Department of Agriculture, Division of Ornithology and Mammalogy, Bulletin No. 6, pp. 50, 51. Washington, 1895.

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HUGH M. SMITH, Commissioner

FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY

By H. WALTON CLARK
Scientific Assistant

AND

JOHN B. SOUTHALL
Shell Expert, U. S. Fisheries Biological Station, Fairport, Iowa

APPENDIX VII TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1919

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CONTENTS.

FRESH-WATER TURTLES: A SOURCE OF MEAT SUPPLY.

By H. Walton Clark, *Scientific Assistant*, and John B. Southall, *Shell Expert, Fisheries Biological Station, Fairport, Iowa.*

INTRODUCTION.

Among the aquatic food resources of the United States to which but little attention has as yet been given are the several species of edible turtles and terrapins of the rivers and lakes. One species of turtle, the famous and much-sought-after diamond-back terrapin, has indeed long been utilized to the fullest extent consistent with the preservation of the species; and in recent years its propagation on privately controlled farms has been inaugurated. The green turtle of the sea has also for a long time been so generally esteemed and extensively fished as to have been brought into actual danger of extinction. It is worthy of note that, while these two species have been regarded as delicacies of a high order, their relatives of the interior waters have been comparatively little utilized, at least under their proper names. It seems quite probable, however, that certain species of fresh-water terrapin have been rather widely used as an illegitimate substitute for the diamond-back terrapin. Within the last year or two a more general interest in the subject of the use of fresh-water turtles as food appears to have developed, and the Bureau has received many inquiries for information in regard to methods of capture of turtles and the preparation of their meat for the table. It is the aim of the present paper to supply answers to these inquiries, so far as the information is at present available. The data herein presented have been secured by the authors through correspondence with dealers in turtles and by personal visits to many markets in the larger and smaller cities of the Middle West and to various points of commercial fishery, principally on the Mississippi and Illinois Rivers.

THE SNAPPING TURTLE.

DISTRIBUTION AND HABITS.

Commercially speaking, by far the most important species of the Mississippi Basin is the snapping turtle, *Chelydra serpentina* (Linnæus) (Pls. I and II), known also in different localities and under different conditions as the snapper, mud turtle, and mossback. Its position in the market and in the consciousness of the people, the methods of its capture, and the like, are so closely bound up with its natural history that, in order to properly estimate its economic status, it is necessary to give in some detail the main facts regarding its habitat and habits.

In the first place, it has a broad geographic distribution, its rang extending from Nova Scotia to the Equator and westward to th Rocky Mountains. It is, therefore, one of the most widely known o turtles; and the New Englander who has migrated to the banks of th Wabash, the Ohio, or the Mississippi, or to the prairies of Illinoi recognizes it at once as an old acquaintance. This wideness of dis tribution indicates a hardiness and an ability to live under greatl varying conditions.

Not less important than its wide geographic distribution is it varied habitat. It is found in a great many different situations— in lakes, ponds, rivers, creeks, marshes, and bogs, and often travel overland a considerable distance from water. Only those familia with the faunas of woodland ponds know the pretty, speckled tor toise; only the travelers along shaded creeks know Blanding's turtle and to those who dwell afar from the larger lakes and rivers th soft-shell is known, if at all, only through the medium of books o museums. There are few, however, to whom the snapping turtl is a complete stranger.

In addition to its great variety of habitat, the leisurely habits o the snapper make it familiar. When approached it does not beat a hasty retreat, as do most other animals, but holds its ground agains all comers. Many who are fairly familiar with the pond turtle and terrapin know them principally as a sudden splash from a log and many who visit the sand bars where the soft-shells love to bas know them principally as a streak over the sand, as a splash at th water surface, and as a wake like that made by a big fish. The snap per, however, is the living embodiment of the status quo. He is will ing to wait for the closest and most scrutinizing inspection; and closely gazed upon, his appearance may have much to do with hi being used as an article of food. One could not exactly call hin handsome; a better statement would be that he looks good enough t eat. His corpulent, bulging body, projecting in rolls from his inade quate shell gives above all else the impression of meatiness. Th rough skin, not greatly unlike that of a freshly plucked chicken, an the narrow cartilaginous bridge and small plastron all suggest eas preparation, much edible material, and little waste.

All the other details about this species—manner of capture, th peculiarities of the market, and, finally, the methods of cooking— are, as will be observed, closely connected with its life history an habits.

SEASONS AND METHODS OF CAPTURE.

During the summer the snappers are rather unsocial. They ar solitary in habits, the individuals being widely scattered, so that it i difficult to take an accurate census of them. Because of these solitar summer habits, there is, generally speaking, very little fishing fo this species in that season. There may, of course, be local exceptions thus it was reported that throughout at least part of the summer o 1913, along the Grand River, Mich., there was an active turtle fishery both snappers and soft-shells being caught in seines and shipped to th large near-by cities, such as Detroit and Chicago. In general, how ever, the summer is a dull season for turtles. One market man re marked that "the turtle is like the oyster, only in season when th name of the months contains an 'r.'" Nearly all the other market men explained the situation by saying that "practically all the turtles are used for soups, and few people eat soups during hot weather." The situation is perhaps a little more complicated; it may have to do also with capture and storage. In summer occasional snappers are picked up while on their migrating trips; a few are now and then caught on set lines; and fishermen sometimes catch them in their seines or in baited hoop nets set for fish. It is doubtful whether any of these occasional summer-caught snappers get into the general market. The greater number are released, and a few are locally consumed.

During the autumn and early winter the snappers collect in considerable numbers and hibernate in suitable locations. In the vicinity of Muscatine, Iowa, it was stated that a favorite place for turtles to hibernate is in muskrat holes. According to report, as much as 5 tons of turtles have been taken from the various muskrat holes in one season. Our informant also stated that as many as 26 individuals have been found in one muskrat burrow, while at another time 1,420 pounds were obtained in one run. From 500 to 1,000 pounds of turtle were estimated as a recent catch for one day.

Along the sloughs of the Mississippi they congregate about and under old logs. A specific instance was cited of a fisherman who obtained 20 snappers, weighing from 10 to 20 pounds each, under a log in one of the sloughs of the Mississippi River.

Along the Illinois River, the Cedar River of Iowa, and, indeed, wherever there are springy places near large bodies of water, the snappers "mud up" for the winter.

It is from their hibernating places that the greater number of snappers found on the market are taken, and the captors are usually fishermen or trappers. The methods of capture employed for the various forms of winter quarters—whether muskrat holes, old logs, or springy places—are all, so far as could be learned, very much the same. The implement used is a stout hook, made by bending an iron rod at one end, sharpening the short or hook end, and leaving the other as it is or driving it into a wooden handle to make it better to manipulate during very cold weather. If there is much ice, it is cut and the hook probed or prodded about until a turtle, which feels much like a chunk of wood, is encountered. It is then pulled out by the hook. It is somewhat difficult to land large turtles, although they are benumbed and offer little resistance. The turtle catchers rely upon their hunting instinct to discover the turtles, and when a good place is found many can be taken from it, as indicated in the account given above.

Activity in snapper catching may be stimulated or depressed by widely different circumstances. The general wage scale probably has little influence, since fishermen and trappers are as much attracted by the fascination of their calling as by its emoluments and are not likely to desert their profession for a better-paying job. A high price for pelts and furs may divert greater attention to trapping. One fisherman said that the existence of saloons greatly helped the turtle market, as they dealt extensively in turtle soup. Under favorable conditions the turtle catcher can make very fair wages and still sell the meat at a reasonable price. During the winter of 1918–19 a market man reported: "Turtle meat is the cheapest meat I can buy."

SHIPMENT AND STORAGE.

Generally speaking, the men who catch the turtles make no attempt to hold or store them but ship them to market as soon as they can collect a sufficient quantity.

The turtles are usually shipped in barrels with holes bored through the bottom and through the sides for ventilation and with burlap nailed over the top. In this condition, of course, the contents are not open for observation, and a thriving turtle fishery may be in active operation in a particular region unknown to the general public. Since barrels have become expensive, the catches are sometimes shipped in crates similar to those used for chickens.

Upon arrival at the larger markets the containers may simply be stored in a cool place, where the turtles will remain in hibernation, ready for disposal by wholesale or retail as the market demands. It is with the return of warm weather that the storage question becomes important.

A good many dealers do not attempt to hold turtles at all but pass them to the consumer as rapidly as possible. In the basement of a large wholesale market at Chicago, a cool moist situation, there is a large turtle pen, or, rather, a series of pens, which will hold about 2½ tons of the living animals. They do very well here until summer arives, when the loss is considerable. Here the snappers are washed off occasionally, but the problem of feeding them has not been satisfactorily solved.

It might do much toward stabilizing the market if the intermediate buyers along the rivers, in order to be ready for early fall delivery, would establish large pounds to retain the spring catch, as well as the occasional turtles taken during the summer. It was stated that there was formerly a storage pen at Clear Lake, Ill., where 25,000 or 30,000 turtles could be satisfactorily kept; but that in recent years, owing to changed stream conditions, together with the consequent diminution in abundance of the animals, the pen has been abandoned. At Grafton, Ill., a pound was observed which has been in existence about four years and which was originally designed to retain carp, as well as turtles and terrapin. It is located near the river and comprises a pond supplied by seepage from the river and by rainfall. The size of the pond varies, therefore, according to weather and stream conditions, but at the time observed its dimensions were about 207 by 135 feet. This pond, having banks of considerable steepness, occupies nearly the entire area of the pen. The walls are riprapped with stone and surmounted by a wire fence of 1-inch-square mesh. The pound was said to contain 4,000 or 5,000 terrapin and 2 tons of snappers. It was observed at Grafton, as elsewhere, that quantities of terrapin are always estimated by number, and snappers by weight. Two kinds of terrapin were distinguished; the river terrapin described as "rough," which proved upon examination to be *Graptemys lesueurii*, and the "pond terrapin," described as "striped," which proved to be *Pseudemys elegans*. The former was regarded as much superior to the latter. During the summer, according to information furnished the authors, the turtles had been fed on fishery waste and on hog lights, of which they appeared to be very fond. They were being shipped to the markets of Boston and Philadelphia.

SOURCES OF SUPPLY.

Dealers at Chicago mentioned their source of supply as the Central States—Wisconsin, Minnesota, Iowa, Indiana, South Dakota, and Michigan—although they also received snappers and terrapin from Kentucky. Specific localities mentioned were Winona, Minn., and Guttenburg and Muscatine, Iowa. At one time the Illinois River was an important source of supply during the winter, and parts of it, especially toward the mouth, continue to be so. Kofoid states:[a] "The Illinois River and its backwaters, under present conditions, contribute annually * * * 15,000 dozen turtles" (probably including both snappers and terrapin). During the progress of the investigation of the Upper Illinois in June, 1918, there was no fishing at all on account of the closed season on fishes and, naturally, no capture of turtles.

MARKET CONDITIONS AND PRICES.

The amount of turtles handled by the markets of the large cities does not, of course, indicate the quantity which is consumed locally. As stated above, the winter is by far the most active market season. However, along the rivers the turtles are eaten the year around, whenever they can be obtained, fried soft-shells being especially consumed during the summer. The wholesale market in Chicago previously referred to handles about 10,000 snappers a year, valued at $5,000. Its buyer thinks he could handle a ton a week. Another market handled 1 to 1½ tons a month. The snappers on the Chicago market range in weight from 5 to 25 pounds each. At Peoria they were said to reach a weight of 30 pounds, the average being 7 or 8 pounds. According to the census of 1908, the Mississippi River Basin produced 713,000 pounds of turtles and terrapin, with a value to the fishermen of $25,000.

In these days of uniform prices for standard commodities ,a striking feature of the turtle market is the variety of prices. A turtle catcher at Muscatine, Iowa, stated that he could get 5 cents a pound live weight or 10 cents a pound dressed at Davenport. He said there was more money selling them alive, as they dressed off more than half, and also the trouble of dressing them had to be considered. One dealer in Chicago sold in wholesale lots at 8 cents a pound and retailed at 10 cents. A buyer quoted them at 6 to 7 cents a pound live weight. At St. Louis it was said that "turtle meat is selling higher than ever before, it being now (June, 1918) about 18 cents; whereas it used to be from 12 to 15 cents a pound."

A published commercial price list (Chicago, 1918) quoted live snapping turtles, usually 10 cents per pound, falling to 9 cents for the week of June 8, to 14, and rising to 11 cents July 20 to 26, 1918, and turtle meat, strictly fresh, 16 to 17 cents, rising during the progress of the summer. In the early part of the season frozen turtle meat was listed at 15 cents.

Many of the points covered above regarding source of supply, prices, and amount handled can best be illustrated by quoting from

[a] Kofoid, C. A.: Plankton studies. IV. The plankton of the Illinois River, 1894–1899, p. 562. Bulletin, Illinois State Laboratory of Natural History, Vol. VI, 1901–1903, Art. II. Champaign.

a letter received June 4, 1918, from a fish company in La Crosse, Wis., which goes into the subject with unusual fullness of detail:

We receive turtles from all of the commercial fishermen of the Mississippi, no one in particular fishing for them especially, as usually they are caught in such small lots that the average fisherman does not make much of an effort to gather them up. Usually the price this last year has been from 3 to 4 cents, and, getting them in such small quantities, the fishermen figured not money enough in them to bother with them.

We also get quite a few from the Indians who are moving about up and down the river. The general selling price has been (Philadelphia) from 7 to 12 cents, the high price being in the extreme cold weather, and usually the wholesale price runs from 4½ cents f. o. b. shipping stations, and the average quotation from the wholesale houses in Chicago and other places is from 7 to 9 cents.

The following is the amount that we have handled since November, 1917, and conditions were such that we have had to carry quite a lot of this stock on hand, as we were unable to sell it at all times or very readily:

	Pounds.
November	13, 166
December	2, 551
January	1, 689
February	90
March	1, 496
April	5, 206
May	5, 411
Total	29, 609

The demand has been diminishing from year to year. Ten years ago we used to handle them by the carloads and could always find a ready market in New York, whereas at present there is very little demand in New York; in fact, practically none.

The kind of turtle we are handling is what is known locally as the mud or snapping turtle. There is some demand for the soft-shell turtles, but not enough to warrant our handling them.

At Grafton, Ill., it was stated that Boston afforded the best market for terrapin and Philadelphia for snappers.

PROPORTION OF WASTE.

In the consideration of any article to be used for food the item of waste is an important feature, since this must be accounted for somewhere between the producer, or in this case the captor, and the consumer. The opinion of dealers differed somewhat as to the amount of waste in the snapping turtle. It varies considerably according to the manner of cleaning. One dealer thought the turtles would dress off more than half, large ones dressing off less than small ones. Another thought a 12-pound turtle would dress off to 6 pounds, and a 5-pound one to 3 pounds. A dealer at Fort Madison, Iowa, said that by discarding the shell they would dress off two-thirds, but that the shell could be used in making soup, serving as a soup bone. One dealer added that "in making soup the liver and eggs are used, so there is not so much waste." In the Washington market some snappers were seen dressed for sale. The epidermis having been scalded off, and the scutes or epidermal plates of the shell removed, the remaining portion presented a very attractive appearance. Along the backbone of the turtle is a considerable mass of flesh known as "tenderloin," which in rapid or "shop" cleaning is discarded with the shell, but in careful cleaning is saved, thus reducing the waste. At Pekin, Ill., where turtles were cleaned rapidly, discarding tenderloin, liver, and eggs, as well as shell, a 14-pound snapper furnished 6 pounds of meat. At Fairport, Iowa, one which weighed 11 pounds produced 5½ pounds of meat when carefully dressed, with tenderloin saved, but shell, liver, etc., discarded. The relatively small difference in market prices between live turtles and turtle meat among practiced dressers and dealers (10 cents alive, 17 cents dressed) does not account for so much waste. since one must also consider the labor of dressing the meat.

In considering the subject of waste it may be of interest to compare turtles with other familiar objects, such as fish and poultry, which may be bought either whole or dressed to suit the wishes of the buyer. The proprietors of some of the fish markets on the Mississippi (Muscatine, Iowa, and New Boston Ill.) and on the Illinois (Peoria), who have much experience weighing fish, since they buy them living from the fishermen and sell most of them dressed, were consulted in this regard, and their reports agreed very closely. Carp were reported to dress off about 30 per cent, or from 30 to 40 or 45 per cent, the higher percentages applying to the females full of roe, which is usually discarded. Buffalofish were reported to dress off somewhat less than carp. Catfish differ greatly, according to kind and condition, but dress off on the average 60 pounds to the 100. At the Fairport biological station two ripe male carp weighting 5 pounds 8 ounces were dressed. The head, scales, and entrails weighed 1 pound 3 ounces and the milt 8 ounces, leaving the weight of the dressed fish 3 pounds 12 ounces, a waste of 31.8 per cent. In looking through publications at hand devoted to poultry, under the subject of waste, cocks were reported to dress off 23.4 per cent, cockerels 26 per cent, hens 24.2 per cent, and pullets 25.8 per cent of the live weight. These wastes, of course, leave bones out of consideration. For fuller estimates and comparisons of the absolute amount of wastes of various fishes the reader is referred to a publication by Dr. W. O. Atwater, published as an appendix to the report of the United States Commissioner of Fisheries for 1880.[a] Unfortunately our data on the flesh of turtles are not in such a condition that they can be compared with the fish discussed in that article.

To one who has not watched the process it might appear that turtles would be difficult to dress. There is not nearly the labor involved in cleaning a snapper, however, that there is in plucking and dressing a chicken, and a novice would acquire the knack even more quickly with the reptile than with the fowl. The bones and joints are not so thoroughly ossified in the turtle and offer less resistance to the carver. Along with economical considerations it may be mentioned that one dealer remarked that "8 pounds of turtle will make soup for 50 people." Another phase of the subject which has to do with economy, but which is more closely related to the subject of cooking, will be discussed in that connection.

QUALITY OF FLESH.

The value of turtle flesh as a food and the extent to which it can be used as a substitute for other meats is a question to be solved

[a] Atwater, W. O.: Report of progress of an investigation of the chemical composition and economic values of the fish and invertebrates used for food. Appendix D, Report of the Commissioner, U. S. Commission of Fish and Fisheries, for 1880, pp. 231–286. Washington.

by nutrition experts, by chemists who can compute its value in terms of calories, carbohydrates, proteins, digestibility, etc., and by experiments with "diet squads." This is fundamentally the most important question. Certain it is that the white and the deep-red, dressed meat as displayed in the fish markets is very attractive in appearance.

Scarcely less important, however, is the question of its gustatory qualities; for whatever gives zest to our necessary foods is by no means to be despised. References in literature to the relative merits of different species of turtle are rather few. Nash[a] says of the common soft-shelled turtle (*Amyda spinifera*): "The flesh of this turtle is considered a delicacy;" and of the snappers: "Their flesh is considered good and in some localities they are much sought after for making into soup."

The flavor of the snapper, like that of other sorts of game or meat, varies somewhat according to the habits of the individual animal and according to the method of preparation. Perhaps the best method of approach to this phase of the subject is a consideration of the habits of the turtle.

The snapper is very voracious, feeding on frogs, fishes, crayfish, young water birds, etc. It has been accused of catching and eating young ducks. Those examined at Lake Maxinkuckee, Ind., had been eating snails (*Vivipara contectoides*), and seven individuals examined at the Pekin (Ill.) market, caught at Fort Madison, Iowa, in June, 1918, contained solid masses of mud. Two had fragments of crayfish in the mud, one a piece of wood, and another the bones of a frog. A large one caught at Fairport, Iowa, a good deal earlier in the season had its stomach practically empty.

In the summer the snappers may be caught far from water, in grassy places, or in mudholes and puddles, and those caught in one place would doubtless differ in flavor from those caught in another. The turtle from the mud puddle would taste differently from the one caught on the grassy sward, just as beef from cattle and milk from cows grazing in a garlicky meadow differ from the products of a blue-grass pasture; just as the canvasback duck well fed on wild celery is the delight of epicures, while the same species feeding on the fetid Chara is as distasteful as any coot and the celery-fed coot excellent eating, and as a carp from a warm, muddy puddle is soft and rank, while one from a cool clear stream or pond is firm and excellent. Doubtless, the hibernating turtles taken from their winter quarters have approached a uniformity of flavor.

Still, taking the snapper by and large, it is sufficient to say that it has been exceedingly difficult to find, either spoken or printed, any words of disparagement. At Lake Maxinkuckee, it is true, the opinion was expressed that old snappers have a rank flavor and are tough; but the animals were there taken in summer from the beds of fetid Chara, which, when fed upon, will give even the choicest waterfowl a rank flavor. In addition to this, they naturally haunted the muddier parts of the lake, and, as has been said, subsisted on snails. Also, the delicious soft-shells were very abundant in that region, and the snapper would naturally suffer by comparison. In

[a] Nash, C. W.: Manual of the vertebrates of Ontario. Published by Dept. of Education, Toronto. 1908.

most other places the snapper met with praise on every hand. Many had eaten no other kind of turtle but snapper, and it was liked in a great variety of ways.

In many respects, indeed, the eating of turtles may be well compared to the consumption of mushrooms. They are looked upon as a viand rather than as a food. Unknown or untried kinds are regarded with suspicion. The flesh of the box turtle is reported on pretty good authority to be unwholesome, and one man along the Mississippi asserted, but probably without reliable evidence, that "the striped turtles are poisonous." The general use of the snapper is much like that of the morel, or sponge mushroom. Persons who eat turtle at all eat this particular kind because they know it and are not so certain about the others. Those who had had experience with various sorts of turtles would always compare the snapper with other species. Some, but rather few, and these usually people fond of a pronounced gamy flavor, liked the snapper best. One man interviewed said: "The meat of the snapper is more like beef, while that of the soft-shell is more like chicken." An almost universal opinion was that the snapper contains several kinds of meat. One man said it contains 6 or 7 kinds; another, 7 to 9 kinds; and still another, 14 kinds.

The living snapper has a somewhat musky odor, but this may disappear or be diluted to a pleasant aroma by cooking, since no one complained of it. The meat of old snappers is said to be rather tough. One man said it was rendered stringy by cooking too long, and in making soup should be cooked only until the flesh left the bones. It may, indeed, be these two qualities—gaminess and toughness—that have made the snapper preeminently a soup turtle. Persons who discussed the matter of turtle soups asserted that "all turtle soups are really vegetable soups in which turtle takes the place of other kinds of meat." Some of these soups are highly spiced and flavored. One dealer reported that "restaurants are the only extensive users of turtles, and the snapper is used only for soup, which is not in much demand during hot weather." In the markets of the large cities there is little or no family buying of turtles, and the citizen who is accustomed to buying live chickens and either having them delivered or carrying them home would not think of doing the same with a snapper. Even the dressed meat is rarely bought for individual or family use. In the small river towns, however, there is more individual buying and a greater number of methods of cooking are in vogue. In one instance, at Pekin, Ill., when a half barrel of snappers, 10 in number, was received, 7 were immediately dressed for local sale. Usually, however, the people prefer soft-shells when they can get them.

THE ALLIGATOR SNAPPER.

The alligator snapper, *Macrochelys temmincki* (Harlan), which is found principally in the southern part of the United States, is similar in general habits to its smaller and more northern relative, the common snapper. It is especially abundant in the swamps of Louisiana, where an active fishery is carried on at certain seasons. It reaches an immense size, examples weighing as much as 219 pounds having been reported. Its sale is confined chiefly to southern markets. As it is too large to ship in barrels, it is prepared for shipment by drilling holes with a breast drill through the edge of the upper and lower shells on each side of the neck and feet, running wires through and fastening it so that the head and legs can not be protruded. The shell of one reported to have been taken at Hannibal, Mo., was seen by the senior author in St. Louis. The turtle was reported to have weighed 27 pounds.

THE FRESH-WATER TERRAPINS.

COMMERCIAL SIGNIFICANCE.

Within the Mississippi Basin the word "terrapin" is either a book name or a commercial term applied by market men to such of the hard-shelled turtles as find their way into the trade. Along the upper Mississippi and Illinois Rivers the only terrapin likely to be used is the Le Sueur terrapin, *Graptemys lesueurii* (Pls. III and IV). Along the upper Illinois a turtle, which from the description was supposed to be this, was referred to as the "Genetta." In the fish markets at Chicago lots of Le Sueur's terrapin and the elegant terrapin, *Pseudemys elegans* (Wied) (Pls. V and VI), were mixed together in barrels, no market distinction being made between them. Some of the *elegans* were said to be from Memphis, and they were called "Texas terrapin." In the turtle pen on the lower Illinois (Grafton) *elegans* was about as common as *lesueurii*, and was known as the "pond terrapin," the other species being the "river terrapin." At St. Louis the only terrapin seen at the opening of the turtle season in autumn was *elegans*. At Grafton *lesueurii* was the most highly esteemed of the two. Throughout the area under discussion there is another terrapin, the map turtle, *Graptemys geographica* (Le Sueur), so very similar to the Le Sueur terrapin that anyone but a specialist (and this includes both zoologist and fisherman) is likely to confuse them. The map turtle is probably as good as the others, but we saw none on the market. It apparently does not reach so large a size, however, and this may help explain its absence.

Exceedingly few terrapin are used even by the dwellers along the rivers, who are familiar with all sorts of aquatic food. This is probably due, not to their lack of excellence, but to the abundance and well-known qualities of the snappers and soft-shells, which have the additional advantage of larger size. The stimulus to the capture and sale of the terrapin, which is as yet rather feeble, comes from a demand in eastern cities, such as Philadelphia and Baltimore, where the diamond-back has been long known and esteemed and where the transition to other terrapin is easy. Along the Mississippi one man, an old fisherman who had at one time been a restaurant proprietor and famous for his cookery, said that they were most excellent eating. One of the fish dealers on the Illinois River said that terrapin is as good as the soft-shell, and each when fried is superior to chicken similarly prepared. In the Chicago market, unlike the snapper, which is sold by the pound, the terrapin are quoted by the individual or by the dozen. At one market they were quoted at from 25 to 30 cents apiece, and a fair sample weighed 2 pounds and 11 ounces. Another dealer quoted them at 75 cents to $3 per dozen.

Along the Illinois River a little more was learned about the terrapin market. No actual fishing was in progress, but a turtle buyer from Philadelphia had visited the various fish markets and had distributed some information about its pecularities and market requirements. He stated that the terrapin were used as a substitute, or partial substitute, for diamond-back, and that for this purpose the males were not desired. What was wanted was the egg-bearing or "queen" terrapin. (At the Washington market in the autumn of 1917, when the first western—Le Sueur's—terrapin were coming on the market, it was learned that one of the "egg terrapin" was mixed with several diamond-back to make "diamond-back soup.") The river fishermen were unable to distinguish the sexes; but the Philadelphia buyer could do so, and readily picked out the "queens" from a lot of terrapin at hand, discarding the rest. During the summer of 1918 "queen" terrapin were being quoted at that place at $1 each. At St. Louis, in October, is was learned that the market men there distinguished the female of at least *Pseudemys elegans* by its much longer claws. There was no opportunity to verify this by dissection; but some of the turtles—a numerically small proportion of those at hand—had much longer and sharper claws than the others, and there was no marked intergradation in this respect. This may be a correlation with their habit of digging for the purpose of laying their eggs. The long-clawed terrapin, assumed to be females, also generally exhibited a different marking on the under side of the plastron. Late in the autumn (1918) a barrel of elegant terrapin, a few individuals of which possessed exceedingly long, sharp claws, was noted at Chicago.

Both at Chicago and St. Louis the market men reported that the only local buyers of terrapin were the Chinese, who are also buyers of the diamond-back shipped from the east. One of the proprietors of a fish market stated that the Chinese used the terrapin chiefly medicinally, "to clear the blood," and that by calling at a Chinese restaurant designated by him further information and a recipe could be secured. Upon visiting the place a very accommodating Chinese chef furnished the following information: "Turtles are good for internal troubles, for the blood, and especially for tuberculosis. They are cooked together with herbs imported from China and for which there is no English name. According to one recipe, the bones of the turtle are removed and the under part of the shell is boiled two or three hours with the skeleton of a duck. According to another, the meat is boiled in a double boiler with strong alcoholic wines, whisky, gin, etc." He added that he partakes of turtle in this manner only a few times in a year, when he feels in need of a tonic, stating that it makes him feel like a new man. Diamond-back terrapin was said to be the best turtle to use for this tonic, but, as it is very expensive, the hard-shell turtle, "Texas terrapin," is used as a substitute. Both from the remarkable similarity of the last given recipe to that of ordinary diamond-back-terrapin soup, and, from the statement of a native of China that the people of that country do not eat turtle, we are inclined to suspect that the use of terrapin is an American extension of the native bill of fare.

The most probable reason for the exceedingly limited use, one might almost say the nonuse, of the terrapin within the Mississippi Basin is the unfamiliarity with them. They rarely stray any distance from considerable bodies of water and are not often seen by the general population. To the frequenters of river and lake shores they are, however, the most commonly seen of turtles.

Other features that have prevented their coming into use are their relatively small size, 2 pounds being about the average, and the amount and hardness of shell, making the percentage of meat relatively small and difficult to get at. So long as there is a great abundance of other forms of game and fresh food the only reason for resorting to them would be the superior flavor of the flesh, and they would be sought after as luxuries rather than necessities. Their appeal would be to the taste rather than to the satisfaction of hunger. There is, of course, the deep-seated feeling that nothing common can be a luxury, as is indicated by the old contracts that servants should not be fed shad too frequently and by the fable about the farmer and crayfishes.

That the terrapin is of excellent flavor would appear from the testimony of those who have tried it and from the fact that it can be successfully substituted for the diamond-back. As a rule, it inhabits clean waters. The different species of terrapin differ in their food and feeding habits, and doubtless in their flavor, to a corresponding degree.

METHODS OF CAPTURE.

Because of their habits, the manner of the capture of the terrapin is entirely different from that of the snapper. They do not crowd together in hibernating places during the winter and can not, therefore, be taken in numbers during that season, as the snappers are. In the summer they are gregarious, crowding together in great numbers on projecting logs and banks. They can be easily taken in traps, a number and variety of which are known along the Illinois River. By simply sinking a box in a place full of snags and brush, a goodly number of terrapin will manage to drop in. A fish dealer reported that one man had a waterproof box sunk in water by weighting it with stones. He visited it daily, removing 30 to 40 turtles. Another form consisted simply of a box with an inclined board for a slide leading up to it. The turtles climbing up the slide to bask crowded the end ones into the box. A still more complicated form had the slide so placed on a pivot that if one or more turtles got beyond the pivot and overbalanced the lower end they were dumped into the box. The success with which an old sunken boat on a bar in Lake Maxinkuckee was observed to catch terrapin indicates the effectiveness of any of these devices. The gunwale of the boat would be crowded with the basking terrapin; and upon anyone's approach they would plump at once into the water, about half of them landing in the boat. The boys in the region, out of sport, caught 50 or 60 of the animals in one afternoon in this manner.

A method used in trapping the "slider," a species of terrapin in the southeastern part of the United States, doubtless would also prove efficacious. A projecting log is chosen and a heavily leaded net placed entirely around it, except at the lower or entering end. The turtles climbing up on the log to bask keep pushing the foremost one off, and, if anyone approaches, all but one or a few at the lower or entering end of the log drop into the net. By this means great numbers can readily be taken.

SHIPMENT, STORAGE, AND MARKETING.

The shipment, storage, and marketing of the terrapin are the same as that of the snapper, except that, as has been said, practically all are sent to eastern markets. In the local markets they are sold by the individual or by the dozen instead of by weight.

THE SOFT-SHELL TURTLES.

Among the possible aquatic resources of the country an important place is occupied by the soft-shell turtles, of which there are two common species—the spiny, or common, soft-shell, *Amyda spinifera* (Le Sueur) (Pls. VII and VIII), and the smooth soft-shell, or leatherback, *Amyda mutica* (Le Sueur). These turtles are generally northern in their distribution. They are confined chiefly to the larger streams and lakes and are therefore rather unfamiliar objects to the general population. They never stray far from the water's edge and are very timid in disposition, taking to the water with exceeding swiftness when alarmed, so that even those who spend a great deal of time along rivers and lakes rarely get a very good view of uncaptured specimens. They are gregarious, assembling in considerable numbers on banks and sand bars.

COMMERCIAL SIGNIFICANCE.

The soft-shell turtles are seldom found in the markets. None was seen in the Washington market nor in Chicago, where it was reported that "they could not be given away, much less sold." And yet, where well known, the soft-shell is regarded as the most delicious of turtles. It is, indeed, a species of soft-shell turtle which is reared in Japan, much as the diamond-back terrapin is beginning to be raised in this country.

One reason for the absence or rarity of soft-shell turtles on the market is that they are too little known at the great market centers and too well known at the place of capture. No general demand has been created, and no special efforts are made to capture them. Numbers are incidentally caught by various forms of fishermen's gear, such as set lines, seines, and hoop nets, especially baited "fiddler nets" (the nets used to catch channel catfish). These incidentally caught turtles are not usually allowed to get beyond the fisheman who catches them; they are consumed mostly in the immediate locality where caught. In the small towns along the Mississippi and Illinois Rivers they are the favorite food turtles. The snappers are shipped to market and the soft-shells consumed locally. The dealers attribute their absence from the markets to several reasons. They do not stand shipment as well as other turtles, being of a more delicate nature. They are flatter and not so meaty as the snapper; so there is more waste. The soft-shells, therefore, rank with those "home-consumption" delicacies, the famous honey banana, the emerald-gem muskmelon, and the fall pippin apple, which are too good for the market place and can not retain their original flavor after passing through the hands of the middlemen. The fish dealer at one of the towns visited shipped out a barrel of snappers, but when visited later it was found that he had a goodly number of soft-shells on hand. "They do not get beyond me," he explained.

The soft-shells are prized, not only for soup, but for frying; and for this purpose the younger individuals, weighing from 1 to 1½ pounds, are preferred. In making soup the shell may either be used or discarded.

The soft-shell loves the clear water over sandy bottoms and prefers a good current. Its principal food, to judge from a few specimens examined, consists of crayfishes. Both its habits and habitat are therefore conducive to an excellent flavor of flesh.

METHODS OF CAPTURE.

On account of their habits, the soft-shells can not be taken in quantities by the methods used for either the snapper or terrapin. They are gregarious, like the terrapin, but, as a general thing, they do not seek elevated positions in basking, any good sand bar proving satisfactory. They would not drop in numbers into boxes, and they do not "mud up" in large numbers, as do the snappers during the winter. They are rather hard to get in an ordinary seine. During the summer of 1907 several hundred were seen basking on one of the sand bars of the upper Mississippi not far below St. Paul. The sand bar was surrounded by a long net, with the expectation of bagging several barrels of turtles. These all took to the water and the net was drawn in. Only two turtles were obtained, the net having passed over the others, which had, no doubt, simply flattened down close to the bottom.

As previously stated, most of the soft-shells are captured incidentally on set lines or in hoop nets operated for fish. They can readily be caught in baited hoop nets, and one fisherman said that it was easier to get them, when desired, than it was to capture snappers. The nets must be visited at least every 12 hours, especially in warm weather, as the imprisoned turtles soon drown. Prof. Jacob Reighard in Ward and Whipple's "Fresh-water Biology," page 66, gives the following description of a turtle net:[a]

> Turtles are best taken in a turtle net, which is a form of fyke net. It should be of heavy twine and coarse mesh and, if it is desired to keep the turtles alive should be modified as follows: The terminal section of the pot is made cylindrical or the whole pot may be made with square hoops. A circular opening is cut in the upper side of the terminal section of the pot and to this is attached the lower end of a cylinder of netting which extends to the water's surface. The upper end of this cylinder is attached to an opening cut in one side of a wooden box, provided on the opposite side with a hinged lid fastened with a hasp. The box is supported at the surface of the water on poles set in the bottom. When turtles reach the terminal section of the pot, they are able to

[a] Reighard, Jacob: Methods of collecting and photographing. Chap. III of Fresh-water Biology, by Henry B. Ward and George C. Whipple. John Wiley & Sons, New York, 1918.

enter the box through the cylinder of netting and are thereby saved from drowning, which would ensue if they could not reach the air. They may be removed through the lid at the convenience of the collector.

SHIPMENT.

In the upper Mississippi and in some of the glacial lakes in the northern part of our country the soft-shell is exceedingly abundant and if made use of would offer a considerable amount of meat to the inhabitants of those regions. The market men say that it can be beheaded and rough cleaned—that is, with just the viscera removed—and shipped on ice. In this condition it keeps as well as fish similarly treated. Frozen, they say, it remains in perfect condition and is as good when thawed as when fresh. Handled in this manner, it could, if there were a sufficient demand, furnish a considerable meat supply to a large area.

Taking the country at large, the turtles are much more scarce than formerly. From along the upper Illinois River comes the complaint that the turtles, especially appreciated there, are "becoming very scarce" or "practically exterminated" and that the local market demand is greater than the supply. This exhaustion is attributed to the draining of the feeding areas of the turtles and the building of levees. The State law of Illinois protects both turtles and terrapin of any size under a 7-inch shell. All that has saved the turtle to this day is probably the fact that it has remained more or less unappreciated.

ENEMIES OF TURTLES.

In spite of the various means with which nature has endowed the turtles for their welfare—the protecting shell of all of them; the timid disposition of the terrapin, which prevents them from wandering afar from safety and causes them to drop into the water at the first sign of alarm; the inconspicuous colors of most of them; the timidity and swiftness of the soft-shells; and the longevity of such as have passed the vicissitudes of early life—they are subject to many dangers and, on the whole, seem to be scarcely holding their own. A good many young appear to perish during the first winter. Muskrats kill a few of the smaller species, but do not appear to molest those of larger size. Leeches often accumulate on turtles in considerable numbers, and, though they may never directly kill them, they doubtless greatly lessen their vitality. In the Japanese breeding establishments old turtles devour their young, and this may occasionally happen in nature. Doubtless carnivorous animals often dig up the nests and devour the eggs, as one often finds eggs scattered about and evidence of digging where the turtles make their nests.

By far one of the most important enemies is man. Fishermen finding turtles in their nets or on hooks often kill and discard them, instead of either releasing or using them. Many persons make it a practice to rob turtle nests by the wholesale, either for so-called sport or to use their eggs for fish bait. By digging into the sand bars used for nesting places hundreds of eggs can be taken and destroyed in a short time. Many turtles, especially soft-shells, are drowned in hoop nets used by fishermen.

PREPARATION OF TURTLES FOR THE TABLE.

KILLING THE TURTLE.

Notwithstanding the formidable appearance offered by the shell, the killing and dressing of turtles is a comparatively easy matter, and the men at the fish markets soon become expert at it and can kill and clean them with surprising rapidity. The first step is to get the animal to protrude its head. In the case of the snapper, this is easily accomplished by presenting to its head a stick of suitable size for the reptile to snap. It takes tenacious hold, and the head can readily be pulled out. The heads of the other species may be made to protrude by applying pressure, as with the foot, to the back or upper part of the shell. After the neck is well stretched out the turtle can readily be decapitated. At fish markets, where many turtles are dressed, the cleaners usually have a killing plank with a sharpened spike driven through at an angle, and the spike is thrust through the chin during the process of stretching.

Once beheaded, a sharp knife is run around the edges of the skin where it joins the shell and the skin pulled back over the legs to the feet, which are then disjointed. The lower part of the shell or plastron is then removed by cutting through the bridges which join the upper and lower shells, cutting close to the lower part of the shell. With snappers and soft-shells, in which the bridges are rather soft and cartilaginous, this can be done with a sharp knife. With the terrapin the bridge may be cut with a hatchet or saw. Having cut the bridges, the plastron or under shell may be readily removed by inserting a sharp knife just under it and lifting it off. This done, the entrails may be extracted with very little trouble, and the four quarters easily taken out from the carapace or upper shell. If one wishes to save the tenderloin in the upper part or "ceiling" of the carapace, the ribs may be cut with a hatchet. To the reader this may appear to be a lengthy and complicated process; but, as stated above, it is a simpler process than killing, plucking, and dressing a chicken.

A visit to a place where turtles are being dressed by professionals would prove very instructive. It need hardly be said that each has his own method as regards the smaller details. Some cut off the feet before skinning; others skin down to the feet and then disjoint. Some even cut off the feet before decapitation, but this is unnecessarily cruel. The smaller turtles and terrapin are often killed by dropping the living animal into boiling water just as lobsters and crayfishes are killed. This is a convenient method and not especially cruel, as death is practically instantaneous. With a large kettle the same method might be used for the soft-shell and snapper.

RECIPES.

Doubtless one reason for the general nonuse of turtles for food is the lack of knowledge as to just how to prepare them for the table and the lack of experience with turtles properly cooked. To meet this deficiency, the following recipes, which have been obtained from various available sources, are offered. A few have been gleaned from cookbooks, but most of them have been procured from persons noted locally for their preparation of turtles. Special thanks are due to Henry Lemm, of Pekin, Ill., and to Mrs. Saunders, of the Saunders Fish Market, St. Louis, Mo., for choice recipes.

SOUPS.

These recipes apply especially to the snapper, which is the great soup turtle of the Mississippi Basin. They could, doubtless, be applied to terrapin and soft-shell also, as they are as good for soups as the snapper.

In making soups, cook the turtle only until the bones leave the flesh. Many cook too long, which makes the flesh stringy.

1. *Turtle soup.*—A favorite way to cook snapper is to make the soup like old-fashioned beef soup, with any assortment of vegetables desired, with the turtle meat cut up into small pieces.

2. *Turtle soup*—Make up a soup stock, without vegetables, but add egg.

3. *Turtle chowder.*—One-half pound turtle meat, 2 medium-sized potatoes, 3 onions, 3 carrots, any other vegetables wanted, as parsley, all diced into the pot; add ¼ pound of salt pork diced, 1 teaspoonful pepper, 1 level teaspoonful of butter, and cook about 2 hours over a slow fire. This is fine, a regular turtle chowder. With soft-shell turtle cut up the shell also, and cook for 4 hours.

4. *Soft-shell turtle soup.*—Use turtle meat same as for beef soup, adding a slice of bacon and onion to modify the flavor. (Soft-shell turtle meat is also good with noodles.)

5. *Turtle soup à la creole.*—This is the ancient recipe for turtle soup, and it is safe to say that when once eaten after this delightful way no other will seem quite so savory. Cut the turtle meat into small pieces. Let it brown in a pot with a little lard, cut up several onions, a slice of ham, and a little garlic, and stir and mix with the turtle meat. Then let the mixture brown well. Put in some flour and mix, pour a quantity of the soup stock into the pot, let it cool, and add a knee joint of veal. Let it simmer for an hour, then put in some thyme, laurel leaf, parsley, shallots, and when everything is cooked add more parsley and a couple of slices of lemon chopped fine. Just before serving add a wineglassful of Madeira wine, or, in lieu of this, ⅔ that amount of lemon juice.

6. *Terrapin soup.*—Use the meat and eggs from 1 terrapin, put into a stewpan with 2 tablespoonfuls of butter, and let it simmer until quite hot throughout, keeping the pan closely covered. Serve with the following sauce: 1 beaten egg yolk flavored with nutmeg and mace, ½ cup currant jelly, 1 pinch of cayenne, salt to taste, 1 tablespoonful of butter.

FRIED TURTLE.

Although the turtles generally preferred for frying are medium-sized soft-shells weighing from 1½ to 3 pounds, many like fried snapper. For frying, the younger and more tender snappers are to be preferred, although the older ones can be used by cooking correspondingly longer.

7. *Fried turtle.*—Cut the turtle meat into small pieces, add salt and pepper, roll in flour, and fry in one-half lard and one-half butter until brown, then add a little water, cover up, and steam until done (about ½ hour).

8. *Fried turtle.*—Fry as above; when browned add some catsup, a few mixed spices, a glass of wine, or, in lieu of this, 2 tablespoonfuls of vinegar and a little water; cover, and steam until done (about ½ hour).

9. *Fried turtle.*—Some cooks prefer to fry dry, without steam; in this case one must cook slowly, and of course old turtles must be cooked longer than young ones.

10. *Fried turtle.*—Simply parboil the turtle meat and fry in butter.

11. *Fried turtle.*—Put the turtle meat into salt water for a short time, remove and wipe dry, sprinkle with corn meal, and fry in hot grease, or use butter, salt, and pepper, and thicken with barley. (The person who furnished this recipe generally preferred snapper to other turtles, and had this species in mind.)

12. *Fried snapper.*—Put the turtle meat into salt water overnight, take out, wipe dry, sprinkle with flour, and fry in plenty of grease. Fry slowly until brown. This is said to be better than fried chicken. For this old turtles are said to be as good as young.

MISCELLANEOUS.

The following recipes were obtained at St. Louis and apply to the native turtles used there. They were meant to apply especially to the snapper; it is believed, however, that they could be applied to the more delicate soft-shell, where procurable, with even better results.

13. *Steamed turtle.*—Take fresh turtle meat, fill with black pepper and a bit of butter, steam until the flesh separates from the bones, then add black sauce (the soy-bean sauce to be found in Chinese restaurants) or Worcestershire sauce.

14. *Turtle cutlet.*—Take lean turtle meat, pound until like hamburger steak, dip into egg, roll in meal, and fry in hot fat. This tastes like veal cutlet.

15. *Simmered turtle.*—Take 1 pound turtle meat, wash, cut into cubes, brown in fat (lard or butter) with 1 large or 2 medium-sized onions, simmer until tender, add Chili pepper while simmering. To serve, pour over boiled rice.

16. *Curry of turtle.*—Take 1 pound of turtle meat, brown as above, with 1 large or 2 medium-sized onions. Put into the pot 1 medium-sized potato, 1 carrot, the onions which have been cooked with the turtle, a small piece of parsley, ½ teaspoonful of pepper, 1 teaspoonful of salt, and ½ teaspoonful of curry powder. Add the browned turtle meat to the mixture in the pot and let simmer until tender. Make molds by hollowing out cups of boiled rice and serve in the molds. This tastes like curry of chicken or curry of veal.

17. *Turtle rivola.*—(*a*) One-half pound turtle meat, best chopped through a food chopper, add 2 onions, cook until tender, add ¼ pound of cheese and salt and pepper.

(*b*) Take 1 cup flour, 1 egg, ¼ teaspoonful salt, make a thick batter, roll out thin into a sheet of noodle dough, and cut into 2-inch dice.

(*c*) Take 1 spoonful of minced turtle meat, lay on the diced noodle dough, fold over 3 corners and inclose the meat, cook like noodles in the water that the turtle meat was cooked in, to which a spoonful of butter has been added.

18. *Turtle sausage.*—Cook 2 pounds of turtle meat until tender, run through a food chopper, add 2 eggs, drop into hot fat or fry right off the spoon until brown.

While the following recipe was originally intended to apply to the diamond-back terrapin, it would doubtless serve very well for the fresh-water species, and possibly for snapper or soft-shell turtle also:

19. *Stewed terrapin with cream.*[a]—Place in a saucepan 2 tablespoonfuls of butter and 1 of rice flour, stir over a fire until it bubbles, then stir in a pint of thin cream, 1 tablespoonful salt, ½ tablespoonful white pepper, ¼ tablespoonful grated nutmeg, and a very small pinch of cayenne, next put in 1 pint of terrapin meat, and stir it all until scalding hot. Move saucepan to back part of stove, where contents will keep hot, but not boil, then stir in 4 well-beaten yolks of eggs. Do not boil, but pour immediately into tureen containing 1 tablespoonful lemon juice. Serve hot.

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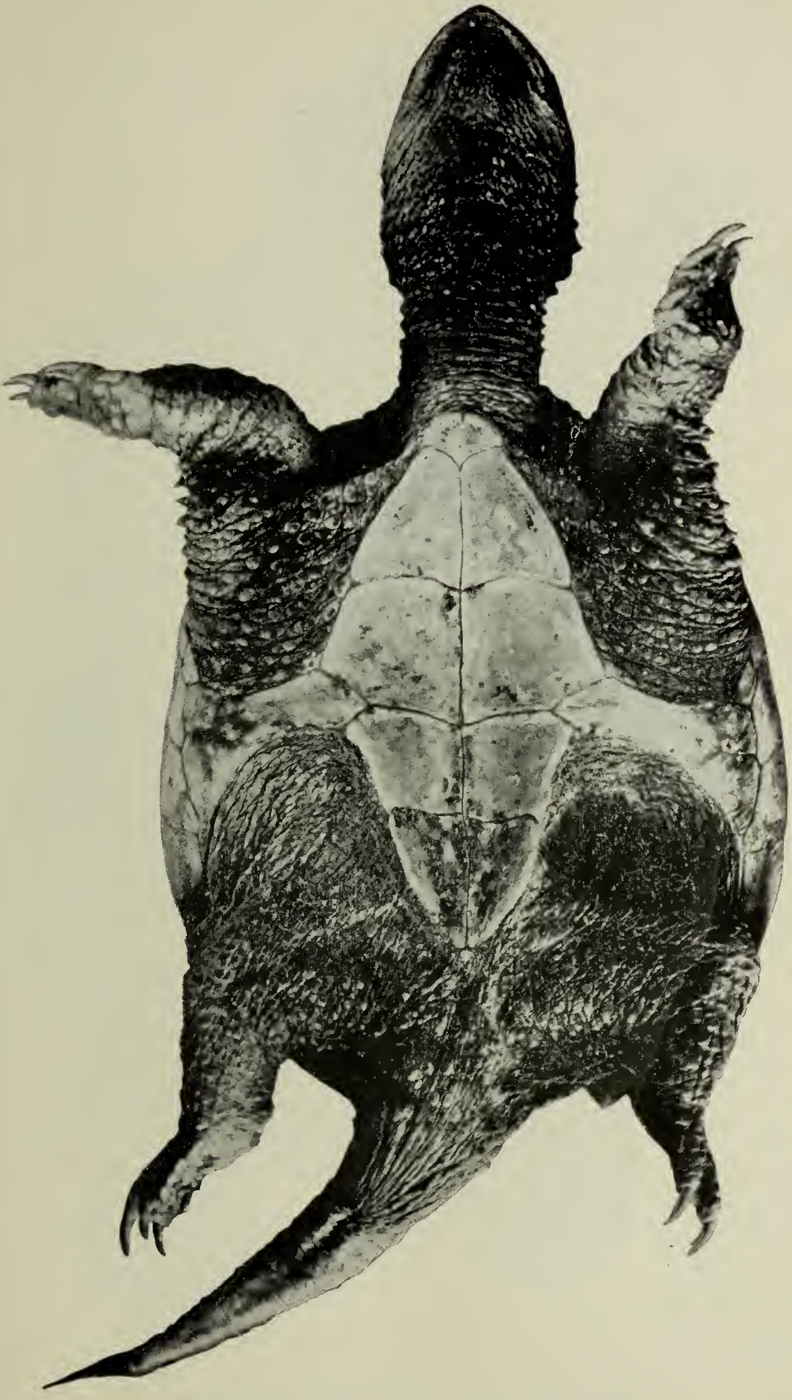
[a] From the "White House Cook Book."

O

SNAPPING TURTLE, CHELYDRA SERPENTINA (LINNAEUS).



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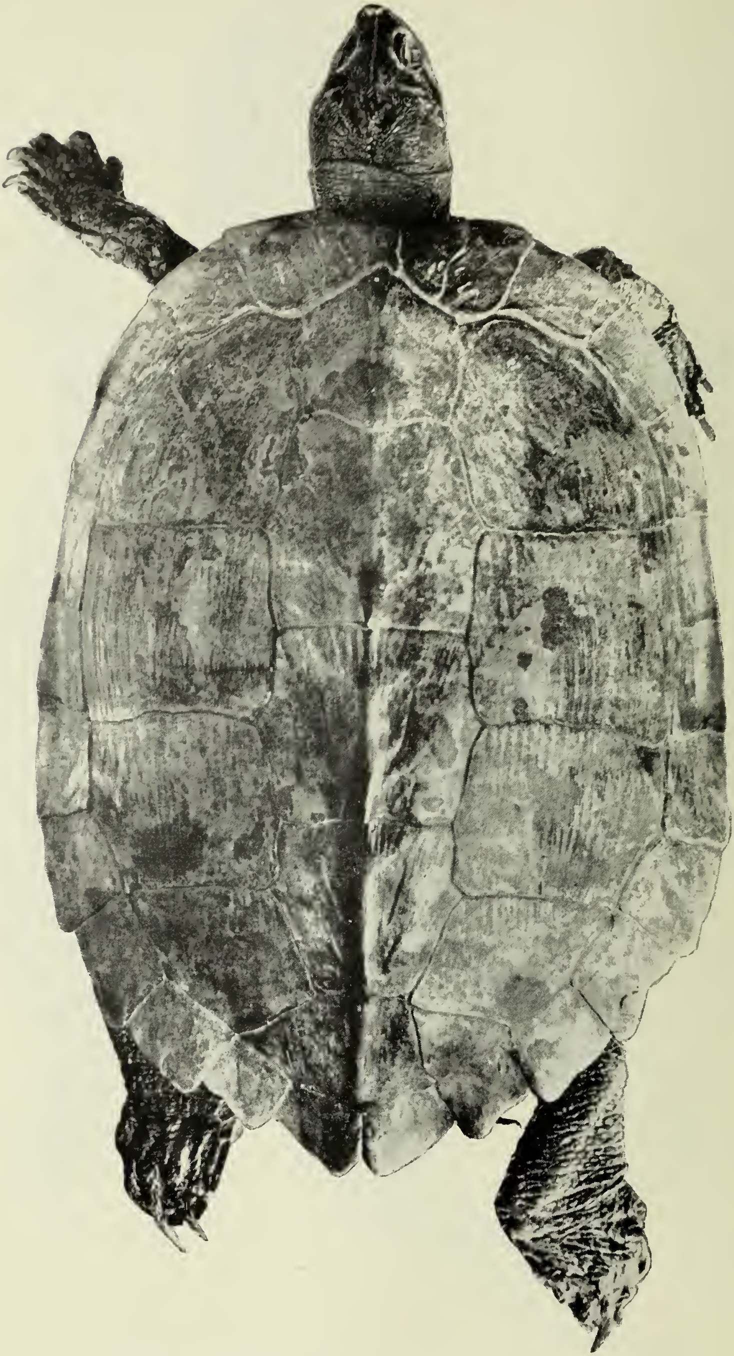
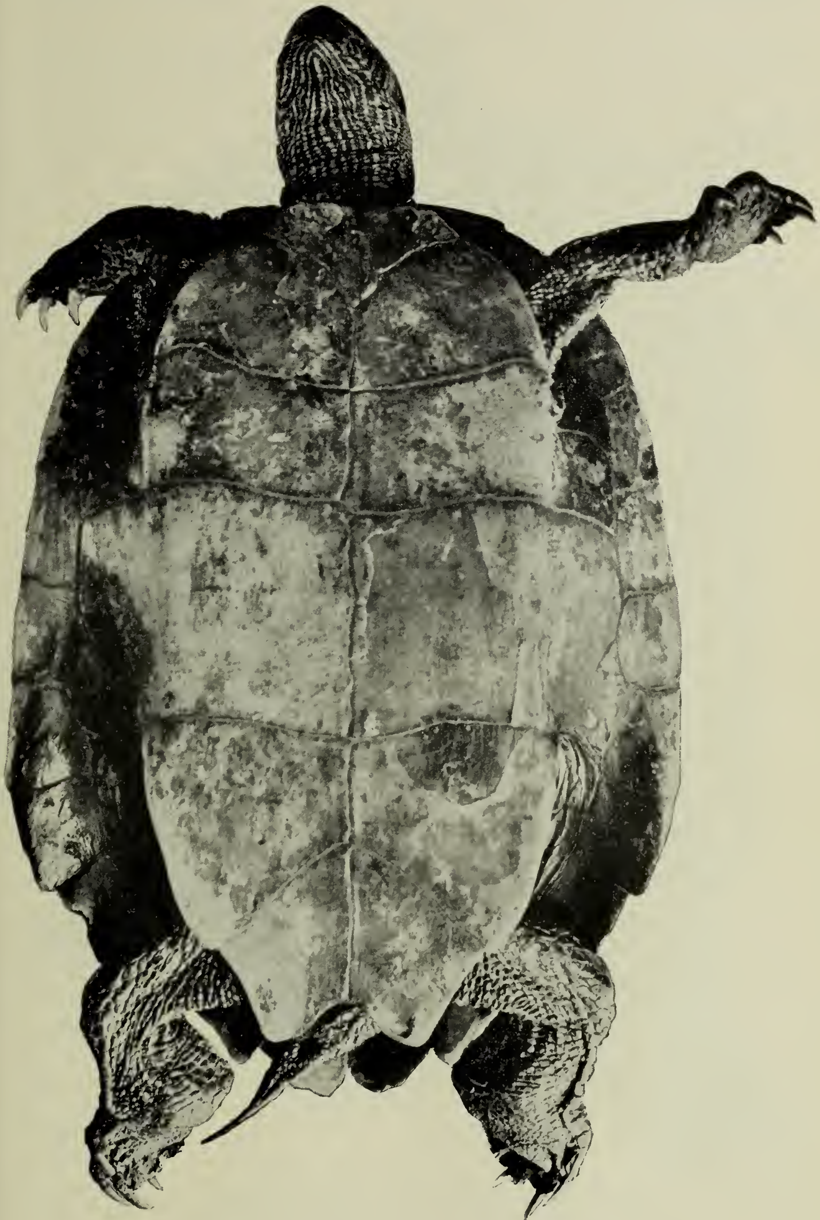


LE SUEUR TERRAPIN, GRAPTEMYS LESUEURII.



LE SUEUR TERRAPIN, GRAPTEMYS LESUEURII.

ELEGANT TERRAPIN, PSEUDEMYS ELEGANS.

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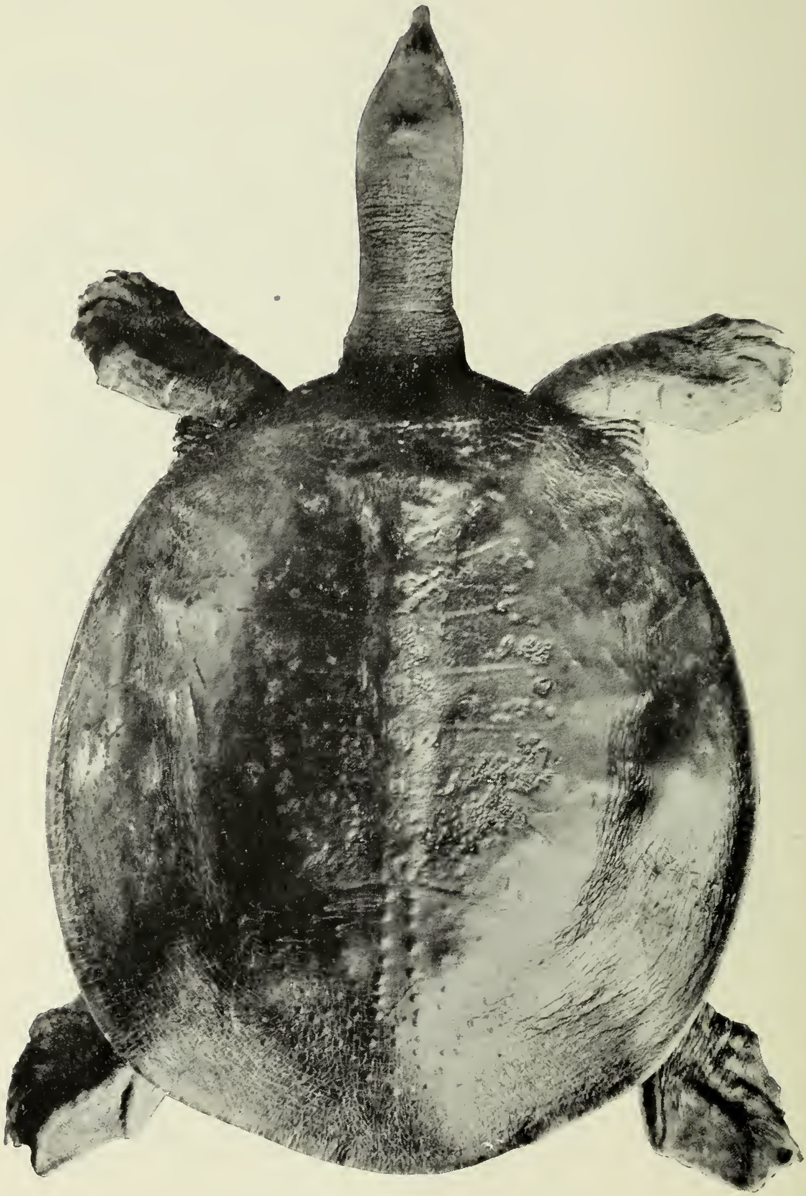
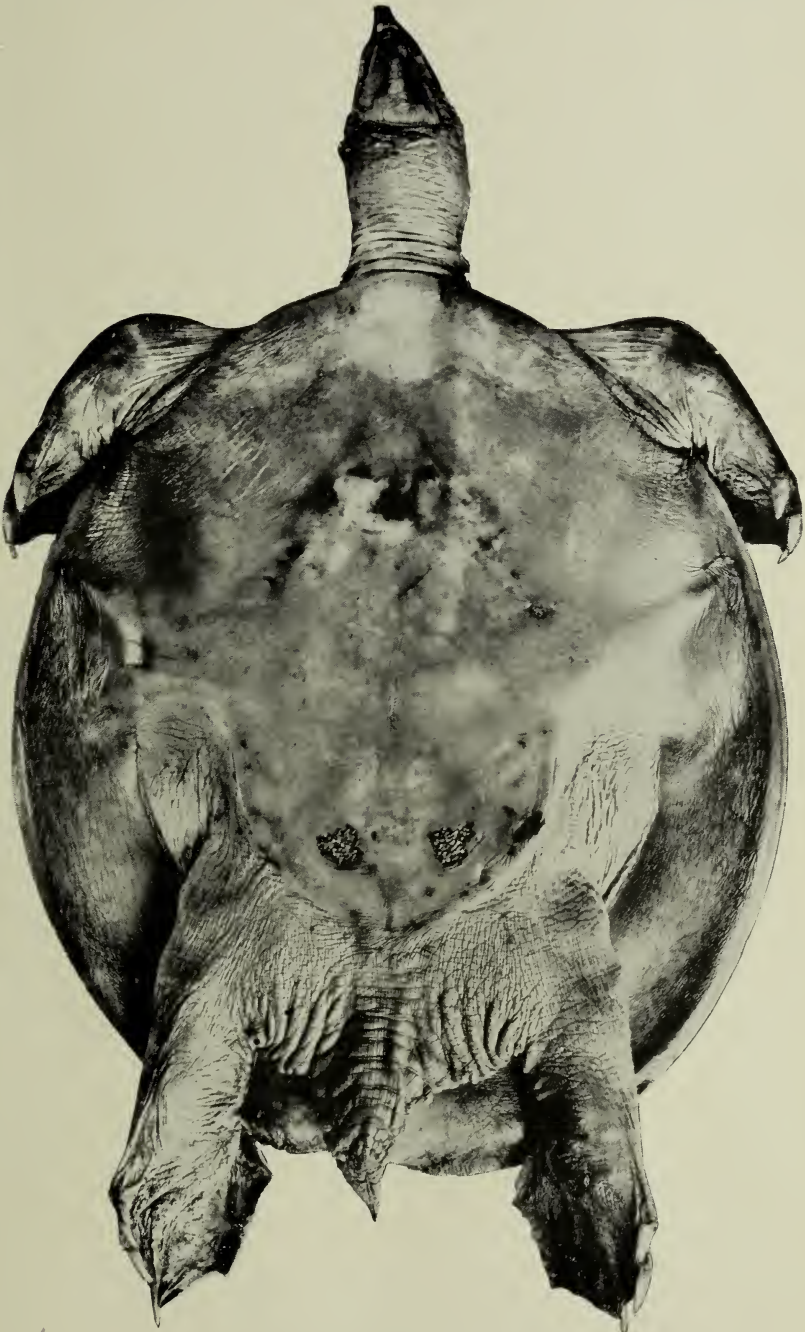


SOFT-SHELL TURTLE, AMYDA SPINIFERA.



SOFT-SHELL TURTLE, AMYDA SPINIFERA.

DEPARTMENT OF COMMERCE

BUREAU OF FISHERIES

HUGH M. SMITH, Commissioner

THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS

By E. P. CHURCHILL, Jr.

Assistant, U. S. Bureau of Fisheries

APPENDIX VIII TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1919

Bureau of Fisheries Document No. 890

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CONTENTS.

BLUE POINTS, FROM NEAR BLUE POINT, LONG ISLAND.

About one-half natural size.

THE OYSTER AND THE OYSTER INDUSTRY OF THE ATLANTIC AND GULF COASTS.

By E. P. Churchill, Jr., *Assistant, U. S. Bureau of Fisheries.*

INTRODUCTION.

The taking of oysters constitutes the most valuable fishery of the United States and one of the most valuable in the world. The annual yield in this country is about 30,000,000 bushels, with a return to the fishermen of nearly $15,000,000. At least 99 per cent of the oysters of the United States are produced on the Atlantic and Gulf coasts, as shown by the following table:

OYSTER PRODUCT OF THE UNITED STATES.

[From statistics collected by the U. S. Bureau of Fisheries.]

Region.	Private grounds.		Public grounds.		Total.	
	Bushels.	*Value.*	*Bushels.*	*Value.*	*Bushels.*	*Value.*
New England States (1910)	5,549,318	$3,439,450	92,703	$157,584	5,942,021	$3,597,034
Middle Atlantic States (1911-12)	7,090,883	5,204,124	11,815,193	4,059,432	18,906,076	9,263,556
South Atlantic States (1910)	456,194	171,298	1,244,804	192,886	1,700,998	364,184
Gulf States (1918)	1,227,969	528,123	2,165,526	578,597	3,393,495	1,006,720
Pacific Coast States (1915)	152,560	548,005	3,544	8,619	156,104	556,624
Total	14,476,924	9,891,000	15,301,770	4,997,118	30,098,694	14,788,118

The report of the Commissioner of Fisheries for 1913 stated that the total number of persons engaged in the oyster industry of the United States was 67,257, the yearly wages paid amounting to $10,876,801, and that the investment in vessels, apparatus, property, etc., was over $17,000,000.[a]

GEOGRAPHICAL DISTRIBUTION.

On the eastern and southern coasts of the United States oysters are found from Wellfleet, Mass., on the inner shore of Cape Cod, to the southern extremity of Texas. The industry on these coasts is bounded by the same limits. Although in past times oysters were found in Maine and New Hampshire, practically none occurs there now, and these two coastal States alone have no oyster industry.

The location of the main oyster beds in each State concerned and the principal towns in which the industry is centered are cited below. The Atlantic and Gulf coast is not lined with a solid bed of oysters along its entire length. Oysters are not found in the open sea, but in coves, bays, estuaries, and mouths of rivers—in a word, in partially

[a] Report U. S. Commissioner of Fisheries, 1913, p. 40. Washington.

inclosed waters rendered brackish by drainage from the land. This fact will become more apparent during the reading of the ensuing paragraphs.

MASSACHUSETTS.

The main oyster beds are in Wellfleet Harbor, in the waters in the vicinity of Chatham, in Cotuit Harbor, and in Poponesset Bay. Some oysters are also taken from Centerville Harbor and from the mouths of Wareham and Taunton Rivers. The principal towns concerned are Wellfleet, Chatham, Cotuit, and Falmouth. The oysters are shipped in the shell or shucked, on ice.

RHODE ISLAND.

The main oyster beds are in Narragansett Bay, the industry being centered at Providence, where there are about a half dozen oyster-houses. The oysters are shipped in the shell or shucked, on ice.

CONNECTICUT.

Although oysters are found along practically the entire coast, the principal beds are inside Thimble Islands, in New Haven Harbor, Milford Bay, Bridgeport Harbor, South Norwalk Harbor, around Great Captains Island, and in the deeper water offshore from these places. All the oysters are shipped in the shell or shucked, on ice. There are 6 oyster houses at South Norwalk, 16 at New Haven, and 1 each at Milford, Stony Creek, Guilford, and New London.

NEW YORK.

The oyster beds of New York are in the waters around Long Island. The oysters are shipped in the shell or shucked, on ice. There are 4 oyster houses at Greenport, 1 at Suffolk, and 2 at Northport, on the north side of the island. On the south, West Sayville and Patchogue are the centers of the oyster trade, there being extensive beds in Great South Bay. New York City is the great center of the oyster trade of the State.

NEW JERSEY.

The main oyster beds are in Raritan, Barnegat, and Great Bay, on the eastern coast, the oysters being handled chiefly at Tuckerton and Keysport; and in Delaware Bay, on the west, especially in Maurice Cove and vicinity. The oysters from this region are shipped from Bivalve, where there are several houses handling oysters in the shell or shucked, on ice.

DELAWARE.

The oyster beds are in Delaware Bay, mainly from Bombay Hook to below the mouth of St. James Creek. Most of the oysters are marketed through Bivalve, N. J.

MARYLAND.

The principal oyster beds are in the Chesapeake Bay, there being some, however, in Chincoteague Bay and Potomac River. The number of oyster houses at the main centers of trade are as follows: Crisfield, 40; Baltimore, 28 (15 being oyster canneries); Cambridge, 25; Oxford, 15; Annapolis, 13; Tilghman, 8; and St. Michaels, 6. There are about 160 oyster houses in all in the State. Baltimore is the only city in the State where oysters are steamed and canned, and is the most northerly point on the coast where this process is employed.

VIRGINIA.

The waters covering the main oyster beds of the State are those of Chesapeake Bay, Chincoteague Bay, and the eastern coast of Accomac and Northampton Counties, and the Potomac, Rappahannock, York, and James Rivers. There are about 35 oyster houses, 19 at Norfolk and Portsmouth, 2 at Hampton, 1 at Phoebus, 3 at West Point, 2 at Urbanna, and others scattered about in Northampton, Middlesex, Lancaster, and Accomac Counties. The oysters are shipped in the shell or shucked, on ice, none being canned. One firm prepares an oyster powder from the dried meats.

NORTH CAROLINA.

Four-fifths of the oyster beds of this State are in Pamlico Sound. There is one cannery at each of the following points: Beaufort, Morehead City, Washington, Vandimere, Davis, Bay River, and Sea Level. There is one shucking house, or "raw house," as such a place is termed in the South to distinguish it from a cannery, at Newbern and several at Wilmington.

SOUTH CAROLINA.

Most of the oyster beds are in St. Helena and Port Royal Sounds near the southern extremity of the coast. There are five canneries at Charleston and six at Beaufort, besides two or three at smaller cities.

GEORGIA.

The oyster beds are found along the entire coast line, especially in St. Catherines, Sapelo, Do Boy, Altamaha, St. Simons, St. Andrews, and Cumberland Sounds. There are 18 canneries in the State—four at Savannah, and the rest scattered along the coast. There are five wholesale dealers in raw oysters, besides several retailers at Savannah, Brunswick, and other points.

FLORIDA.

The principal oyster industry of the State is located at Apalachicola, where there are four canneries and nearly a dozen raw houses, the oysters coming from Apalachicola Bay and contiguous waters. There is a small oyster business at Carabelle and some beds at Cedar Keys. A few oysters are canned at Fernandina, on the east coast. There is a small local oyster business at other points in the State.

ALABAMA.

The oysters are found in the lower part of Mobile Bay and the east end of Mississippi Sound. There are 13 dealers in oysters in Mobile, but most of the oysters are opened or reshipped in the shell at Bayou Labatre and small adjacent points on the Mississippi Sound. The only oyster cannery in the State is located at Bayou Labatre.

MISSISSIPPI.

The principal oyster beds in this State are in Mississippi Sound, but 90 per cent of the oysters opened in the State are brought from Louisiana waters, especially from St. Bernard Parish. At Biloxi there are 12 canneries and 6 raw houses, the only city having a larger number of canneries being Baltimore, Md., which has 15. The following Mississippi cities have one cannery and one or two raw houses each: Gulfport, Pass Christian, Bay St. Louis, and Ocean Springs.

LOUISIANA.

The principal oyster beds are in the waters on the east of St. Bernard Parish, although important beds are found on the coast of Terrebonne and Plaquemines Parishes, and others are being developed to the westward. As a result of experiments conducted by the U. S. Bureau of Fisheries between 1906 and 1909, valuable oyster beds were established in Barataria Bay. These were subsequently broken up by a hurricane and the oysters washed about to different parts of the bay. From the natural propagation of the oysters so scattered several beds developed which have grown to be of considerable value. There are about 24 wholesale oyster dealers in New Orleans. One cannery is located near New Orleans, two farther down the river, two or three at Houma in Terrebonne Parish, and a new one is just starting at Franklin.

TEXAS.

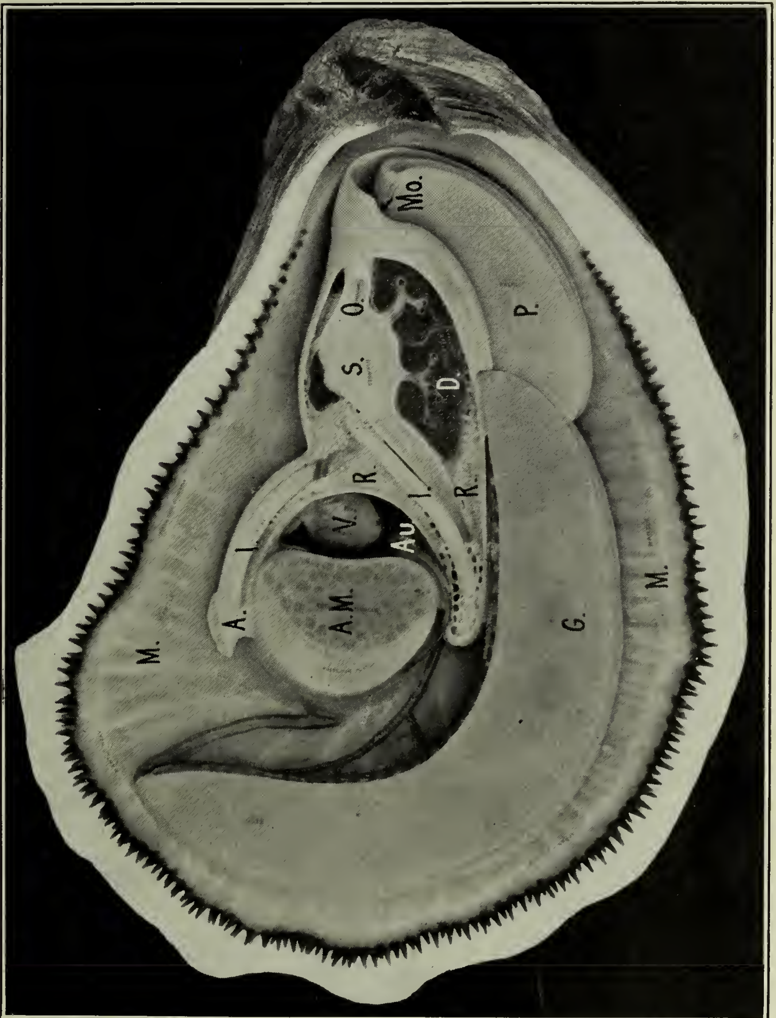
The principal oyster beds of this State are in Galveston, West, Matagorda, Lavaca, Espiritu Santo, Aransas, Mesquite, and Corpus Christi Bays. There are from two to six oyster-shucking houses at Corpus Christi, Port Aransas, Rockport, Port O'Connor, Port Lavaca, Seadrift, Palacios, Matagorda, and Galveston. There are no oyster canneries in this State.

OUTPUT OF VARIOUS REGIONS.

Chesapeake Bay produces more oysters than any other body of water in the world.[a] Some notion of the size of the industry there may be gained from Plate XVIII, figure 1, showing the oyster fleet operating out of Cambridge, Md., which is only one of the several large oyster centers on this bay. Virginia and Maryland, within whose borders Chesapeake Bay is embraced, lead the United States in oyster production with over 5,000,000 bushels each annually.[b]

---

[a] Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 231. Washington.
[b] Report, U. S. Commissioner of Fisheries, 1913, p. 41. Washington.



OYSTER WITH RIGHT SHELL AND MANTLE REMOVED.

A., anus; A. M., adductor muscle; Au., auricle of heart; D., digestive gland or liver; G., gills; I., intestine; M., mantle; Mo., mouth; O., oesophagus; P., palps; R., reproductive organ; S., stomach; V., ventricle of heart. (Photo from American Museum of Natural History.)

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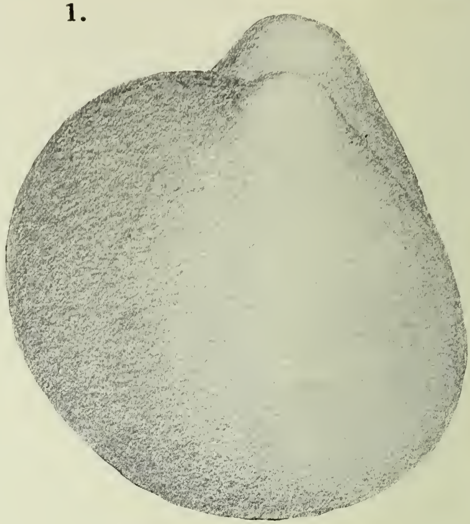
2.



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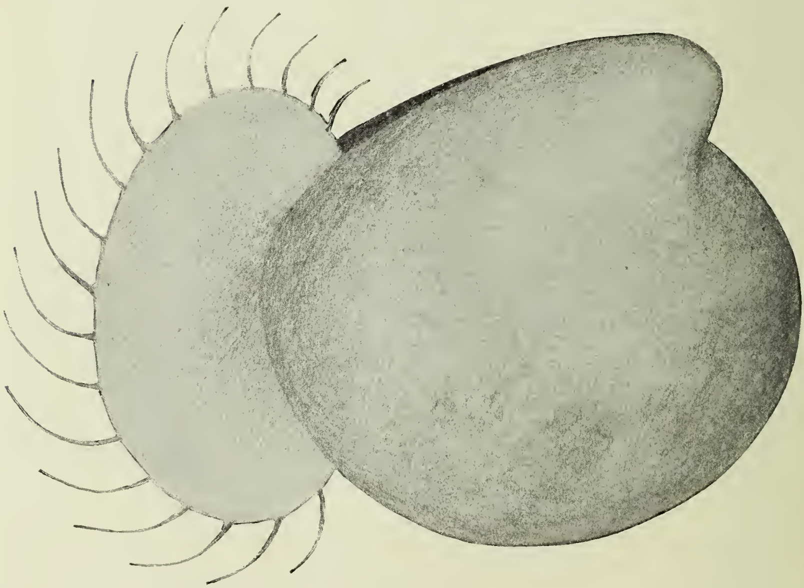

4.

FIG. 1.—SPERMATOZOON OF MALE OYSTER. Magnified 1,700 diameters. (AfterStafford.)
FIG. 2.—OYSTER EGG. Magnified 600 diameters.
FIG. 3.—FREE-SWIMMING LARVA OF OYSTER, ABOUT 10 DAYS OLD. Magnified 300 diameters.
FIG. 4.—FREE-SWIMMING OYSTER LARVA WITH VELUM, OR SWIMMING ORGAN EXTENDED. Magnified 300 diameters.
(Figs. 2, 3, and 4 drawn by J. S. Gutsell.)

Connecticut is third with over 4,000,000 bushels. Rhode Island, New York, New Jersey, and Louisiana produce over 1,000,000 bushels annually.

DESCRIPTION AND ANATOMY.[a]

CLASSIFICATION.

The oyster of commerce in the United States, with the exception of certain parts of the Pacific coast, is the so-called "eastern oyster," belonging to the species *Ostrea virginica*, Gmelin. It is a member of the group of molluscs popularly known as bivalves, since it has two valves, or shells, which are joined at the narrower ends by a hinge.

EXTERNAL APPEARANCE.

The figures in Plates I, XX, and XXI, though reduced in size, give an idea of the usual shape and appearance of the oyster. The average length of the shells of the marketable size is about 5 inches. Oysters, however, may grow to much greater dimensions, and under certain conditions of growth, such as crowding or development on a mud bottom, are forced into various distorted or elongated shapes.

The shell of the adult oyster varies greatly in thickness, ranging in extreme cases from somewhat less than one-fourth inch to an inch and one-fourth. The usual thickness is from one-fourth to three-eighths inch, decreasing to paperlike thinness on the margins of a rapidly growing shell.

The exterior is marked by laminations and more or less concentric lines of growth; it is often covered by a yellowish cuticle, but is sometimes white and flinty in appearance. The inside of the shell is generally white, somewhat tinged with purple near the margins, and with a more or less pearly luster. The muscular impression is generally nearer to the posterior margin than to the hinge; it is a well-defined scar, kidney-shaped in specimens of ordinary size, but becoming more elongate in very large individuals; in young specimens it is pale, but it afterwards becomes purple or almost black. The left, or lower, valve is deeply concave within, the upper valve being flat or, usually, slightly concave. The animal portions are large, nearly filling the shell, and the mantle border is comparatively narrow.[b]

ANATOMICAL FEATURES.

The two valves of the shell of the oyster are held together at the hinge by a dark-colored elastic ligament so placed that it tends to throw the free ends of the valves slightly apart when the large muscle of the oyster is cut or relaxed. The main structures of interest making up the body of the oyster are shown in Plate II and in text figure 1. Plate II represents an oyster lying in the left valve, which is deeper than the right, and more cup-shaped. This is also nearly always the valve by which the oyster is attached to rocks, etc. The flatter right valve is represented as having been removed. The narrow part of the oyster is the anterior or front end, the mouth being located in that region. The broad part is the posterior or rear end. The back or dorsal side is at the top of the picture and the ventral or under side below. The oyster, however, being attached by its left side, may rest in the water in any conceivable position, depending on the surface to which it has fastened itself.

---

[a] The brief account of the anatomy and life history of the oyster is based chiefly on the researches of Brooks (1895), Julius Nelson (1888–1893 and 1900–1915), and Stafford (1913).

[b] Moore, H. F. (1897, p. 266.)

Each valve or shell is lined with a thin membrane called the mantle, fringed on the edge and attached to the shell over nearly all its expanse, but free along the margin. The right mantle has been removed with the shell in Plate II. In about the center of the body is the large adductor muscle, by the contraction of which the oyster closes its shell. As stated above, when this muscle is relaxed or cut, the ligament in the hinge forces the valves apart. The main body of the oyster lies between the right and left sides of the mantle and is attached to it and the adductor muscle. It will thus be seen that the oyster is held to the shell by the mantle and the muscle.

In Plate II part of the body wall is represented as having been removed with the right side of the mantle, thus exposing to view the liver or digestive gland and the œsophagus or gullet leading from the mouth to the stomach, which opens into the intestine. This extends downward and backward beneath the muscle, then curves sharply and runs forward on the left of the stomach to the œsophagus, where it again turns to the rear and extends backward to the vent or anus above the muscle.

In a thin-walled sac, the pericardium, immediately in front of the muscle, lies the real heart of the oyster. (The adductor muscle is often erroneously referred to as the "heart," since when it is cut the oyster eventually dies from inablility to close its valves.) The circulatory system of the oyster is of the "open" type; that is, the arteries do not terminate in capillaries which lead to the veins, as in man, but deliver the blood, which is colorless, into large spaces, or lacunæ, between the tissues. The blood, as it spreads through these lacunæ, bathes the various cells of the body and is then gathered up by the veins and collected in the auricle or lower chamber of the heart. It then passes into the ventricle, or upper chamber, which contracts and forces the blood through arteries to the different parts of the body. A hinged valve between the two chambers of the heart prevents the blood being driven back into the auricle.

The nervous system of the oyster (not shown in the figures) is very simple, consisting of two ganglia or knots of nervous matter, lying just over the gullet and two nerves passing back from them, one on each side, to another pair of ganglia beneath the adductor muscle. Smaller nerves extend from these two pairs of ganglia to the various parts of the body.

At the anterior end of the body four thin lips or palps hang free in the mantle cavity and extend backward from beneath the mouth for about one-third the length of the body, the posterior ends lapping under the ends of the gills. The latter, four in number, are somewhat similar to the palps in appearance, and extend backward and upward in crescent fashion, as shown in Plate II. Microscopic examination shows that the gills are covered on both sides with very fine hairs or cilia, arranged in rows. These beat back and forth and, when the oyster is lying with the valves open, cause a current of sea water to pass on to the gills. The water is forced through fine openings on the surfaces of the gills into water tubes inside the gills and thence into the cavity above them. As the water passes through the gills the blood is aerated as in the case of a fish. In Plate II the openings of the tubes can be seen on the inner edge of the gills. The right mantle having been removed, the cavity into which the water passes is exposed. It lies in the space just above the inner edge of the gills.

From this cavity the water passes behind the adductor muscle and out between the edges of the valves of the shell around the rear end of the gills, at a point in the upper left of the figure.

The food of the oyster consists entirely of minute animal and vegetable organisms and small particles of organized matter. Ordinary sea water contains an abundance of this sort of food, which is drawn into the gills with the water, but as the water strains through the pores into the water tu. the food particles are caught on the surface of the gills by a layer of adhesive slime . ·h covers all the soft parts of the body. As soon as they are entangled the cilia strike gainst them in such a way as to roll or slide them along the gills toward the mouth. When they reach the anterior ends of the gills they are pushed off and fall between the lips, and these again are covered with cilia, which carry the particles forward until they slide into the mouth, which is always wide open and ciliated, so as to draw the food through the œsophagus into the stomach. Whenever the shell is open these cilia are in action, and as long as the oyster is breathing a current of food is sliding into its mouth.[a]

The food then passes to the stomach, is acted on by the fluids from the liver, and moves along the intestine. The nutritive portion is

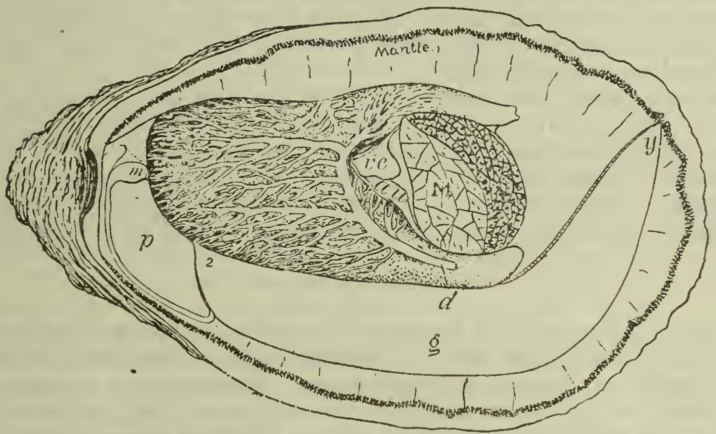

FIG. 1.—Diagram of dissection of oyster to show reproductive organ, consisting of the branching tubules spread over the dotted portion. *au*, auricle of heart; *d*, external opening of reproductive organ; *g*, gills; *M*, adductor muscle; *m*, mouth; *p*, palps; *ve*, ventricle of heart; *y*, posterior end of gills. About natural size. (After Moore.)

absorbed and the feces are thrown out the vent in long, ribbonlike form and carried outside the shell with the stream of water passing out from the chamber over the gills.

The position, form, and general appearance of the reproductive organs of the oyster are the same for both sexes. Really there is but one reproductive organ, which consists of a mass made up of microscopic tubules and connective tissue lying between the folds of the intestine and investing it and the stomach and liver in such a manner as to cover the visceral organs when the opened oyster is viewed from either side. In Plate II most of the reproductive organ has been removed, a small portion being shown about the folds of the intestine. Text figure 1 represents an oyster with the left valve and mantle removed, showing the reproductive organ as it appears from the left side, covering the visceral mass and partially surrounding the heart and adductor muscle. Numerous ducts arise from the organ, unite into one and open at point *d* below the adductor muscle. A view

[a] Brooks, W. K. (1880. p. 9.)

of the right side of the organ would present practically the same appearance, there being a similar system of ducts opening on that side beneath the muscle. Through these two openings the genital products are discharged into the water at spawning time.

LIFE HISTORY.

TIME OF SPAWNING.

The oyster may spawn when the water reaches a temperature of 68° F., but spawning proceeds at normal speed only when the water is 70° or above. For this reason the spawning period varies in different regions, depending on the temperature of the water, which is regulated by the depth of the water and the general meteorological conditions. Shallow bodies of water, even though in more northern latitudes, often become warm as early or earlier than deeper waters farther south. In the north, where the season is shorter, the spawning period is relatively short, often lasting only two or three weeks, while in the south oysters may be found in a spawning condition from early spring until fall.

In Long Island Sound, the bulk of the oysters spawn about the last of July; in Great South Bay, spawning occurs from about June 5 until after the Fourth of July. In New Jersey waters spawning begins about June 1. Spawning extends in Chesapeake Bay from May until September. On the Gulf coast, spawning begins in March and spawning oysters may be found as late as November.

REPRODUCTION.

In spite of the fact that the sex of the oyster can not be distinguished by the external appearance of the shell, of the body, or of the reproductive organs, the sexes are separate. Some oysters are male, the reproductive organs developing spermatozoa or milt; other oysters are female and produce ova or eggs. While it has at times been stated that the sex might change from year to year, an oyster being perhaps male one year and female the next, or the reverse, there is no evidence on which to base this belief, except some inconclusive researches made nearly 50 years ago and not borne out by subsequent investigations. It can be almost conclusively stated that the sex of the eastern oyster is permanent and does not change during the life of the individual.

The sexes can be distinguished only by an examination of the products discharged by the reproductive organs. The spermatozoa and eggs are so extremely small that a lens must be employed to distinguish one from the other. The eggs (Pl. III, fig. 2) vary from roughly pear-shaped to oval or nearly spherical and measure about $\frac{1}{500}$ of an inch in diameter. It is estimated that a female oyster will produce over 16,000,000 eggs. The male genital products, or spermatozoa, are many times smaller than the eggs. Each spermatozoon (Pl. III, fig. 1) is made up of a head about $\frac{1}{10,000}$ of an inch in diameter, pointed at one end and flattened at the other. To this flat base is attached a very slender threadlike tail about 20 times the length of the head. This tail lashes about and moves the spermatozoon around in the water after it has been discharged by the male oyster.

Fertilization of the eggs occurs in the water. The oysters, male and female, lying about over the bottom, at spawning time discharge the reproductive elements into the water where they mingle as chance nay bring about. The more numerous the oysters on a particular ɔed, the greater the chance of the actively moving spermatozoa neeting the eggs. The spermatozoa swarm around the eggs, many ıbout each one, until a spermatozoon penetrates the egg membrane, he head only of the spermatozoon passing on in, the tail dropping ɔff. The material of the head unites with that of the egg, and mportant changes in the latter are thereby initiated.

The single cell of the egg begins to divide into many cells and to change its form and in the course of from 5 to 10 hours develops nto a small oyster larva, which swims by means of fine hairs or cilia on the outside of its body. A shell then begins to develop and soon covers the entire body, so that the larva resembles a tiny hard clam. A definite organ of locomotion also appears, consisting of a disk, nown as the velum, borne on the end of a thick stalk which is proruded from between the valves of the shell in front. The disk ɔears cilia which by their movement enable the larva to swim about apidly (Pl. III, fig. 4). When the velum is retracted the larva ettles to the bottom.

The larva is now about two days old and measures about 0.08 mm. n length. As it increases in size certain elevations, the umbones, an be noted on the upper part of the hinge, one on each side. Shortly ne valve becomes much deeper than the other, and the umbo on t much more prominent than that on the right side, and by this haracteristic the oyster larva may be readily distinguished under he microscope from the larval form of any other bivalve. The leeper valve is the left one and that by which the oyster later becomes ttached. During the advanced stages of the larval form, the left ımbo is very conspicuous, jutting back in almost the form of a ıook (Pl. III, fig. 3).

The period passed through by the oyster larva from the developnent of the cilia, a few hours after fertilization, until it "sets" or strikes" is known as the free-swimming stage. Although the ırva swims about freely in the water, being so small, its movenents and location at any particular time are largely subject to the ides and currents. The free-swimming period lasts from about 14 o 18 days in the more northern waters and a somewhat shorter ime in the southern. The warmer the water the more rapidly evelopment occurs and consequently the shorter the free-swimming eriod.

At the close of the free-swimming period, when the oyster is about ne-third of a millimeter (one seventy-fifth of an inch) long, it "sets" the proper conditions are present. It attaches itself by the left alve to some surface in the water, a rock, shell, stake, in fact almost ny object (Pl. IV).

The first essential is that the surface should be clean and that it should remain so sufficient length of time to enable the young oyster to firmly establish itself. So ng as this condition obtains, the nature of the material seems to matter but little. ı most bodies of water the spat fixes itself at all levels from the surface to the bottom ıt in certain parts of the coast its place of attachment is confined to the zone between gh and low water, the midtide mark being the place of maximum fixation.[a]

[a] Moore, H. F. (1897, p. 274.)

Once secured, the swimming organ disappears and the oyster never wanders again of its own volition.

GROWTH.

The shell is secreted by the mantle, the membrane lining the shell. Horny material is first deposited over the outer surface of the mantle, and to this is added lime, forming the familiar hard shell. As the mantle increases in size with the general growth of the rest of the body, and as it can be extended somewhat from between the edges of the valves, new shell material is added to the inner surface of the valve and to the outer edge. This makes each valve thick in the central portion, sloping to a condition of extreme thinness at the edges. The outer edges of the valves of a rapidly growing oyster are so thin and knifelike that care must be exercised in handling them to avoid cutting the fingers.

The rate of growth of oysters varies widely, depending on temperature, density and food content of the water, season of the year, and other factors. Its growth is more rapid in the warmer southern waters than in the colder northern. In Long Island Sound about four years are required for an oyster to reach a length of 4 to 5 inches, or marketable size. In southern waters that size is reached in two years. Oysters if left undisturbed may attain a length of 8 to 10 inches or more. While the exact age which an oyster may reach can not be definitely stated, oysters have been found which appeared from the number of layers in the shell to be at least 15 years of age.

Oysters which have unrestricted space for growth acquire the normal shape shown in Plates I, XX, and XXI. When crowded together, the shape becomes modified, even greatly distorted at times. Often numerous set will fasten upon a relatively small piece of cultch, and as growth proceeds a crowded cluster of oysters will result. If broken apart by pressure of growth or by artificial means, their shape will improve.

The crowding of oysters reaches its climax upon the "raccoon" oyster beds. Raccoon oysters are usually found in localities where the bottom is soft and the only firm place which offers itself for the attachment of the spat is upon the shells of its ancestors. Temperature and other conditions are favorable, growth is rapid, the young oysters are crowded into the most irregular shapes, the shells are long, thin, and sharp-edged, and eventually the mass of young is so dense that it crowds out and smothers the preceding generations which produced it and offered means for its attachment. Oysters crowded in this excessive manner are poor-flavored, as well as ill-shaped, but both defects are corrected if they be broken apart, as may be readily done, and planted elsewhere.[a]

FACTORS OF ENVIRONMENT.[b]

TEMPERATURE OF WATER.

The fact that the oyster is found from Cape Cod to Mexico shows that it can become adapted to living in waters of considerable difference of temperature and in certain regions may withstand wide changes during the course of the seasons. In Long Island Sound

[a] Moore, H. F. (1897, p. 275.)

[b] The outline of this section, "Factors of Environment," and of the one following, "Natural Beds," and the details of certain topics therein, specifically stated in each such case, are substantially as prepared by Dr. H. F. Moore, Deputy Commissioner of Fisheries, for an uncompleted revision of his "Oysters and Methods of Oyster Culture" (1897).

he temperature over the oyster beds falls in winter nearly to 32° F., he freezing point, and in summer rises to 72° in deep water and 75 to 78° over the inshore beds. In Chesapeake Bay oysters in ertain shallow water beds withstand variation from the freezing oint, below 32 to 90° F.[a] In the Gulf of Mexico the usual range f temperature over the oyster beds is from 50 to 90° F. The relaion between temperature and the spawning of oysters has been liscussed on page 12.

DENSITY OF WATER.

The higher the proportion of salt contained in sea water the reater the density. Therefore, it is common practice to estimate he proportion of salt by measuring the density of the water with the alinometer. This consists of a glass bulb with a narrow stem at one nd on which are gradings reading from 1.000 to 1.031. The bulb s weighted at the end opposite the stem, so that it will sink somewhat below the surface, leaving the stem projecting from the water. he less salt in the water the less the density and the lower the alinometer will sink. Fresh water is arbitrarily considered as .000 and the point on the stem of the salinometer to which the water eaches when the instrument is placed in fresh water is so marked. rades are marked below that on the stem, the bulb rising higher n the water the greater the density. The highest grade is usually .031. For convenience three bulbs are usually used, one reading rom 1.000 to 1.011, one from 1.010 to 1.021, and one from 1.020 to .031. Common sea water usually reads from 1.025 to 1.026 on the alinometer. Oysters are found in water ranging in density from .002 to 1.025, but can not withstand densities lower than 1.007 or indefinite periods. In general they seem to thrive best in ensities between 1.011 and 1.022.

Oysters are not usually found out in the main body of the seaater, away from the influence of the fresh water from the streams, here the density is 1.025 or more. It will thus be apparent that ysters have become adapted to a certain range of densities, and atural beds have grown up at points fairly close to shore or in iclosed bays where the salinity of the seawater is modified by the iflowing of fresh water.

MUD, SILT, AND SUSPENDED MATTER.[b]

A bottom composed of slightly shifting sands or of very soft mud ito which the adult oysters will sink and on which the minute spat in gain no firm support is alike unfavorable to oyster culture and the development of natural beds. If, however, hard objects be istributed on or above such bottoms they will become collectors of oat so long as they remain clean and free from slime or sediment, id if it be desired to produce permanent beds or to catch the floatig spat for the purpose of seeding other beds it is manifest that, ie scouring action of the currents being equal, waters containing minimum of sedimentary matter are to be preferred to those more less laden with mud.

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[a] Moore, H. F. (1897, p. 280.)
[b] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

In this connection a distinction must be drawn between beds used for seed production and those employed in growing and fattening stock for the market. Oysters will frequently grow more rapidly in silt-laden waters, on muddy bottoms, or in their vicinity, than they will elsewhere, as such places are usually more productive of food organisms, owing to the larger amount of dissolved material available for the sustenance of the minute plants which constitute a considerable part of the food of the oyster.

Even adult oysters may be destroyed, however, by heavy deposits of silt such as often result from freshets and crevasses. For the purposes of seed culture or the establishment of self-perpetuating beds the most desirable waters are those which contain an abundance of microscopic vegetation with a minimum of suspended inorganic particles, although an organic slime such as rapidly forms on submerged surfaces in some localities is as effective in preventing the fixation of spat as is inorganic sediment. In many places in Chesapeake Bay and in the bays on the New Jersey coast the sediment, as well as the bottom mud, is largely composed of finely comminuted fragments of seaweeds and other vegetable matter the rapid deposit of which soon covers with a flocculent film the surfaces of all objects exposed to it, excepting when the currents are sufficiently strong to exert a scouring influence. During warm weather this organic deposit is likely to undergo rapid decomposition, the toxic products of which sicken and kill the oysters.

The more or less constant dribbling of fine material upon the bottom has comparatively little effect upon adult oysters, operating mainly to cover the shells and prevent the attachment of spat or to stifle the young oysters after attachment. This rain of fine material occurs almost everywhere but especially where the currents are weak, and it is generally in the latter localities that it is of sufficient volume to be obnoxious.

TIDES AND CURRENTS.

The effects of tides and currents upon the development and growth of oysters are quite important. The genital products, cast directly into the water as previously stated, are moved about so that more opportunity is afforded for the contact of the spermatozoa of the male with the eggs of the female.

The free-swimming larvæ are carried to and fro by the tides and currents, and thus when large enough to set are often some distance from where they were spawned. The importance of this fact in the method of oyster culture by planting cultch is very great and the matter is discussed under a separate section on page 31.

Tides and currents tend to prevent the fouling of material upon which the larvæ set by washing away silt and débris. In still water, as in an inclosed bay, the suspended débris has an opportunity to settle upon the cultch and form a slime and film which prevents the attachment of the larvæ. If the larvæ have attached, the deposit is often sufficient to smother them.

Since the food of oysters consists of microscopic materials found in the water (see p. 19), it follows that currents affect the distribution of the food of the oyster. In still water, nearly all the organisms might settle to the bottom or those in the neighborhood of the oyster might become exhausted. Currents keep the material agitated and cause a fresh supply to sweep across the oyster beds.

Movement of the water also brings a fresh supply of oxygen to the oyster which aerates the blood by oxygen derived from the water passed through its gills.

DEPTH OF WATER.[a]

The known vertical range of oysters under natural conditions is from or near high-water mark to a depth of about 130 feet, the latter extreme occurring over densely stocked and productive beds in Patuxent River, Md. In a large part of the oyster region of South Carolina the natural beds occur almost exclusively between high and low water marks, and some of the beds of Florida are similarly situated, the oysters growing on the aerial roots of mangroves, as they frequently or generally do in Porto Rico and others of the West Indies. In places on the Gulf coast oysters set and grow in limited numbers in the grass on the edges of the marsh prairies above the level reached by many high tides, but in such situations they are frequently killed by freezing.

In the Mississippi delta region a good set is often obtained on cultch planted at or near high-water mark, but the young oysters are removed to deeper water before cold weather arrives.

Elsewhere oysters are rarely planted in this country on bottoms exposed at low water. In most places comparatively shallow depths ranging from 2 to 12 or 15 feet are utilized in oyster culture, but in Long Island Sound the practice has been successfully extended to depths of 60 feet or more.

FRESHETS, STORMS, AND ICE.[a]

Freshets occur with more or less frequency in the rivers discharging near the oyster beds of many of the South Atlantic and Gulf Coast States, and with them are to be classed the crevasses or breaks in the levees which sometimes accompany high water in the coastal streams of Louisiana.

The effects of a freshet are twofold. The most immediate effect is that, owing to the vastly increased volume of fresh water discharged, the salinity of the water over the oyster beds is reduced far below the normal and in many cases becomes fresh or practically so for considerable periods. As already stated in another connection, this is often fatal to the oysters already on the beds, and, even when this is not the case, the production of a set is inhibited during the prevalence of the abnormal conditions.

Freshets also carry large quantities of mud and débris scoured from old channels and washed from the land, and as the currents slacken in the bays and estuaries, where the oyster abounds, their carrying power diminishes, and the materials are dropped on the beds. If the deposits so made be deep, the old oysters may be killed, while even a light deposit is sufficient to prevent the attachment of spat until it be again gradually scoured from the shells and other hard bodies on the bottom.

[a] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

It sometimes happens that a freshet of unusual severity, while disastrous in its immediate effects, results eventually in an increased productiveness of the beds. If the disaster be due to a prolonged freshening of the water without an undue deposit of silt, the shells are often left in a much-improved condition. This is apparently due in part to the more active scouring action of currents of more than usual velocity, but mainly to the destruction of the organic slime, which often covers the shells in sea water, and the cultch is thereby left in a more favorable condition for the attachment of spat carried from more or less distant beds. The fresh water also exterminates the drills which feed on the little oysters, and, as Dr. Moore's observations of improved sets under the conditions described indicate that sets usually occur in waters of rather high normal salinity, where the drill ordinarily thrives, it is probable that this action of the fresh water is no unimportant beneficial factor. The oysters, from the nature of their reproductive and developmental characteristics, are able to reestablish themselves much more rapidly than their enemies.

Gales, to have an effect on adult oysters in moderately deep water, must be of extraordinary severity, but they frequently do great damage or exterminate beds in shoal water. The waves sometimes pick up the oysters and throw them on the beach, but more frequently they are destroyed by being buried in situ by sand, seaweeds, and débris piled up by the sea. Cases are known of where well-established beds have been overwhelmed by such deposits and others in which thick strata of sand between layers of old shells indicate a succession of such disasters in the more or less remote history of the beds.

Sometimes the eroding effect of currents and waves will uncover the buried oysters and shells, and the beds will again reestablish themselves through the attachment of young; but in other cases the beds are permanently destroyed. The former is the usual result when the reefs rise rather abruptly from the surrounding bottom, and the latter is frequent when they are but little elevated above the general floor of the sea. Planted beds, which usually lie at the general level of the bottom, are usually permanently covered.

Gales are sometimes agents in the establishment of new beds, carrying oysters and shells to surrounding barren bottoms, where they form a nucleus that gradually develops into economic importance. Certain productive beds at the eastern end of Mississippi Sound, by character and by repute, appear to have been so established.

The free-swimming larvæ are more susceptible to the weather conditions than are the adults, and cold rain storms, which would have no effect on the latter, undoubtedly kill large numbers of the swimming young. This was first noticed by Ryder and has been amply corroborated.[a]

Ice is occasionally destructive to oyster beds quite independently of the factor of temperature. When heavy ice grounds at extremely low tides, it sometimes crushes the oysters or presses them into

[a] The author and J. S. Gutsell, during the study of the occurrence of free-swimming oyster larvæ in Great South Bay, 1919, found that the average number in 50 gallons of water was 8,339 on July 8. A violent squall and rain followed, together with a drop in temperature of 5° F. On July 11, as soon as collections could be made, the average number had dropped to 3,558 larvæ per 50 gallons of water.

the bottom, and occasionally they freeze fast to the underside of the ice and are carried away when it floats.

FOOD OF THE OYSTER.

The food of the oyster consists of microscopic plants and animals and organic detritus growing or found in the water on and above the bottoms on which the oysters lie, or carried to such waters by currents.

A large proportion of the oyster's food is made up of the plant forms which are known as diatoms. There are many species of diatoms, typical forms being shown in text figure 2. Diatoms are found in more or less abundance in almost all waters, varying greatly

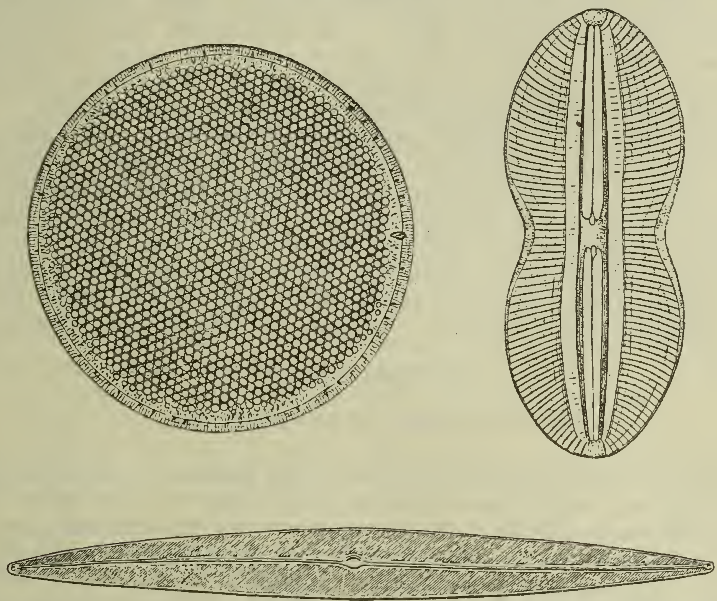

FIG. 2.—Typical diatoms, which make up a large part of the food of the oyster. Magnified about 500 times. (After Moore)

in numbers in different places and at different seasons in the same place or in the same season of different years.

Diatoms derive their sustenance from the various organic materials washed down from the land and held in solution in the water. These organic fertilizers consist of decayed and decaying vegetable and animal matter gathered up from the land by the water resulting from rains and carried down streams and rivers to the sea. The food supply of oysters is thus directly affected by the character of the soil adjoining the tributaries leading to the water over the beds, by the kind and amount of forest or other vegetation and animal life on that soil, by the industries carried on there, and by the amount and seasons of rainfall.

While a large portion of the food of the oyster is made up of diatoms, considerable numbers of microscopic animal forms are also eaten. The recent work of Dr. T. C. Nelson [a] shows that a larger proportion of the oyster's food is of this nature than was formerly supposed. Copepods, or "water-fleas," the free-swimming larvæ of snails and bivalves (including the oyster), worms, rotifers, and protozoa have been found in the stomach of the oyster. These animals, like the plants, are found in greater or less abundance in all waters. A systematic effort to ascertain the food content available for oysters in any particular water should include the determination of the quantities of the suitable animal as well as plant forms present.

Dr. Nelson kept under observation a number of oysters in water shallow enough for a system of wires and levers to be connected with the shells in such a way that the opening and closing of the valves were recorded on a revolving smoked drum or chimograph in the floating laboratory above. It was found that, during the summer months at least, the oysters remained open, and consequently feeding, for 19 to 20 hours out of 24. Feeding is thus evidently a fairly continuous process during the warmer months.

Organic detritus or débris resulting from the decay and disintegration of plant and animal life undoubtedly contributes to the food of the oyster. As the diatoms and other plant forms become broken up some of their fragments are ingested by the oyster, and a certain amount of nutriment is derived therefrom. After death, animal forms disintegrate and release fats, albumens, etc., into the water. It has been found that the fresh-water mussel may make use of such products, and probably the same is true in the case of the oyster.

NATURAL BEDS. [b]

DEVELOPMENT AND DESCRIPTION.

A natural oyster bed is an area of the bottom on which oysters have become established without the voluntary and intentional agency of man. In law, the term is usually held to include only such bottoms as bear oysters in sufficient quantities to make fishing for them by legitimate methods a means of reasonable livelihood or areas which have formerly been such and whose present character indicates a reasonable likelihood that they may again become productive. The only difference between natural and artificial beds lies in the fact that the latter originate by the intentional act of man, whereas the former arise from natural conditions purely, from accident, or from unintentional human agency incidental to other works and purposes. In most cases the natural beds, and especially the larger ones, have been produced by the operation of factors in which man has no part, and we know nothing of their origin. In a few instances, small beds have been caused by shipwrecks and other accidents; but on the other hand there are many beds, some of them very productive, which have grown on ashes and similar material thrown overboard from vessels and upon shells culled from the live oysters by oystermen and strewn at random over the bottom. Whatever their origins, all oyster beds, if left to

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[a] Nelson, T. C. Forthcoming report, N. J. Agricultural College Experiment Station.
[b] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

themselves will assume the same general physical and biological characters in so far as their environments permit.

The natural beds of the Atlantic and Gulf coast practically all lie like islands in a sea of mud more or less soft. In some places the oysters are in clusters rooted in the mud, in others the substratum is hard to a greater or less depth, but examination will show that this hardness is in most cases superficial, and below it lies mud of a consistency corresponding to that which surrounds the bed. There are a few beds which have grown on rocky bottom, and there is a larger number lying on firm, unshifting sand; but there are few rocky outcrops on the coast south of New England, and most sandy areas tend to shift more or less and engulf such oysters and shells as may be lying on them. The oyster is an inhabitant, par excellence, of the muddy bays, sounds, and lagoons, and in them attains its best development.

In tracing the history of any oyster bed, reference must be made to the nature and characteristics of the young oyster as it develops from the egg. As has been explained on page 13 the embryo oyster is a minute organism endowed with certain feeble powers of locomotion, which are sufficient for awhile to keep it suspended in the water and permit its being carried by the currents. In some cases it may be carried several miles from its parents before the setting stage is attained. The chances are many that when this happens it will lodge on mud and end its story, for so small is the larva at this stage that a mere film of ooze suffices to stifle it. If, however, by rare good fortune it, at this time or just before, comes into contact with a shell, pebble, twig, rocky ridge, or other clean body, whether at the bottom or not, it speedily attaches itself and continues its growth.

So abundant is the supply of larvæ in any prolific oyster region that ordinarily several or many will attach to each square inch of clean surface, and a shell may furnish attachment for a hundred or more. Under such circumstances there soon begins a struggle for existence that is none the less rigorous for being purely passive. As the young oysters grow there is not room for all, and the more vigorous ones, themselves distorted by the crowding, overgrow, stifle, starve, and eventually kill those of slower growth or less advantageously situated. At the end of the first year there has developed a cluster of perhaps from two to a dozen young oysters growing on the original shell, all projecting upward and crowding one another into long, narrow shapes. Upon the projecting mouths of these shells there is another set of spat on the succeeding year, and as this grows some of the survivors of the earlier generation are in their turn crowded and killed. The result of this is that in the course of a few years there is formed a cluster like an inverted pyramid with its apex being gradually driven into the mud by the increasing weight above, while its broad base is made up of several generations of living oysters attached to the dead shells which constitute the middle parts. The oysters around the edge where they have room to grow are often of fair shape and quality, while those more centrally located are irregular, long, narrow, and usually poor, owing to their crowded condition and difficulty in obtaining food.

From the decay of the hinge ligaments of the dead valves, the corroding effect of boring animals, and the solvent action of seawater on the limy shells, these top-heavy clusters tend to break up under their own weight and under the force of the waves. On hard bottom the disintegrated parts are rolled about and more or less evenly distributed, resulting eventually in the production of other similar clusters scattered at intervals. On soft mud the shells can not roll so readily, and they fall and remain close to the base of the original cluster, where, if not completely engulfed, they form places of attachment for new generations. If the mud be very soft they sink for a short distance and accumulate until they harden the bottom and form a firm support for the shells which fall later, and which in turn are covered with a growth of young.

As these phenomena recur year after year the original single cluster gradually extends around its edges now more or less at the top until it becomes converted into a little bed composed of a dense mass of clusters, with its boundaries sharply defined and limited by the soft mud surrounding it. A number of other clusters have probably been growing simultaneously on the same muddy bottom, and, the areas between becoming narrowed and obliterated, there results a great flat bed made up of a number of smaller patches separated by a muddy network. Where a deep, muddy channel occurs the oyster growth usually stops near the edge of the slope, the shells which would else serve as clutch sinking down into the deep soft ooze. Opposite the mouths of smaller streams, even where there is no such deep channel, the oyster growth is also inhibited, partly by the freshness of the water, but principally and often entirely by the deposit of silt which soon spreads its thin coating over everything lying on the bottom. In some cases the beds may be completely interrupted, but in others they are continuous in their offshore part, passing by and inclosing the unfavorable area as an oval or subtriangular barren, muddy patch surrounded, excepting on its shoreward side, by productive oyster bottom.

It is difficult to say what may have been the condition of the natural beds in Chesapeake Bay before they were disturbed by man, but at the present time they are essentially in the condition so far described, though with their boundaries often ill-defined and the clusters usually smaller and less dense as a result of tonging and dredging. They usually exhibit no great depth of shells, though the bottom is more or less hardened by their accumulation in the underlying mud. They usually extend alongshore, their greatest length in the direction of the currents and their width extending from a couple of feet below low water toward, and often to, the edge of the deep, muddy channels.

In South Carolina and adjacent regions the beds are of essentially the same type, excepting that they are smaller and narrower, and particularly that they are crowded closer to the shores and almost entirely confined to the area between high and low water, a situation impossible in Chesapeake Bay and more northern regions, owing to the killing cold of winter.

Further development in the history of natural oyster beds beyond the stage which has been described results in a gradual thickening of the deposit of shells and the production of a short reef or lump, with a more or less distinct shoaling of water over its top. The living oysters standing vertically in the dense mass, with their growing tips directed upward and kept clean by the currents, present the only available place for spat fixation. Each year the set occurs on preceding generations, raising the living parts of the bed higher above the bottom, while the interstices beneath become filled with old shells, fragments, sand, and mud to form a compact mass. Eventually, in shallow water, the living oysters approach low-water mark or in some parts of the coast rise above it, where their progress is arrested by cold or long periods of exposure to the air.

Each year a set may occur only to be killed in winter, the dead shells, fragments, sand, and mud piling up under wave action, until the crest may become raised to a level several feet above high water, producing a shell island usually surrounded by a more or less dense growth of live oysters. Such islands are not uncommon in the South Atlantic and Gulf States, and they frequently accumulate in time a growth of grass and brush, which more or less obscures their true character. Sometimes the material is thrown up around their edges atoll-like, leaving a depression in the middle in which muddy deposits collect and support a growth of brush. In places where the bottom is composed of very soft mud the sides of these lumps are comparatively steep and soundings will change 1 or 2 feet within a few yards, the difference being due to the depth of shells and oysters.

In open waters, not especially subject to freshets, where the currents are moderate and the silt carried not excessive, such lumps tend to maintain a round or oval outline, with no great difference between the long and short diameters; but where the currents are rapid or the bodies of water constricted, there, as soon as they rear themselves well above the bottom, they show a strong tendency to grow transversely to the tides, especially if the water be silt-laden. Such long, narrow reefs are common in the rivers of North Carolina and in the bays and rivers of Florida, Alabama, Louisiana, and Texas. In James River, Va., and probably in other rivers of the Chesapeake region, the beds, while often showing their greatest extent in the direction of the current, usually have their shoalest parts transversely to it or are made up of a series of transverse shoals and ridges composed of a dense mass of shells and fragments.

The reasons for this transverse development are as follows: The upgrowing reefs form partial dams or obstructions to the flow of the currents, and, in accordance with well-known laws, cause eddies or backwaters on both the side presented to the current and on that sheltered from it, in tidal waters the two being periodically reversed with the reversal of the tide. When the velocity of a silt-laden stream is checked, it deposits part of its load in the slack water, and, under the conditions stated above, mud falls on the upper and lower sides of the reef, while the somewhat accelerated flow around the ends scours the shells and keeps them clean and fit to receive fresh sets of young oysters. These factors operate more energetically the more heavily silt-laden the water, and they would become nonoperative in perfectly clear water. Not only does heavily silt-laden water deposit more mud when its velocity is checked, but it scours more energetically when its velocity is accelerated, the particles of sand and other materials carried in suspension, acting as so many small brushes to rub off such materials as may have previously lodged. The greater volume of water passing the ends of the reef has still two other effects—it brings a large number of swimming larvæ in contact with the shells and it carries more food to the oysters living there. Clean cultch, abundant larvæ, and ample food, three principal factors in heavy production and rapid growth of oysters, are, therefore, found better fulfilled at the ends of the reef than at the sides lying across the currents. This tendency to transverse growth once established is increased with every increase in the length of the reef, the jetty effect, retarding the flow of water in one place and accelerating it in another, becoming more pronounced.

It frequently happens that reefs similar in general character to those just described begin their development from or close to the shore, usually at projecting points. They grow, of course, principally at their outer ends and extend outward from the shore at right angles to the current, maintaining a nearly uniform width throughout their length.

In the foregoing description of natural beds consideration has been given solely to the oyster itself, but the conditions are always complicated by the presence of other organisms between which and the oyster there are more or less complex biological relations. Some of the minute forms, especially the plants, constitute the oyster food, while many of the larger species either prey actively on the oyster or its young or compete with it in the struggle for food, oxygen, and space in which to grow.

DEPLETION.

Until the last 40 years the majority of the oysters taken from Cape Cod to Mexico came from natural oyster beds which covered an area of such great extent that they were regarded as inexhaustible. That this belief is quite erroneous is shown by the fact that on the northern parts of the coast, where the temperature is about the minimum for the support of oysters, the natural beds have disappeared or have become sadly depleted. Those of Massachusetts are greatly exhausted, and few are found in Narragansett Bay. On the Connecticut coast only two beds of importance remain—one in the mouth of New Haven Harbor and one west of Stratford Lighthouse, near Bridgeport. There are very few in New York waters. Many of the beds of Chesapeake Bay are seriously or quite depleted, although many still remain. From that point southward the depletion has not been nearly so great, as the oyster fishery has not been pursued as vigorously and the environment has been such that the oyster reproduced much more abundantly than in the north, where a failure to obtain set is only too common.

In some cases the depletion or destruction of natural beds is the result of natural causes, such as the cutting off of the inlet to a bay or sound and the reduction of the salinity of the water; the covering of the beds with silt, débris, and fresh water during a freshet; the shifting of sand or mud by storms; or the inroads of living enemies.

The greatest enemy to the oyster, however, is man. Most of the depleted condition of the natural oyster beds is the result of careless overfishing by oystermen. The beds are stripped down so completely that not enough adult oysters are left to furnish sufficient spawn to insure a subsequent crop. Although millions of eggs and spermatozoa are produced, those products are thrown into the water, where many of the eggs fail of fertilization; many eggs and larvæ die or are eaten by enemies; and many fall at setting time on soft bottoms and are smothered. The percentage that finally reaches the adult stage is relatively small. For that reason too complete removal of the adult oysters from a bed destroys hope for an ensuing generation.

During the past 40 years certain methods of oyster culture have been developed, especially in certain regions, whereby new beds have been built up and a constructive system of increasing the oyster supply has been initiated in addition to the negative one of restrictions on fishing, such as close seasons and the like. Biologists have become concerned in this work, and efforts have been made to promote, by experimentation, methods for the improvement of oyster culture.

CULTIVATION.

From the table on page 5 it will be seen that about half the oysters produced in the United States are taken from private or planted beds, the rest coming from natural or uncultivated areas. It will also be noted that in New England over 90 per cent of the oysters are produced on planted beds, that in the Middle Atlantic States the natural beds are considerably in excess, and that in the South Atlantic and Gulf States the proportion of natural beds is much higher yet. The table shows, however, that the value of the oysters from the planted beds is nearly twice that of those from the natural. This is due largely to the better quality and shape of the oysters produced by cultivation.

It is intended mainly to set forth here the methods of oyster culture which so far have proved to be commercially successful on the Atlantic and Gulf coasts, together with such suggestions concerning their improvement as biological science has to offer. Since there yet occasionally arise false hopes that the so-called artificial propagation, or the hatching and rearing of oysters in tanks or ponds, as is done in the case of fish, is on the verge of practical accomplishment, it may be well to dispose of this matter before proceeding to the treatment of the successful methods mentioned above.

ARTIFICIAL PROPAGATION.

This attempted method of oyster culture can be treated most simply by stating that its perfection and practical application are substantially no nearer solution than when the problem was opened up by Brooks (1880, pp. 10 to 18). He succeeded in artificially fertilizing the oyster eggs with spermatozoa of the male oyster and in rearing some free-swimming larvæ to the age of four or five days. Brooks's methods are in themselves not difficult, and the experiment has been repeated time and again both by biologists and laymen. Owing, however, to the immense practical difficulties of restraining the microscopic larvæ in receptacles or tanks and at the same time providing for a change of water and the introduction of the proper food and removal of waste, no one has succeeded in rearing many of the larvæ until they attach to cultch. It would seem, moreover, impossible to do this on a scale sufficiently large to be of practical application in the oyster industry.

The same statements are true regarding the adaptation of this method, in which attempts were made to substitute for the tanks ponds connected by narrow inlets or ditches with tidewater. While elaborate designs have been constructed for the manipulation of such ponds and the catching of set on cultch placed in the ponds or the connecting ditches, none has proved to be of any practical value whatever. The principal difficulty seems to have been that, in the effort to confine the set to the pond, too scanty an inlet was provided for the entrance and exit of the tide, and the oysters suffered in consequence. In the cases where efforts were made to catch the set on cultch placed along the connecting canal, if the latter were broad enough to allow sufficient rush of water to keep the cultch clean, most of the set passed out to sea.

Oysters, on the other hand, will reproduce, grow, and fatten in ponds or inlets to which the tide has access in sufficient volume to render the water properly saline, provide the requisite food, and remove the débris. The set from such oysters is at the mercy of the tide; some may be caught in the pond or inlet, and some will be carried outside. In France ponds or "claires" are profitably maintained for the growth and fattening of oysters. The seed oysters placed therein consist of set from outside oyster beds which has been caught on collectors placed in the water along the beach.

While it can not be said that the problem of so-called artificial propagation may not be solved at some future time, for the present it must be emphasized that oyster culturists should base no false hopes on the practical application of this method.

In view of the barren results of 40 years' experiments in this line, it is best to devote attention to the amplification and perfection of methods which have proved to have a certain measure of success and which are applicable to the industry as carried out on such a vast scale in the United States.

LEGAL CONSIDERATIONS.

PROCURING GROUND.

In order to carry on oyster culture either by catching set or planting seed oysters, it must first be ascertained whether ground for that purpose can be leased or otherwise obtained from the State and, if so leased, whether public sentiment is such that the laws will be respected and enforced. In some States ample provision is made for the rental of oyster grounds and the lessee is protected. Oysters are not taken from his beds any more than corn is taken from a man's cornfield. In other States conditions have been in the past such that protection of leased ground, if attempted at all, was an absolute failure. Considerable improvement is noted, however, in this respect within recent years.

In selection of ground for locating oyster beds care must be exercised to avoid waters into which trade wastes are discharged in quantities sufficient to kill either the free-swimming larvæ or the oyster after it has set. It has been found that certain trade wastes from factories are injurious to oysters if present above certain concentrations. Further, the Federal and State health laws must be borne in mind in order to avoid grounds condemned by health authorities because of pollution by sewage. Stringent laws forbid the use of such grounds for raising or fattening oysters.

MARKING BEDS.

Some States employ competent surveyors, and oyster beds are laid out with the aid of ranges, such as important natural objects or special signals set for the purpose. The planters then place stakes or buoys along these lines in such a way that each man knows exactly where his boundary line lies. Such practice is to be highly recommended as tending to avoid disputes and litigation.

METHODS OF OYSTER CULTURE.

Owing to the great size of the oyster beds, to the large number of oysters handled, and to the high price of labor and the relatively low price of the product, it is not practicable in the United States to use the intensive methods of oyster culture employed in European countries, such as France, or in Japan. In those countries, special devices are used for catching the oyster spat and the individual oysters are removed by hand from the collectors and placed on specially prepared bottoms or in ponds for growth and fattening. In the United States, oyster cultivation, in general, is limited to operations which can be carried on by mechanical means on a fairly large scale over areas of considerable size, thousands of bushels of oysters being involved.

Oyster culture in the United States involves two main methods, the catching of spat, or "set," on artificially placed cultch and the planting of "seed" oysters. Where oyster culture is practiced one or the other or both of these processes is carried on, depending on the region and the desires of the planter.

CATCHING OF SPAT, OR "SET."

As stated previously, for some days after hatching the young or larval oyster is free-swimming. At the close of that period, it becomes attached to some fairly smooth, hard surface in the water, usually rocks, shells, etc., on the bottom. Once fixed, it is there for lif and never wanders but proceeds to develop and grow. Failing to make such an attachment, it dies. Both while free-swimming and for a time after fixation the oyster larvæ are referred to by oystermen as "set."

Advantage is taken of this habit of the oyster larvæ, and artificial means are employed to increase the area of suitable surface upon which to "catch a set" of young oysters. Various sorts of material are put down to provide a suitable surface upon which the set may become attached. The material used for such a purpose is known as cultch. The most commonly used cultch is oyster shells, although the light thin shells of other bivalves, especially the "jingle" shells, are sometimes employed. Oyster shells, being available in great quantities from the opened oysters, may be returned easily to the bottoms, thus providing the cheapest, most abundant, and most suitable form of cultch for the large beds cultivated by American oyster planters.

After a set is thus obtained on the shells it may be left there to mature into oysters of marketable size, or the shells with the attached set may be taken up and shifted to other beds. This is commonly done in the fall after setting occurs, but sometimes set is allowed to grow for a year or two and then treated as "seed," which is discussed on page 33.

This method of oyster culture is more extensively practiced in Long Island Sound, Narragansett Bay, on the southern side of Long Island, in New Jersey waters, and in Louisiana than elsewhere. The bottoms are cleaned up by dredging from them the old shells, débris, etc. This is done in May, after the close of the season. The shells are put down during the last half of June or the month of July. In Long Island Sound the old rule was to begin "shelling" the day after the Fourth of July. In Louisiana the shells are put down in June, since the oysters spawn earlier there because of the higher temperature of the water.

For shelling purposes in northern waters, the shells are usually loaded upon large scows (Pl. V, fig. 1) and towed out to the grounds by steamers or gasoline boats. Then while the scow is towed slowly back and forth over the beds, the shells are shoveled overboard by men on the scow (Pl. V, fig. 2). If the ground is new and somewhat soft, sufficient shells are put down to form a firm coating such that the upper layers remain clean and exposed above the mud. In any case, enough shells are put down to form a fairly level continuous layer over the bottom.

In northern waters, examination is made about September 1 to 15 to see whether a set has been obtained. Since many factors—such as time of spawning, condition of the cultch, temperature of the water, storms, currents, etc.—enter in to affect the setting, this is the most critical point in the cultivation of oysters by this method and is the one at which the most failures occur. If no set of consequence has fixed on the shells, sometimes they are left until the following season and "harrowed" just before setting time by dragging over them an oyster dredge with the bag removed. This stirs them up and cleans them somewhat, so that often a fairly suitable surface is provided for the attachment of set. Often, however, they are dredged up and heaped upon the ground beside the oyster house. Here they dry, any oyster enemies upon them dying in the meantime, and may be used over again next season. In case a set (by which the oysterman means a sufficient quantity to be of commercial importance) is found upon the shells, they are either left, in order that oysters may develop on that bed, or are shifted to other beds.

The shifting is accomplished by dredging up the shells, set and all, with ordinary oyster dredges or, rarely, by lifting them with tongs. Sometimes the oysters are moved after attaining the age of one or two years, since growth and fattening proceed more rapidly on some beds than on others, due to differences in food content of the water, etc. In certain places oysters become green, and their sale is hindered by the unsightly appearance. When shifted to certain other beds, this color is thrown off in the course of a few months and the oysters are marketed.

The planting of cultch to catch set is mainly performed on "barren" ground, that is, bottoms practically free from oysters. Such ground is leased from the State or purchased outright by the planters. Some States make ample provisions for such procedure, and the lessee or owner has complete protection for his oysters. In other States public sentiment has not supported efforts to provide for leas-

OYSTER SPAT OR SET TWO OR THREE WEEKS OLD ON INSIDE OF OYSTER SHELL.

Natural size. (After Moore.)

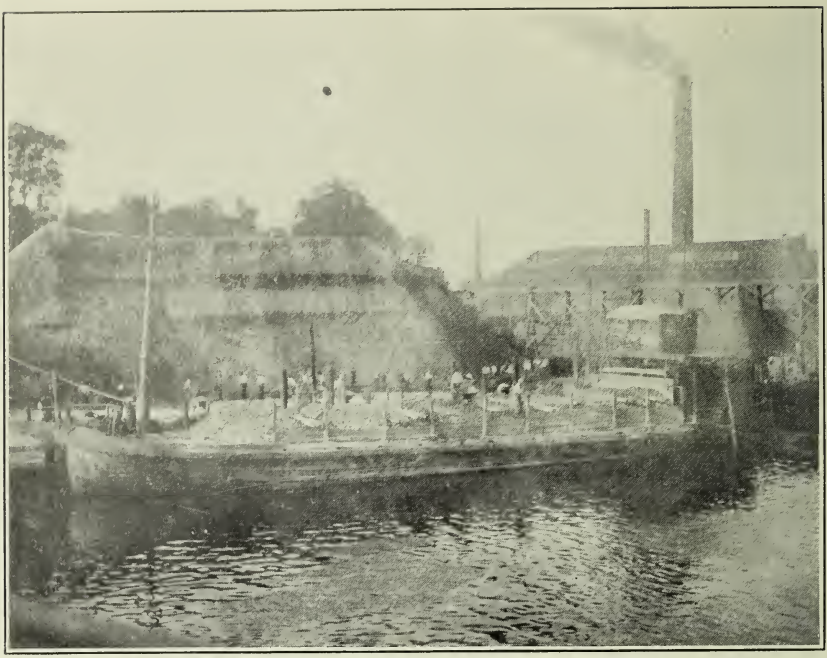


FIG. 1.—LOADING SHELLS ON BOAT FOR PLANTING.

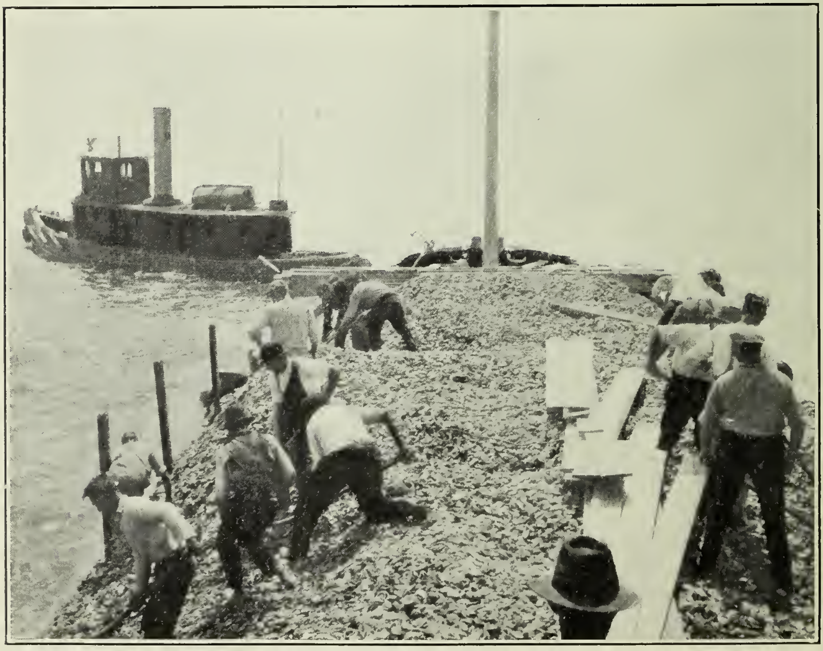


FIG. 2.—PLANTING OYSTER SHELLS IN LONG ISLAND SOUND IN ORDER TO CATCH SET.

The large scow loads of shells are towed by a gasoline boat or steamer.

ing of ground for this purpose and dependence is placed largely on natural beds for the supply of oysters.

In some few cases a State plants a limited amount of cultch upon certain partially depleted natural beds for public benefit. In general, however, the natural beds are staked off and reserved for general public use by the "natural growther" subject to certain restrictions, mentioned elsewhere.

The principal considerations involved in this method of oyster culture are character of the cultch, character and preparation of the bottom, time for planting cultch, the proper location of cultch beds with respect to tides and currents and the spawning oysters, and the location of beds of spawning oysters.

Cultch.—While formerly limited use was made in the United States of various forms of cultch—such as tin cans, bits of pottery, brush, pebbles, "jingle" shells, and oyster shells—only the last three materials have proved to be of practical value, and at the present time the cultch used consists almost entirely of oyster shells. A few "jingle" shells are known to be employed at one point in Long Island Sound. Oyster shells are large and afford surface for the attachment of quantities of spat (Pl. IV). As this grows, overcrowding is apt to result, since the shells are too heavy to be broken apart by the pressure of the developing set. This is overcome by breaking apart and culling the clusters thus formed.

The advantages of oyster shells as cultch consist largely in their general adaptability, presenting a smooth surface for the attachment of the set, and their abundance and convenience, since an oyster-shucking house has only to turn about and convert its shell pile into spat collectors by the use of its own boats. At the same time the gradual disintegration of the shells provides lime for the succeeding generations.

"Jingle" shells, or silver shells, belonging to the species of Anomia, and scallop shells are thinner and more fragile than oyster shells. Consequently, they make a superior form of cultch, since the pressure of the growing young oysters breaks them apart and the formation of clusters is prevented. Unfortunately, the supply of such shells is so limited that very few are now used.

Character and preparation of bottom.—If the bottom at the point where it is desired to plant cultch is sufficiently hard to support it a layer of shells is spread upon it broadcast, as previously described. In case the bottom is soft, it may be prepared by putting down sand or gravel in sufficient quantities to support the shells. Often, however, the bottom is stiffened merely by the use of shells. Sufficient quantities are put down and allowed to sink, until a substratum is formed firm enough to support a layer of cultch several inches or a foot thick above the ground. A bed on which cultch has been placed for several years in succession will gradually be made firmer by the setting of a part of the shells.

Time for planting cultch.—Since sea water always contains more or less suspended débris, which gradually settles upon the bottom or any object thereon it follows that cultch will more or less rapidly become coated with a layer of slime or débris. If this becomes too thick the oyster larvæ are prevented from setting upon it. Movement of the water by tides and currents obviates this difficulty somewhat by washing the débris from the cultch. In bodies of water where there is little movement, especially in inclosed bays or the like, the deposit accumulates upon the shells rapidly. Such waters, while often very desirable for growing or fattening oysters, are for this reason poorly adapted to catching set.

It early became apparent, then, that it would not suffice merely to spread the cultch at any season of the year most convenient to the planter. Cultch should be put down just as shortly before the bulk of the free-swimming larvæ reaches setting time as it is possible to do it. In general this has been ascertained by experience in the various regions where this method is practiced. For example, in Great South Bay it is planned to complete "shelling" by July 1. In Long Island Sound shelling often begins immediately after the Fourth of July and is completed early in August, individual planters having different ideas as to the best time for planting cultch. In Louisiana cultch is put down in June.

In the case of the large oyster firms, owing to the great quantity of shells handled, it is impossible to concentrate all the shelling into a few days preceding setting time. Such firms often require a month or six weeks in which to complete the process. The best that can be done is to make this period coincide with the weeks immediately preceding setting time.

The proper time of year for planting the cultch has been fixed approximately at certain seasons for each locality, largely by experience derived from the results of some years' practice in this method. The appearance of the adult spawning oysters is noted at intervals each year and the time of planting varied a few days or weeks one way or the other. The aim has mainly been to have the cultch down before any appreciable quantity of spawn has been thrown out by the oysters.

It has been thought until relatively recently that the oyster larvæ set within 3 or 4 days after the spawn was thrown out. It is now known that from 14 to 18 days elapse in New Jersey waters and northward, and a somewhat shorter period in the warmer waters of the Southern States. With this longer period in mind, it will be seen that the time of setting is at least two weeks subsequent to the throwing out of the spawn. In case the spawning period is extended over several weeks, the problem is complicated. In the more northern waters, especially in Long Island Sound, the spawning period has been found to be short, hardly more than two weeks in length, the bulk of the spawn being thrown out in the course of a few days. In such case, keeping in mind the two weeks free-swimming period of the larvæ, it is possible to judge the time of putting down cultch quite accurately.

Since seasonal variations affect the time of spawning, it follows that no exact date which will hold good for each year can be set for planting cultch. As a result of a survey of the free-swimming larvæ made by the Bureau of Fisheries, it was found that the setting time of the bulk of the larvæ in Long Island Sound in 1918 occurred during the week of August 10 to 17. In 1919 there was no setting time in Long Island Sound, since no larvæ developed to setting size, owing, doubtless, to the abnormally low temperature of the water. In 1919, in Great South Bay, setting began about July 1, but the bulk occurred July 15 to 17. These data were secured by following the development and movements of the free-swimming larvæ by means of examinations of samples of water of definite volume taken in various places from day to day.[a]

This method consisted essentially in noting the number and size of free-swimming larvæ found in samples of water taken daily over the oyster beds by pumping 50 gallons through a net or bag of No. 20 bolting silk. By the study of a considerable number of samples taken each day the general abundance and size of the larvæ could be ascertained and the setting time predicted several days ahead.[b] As the larvæ approach setting time, with the accompanying increase in size, the left valve of the shell becomes very prominent, as stated on page 13. This renders them readily distinguishable from other bivalve larvæ, and it is easy, after a little practice, to recognize them under the microscope.

It would seem that the advent and development of the larvæ could be noted by this means each season. The State commissions could hire a biologist for a month to make the examinations or train one of their own members to do the work. The development and movement of the larvæ could be followed in a few representative places in the waters of the State and exact information relative to setting time ascertained and imparted to the oyster planters. After a few years it would be found that the time varied within certain fixed limits, and examinations would need to be made only to learn the variation within that period for the particular year.

Location of cultch beds.—The different oyster planters have determined by experience the locations at which beds of cultch are placed. After a term of years each man has found the portion of his ground on which cultch may be placed with what seems the most likelihood of getting a set. Individual planters have their own views as to the proper position of the cultch in relation to the beds of spawning oysters. Sometimes beds of cultch and of oysters are placed side by side; sometimes several are located alternately. Some planters place a certain number of spawning or "mother oysters" about in groups on the cultch bed.

Since the free-swimming larvæ are carried about by the tides and currents, it becomes of importance to follow in each locality the movements of the larvæ in order to ascertain as nearly as possible the place in which they will set. This involves a study of the tides and currents and the directions in which and the distance to which they carry the larvæ in any particular bay, cove, or river mouth. Accurate knowledge of these facts would enable one to state where the cultch should be placed in relation to the spawning oysters. Since the tides and currents depend on the contour of the bottoms and coasts, they are the same from year to year, unless disturbed by storm. The data, once accumulated by perhaps two or three years' study, would have permanent value.

Investigations calculated to ascertain the advantages of such knowledge of the movements and points of aggregation of the free-swimming larvæ were carried on in 1919 by the United States Bureau of Fisheries, using Great South Bay, Long Island, as a testing

[a] Churchill, E. P. Jr., and Gutsell, J. S. Reports on Investigation of Oyster Larvæ in Long Island Sound, 1918 and 1919, *and* Investigation of Oyster Larvæ of Great South Bay. (Contains methods.) Forthcoming reports, U. S. Bureau of Fisheries.

[b] Dr. T. C. Nelson (1916), in his study of the occurrence of free-swimming oyster larvæ in Little Egg Harbor, N. J., was able to ascertain the relative abundance of the larvæ in different areas and to predict the setting date about 10 days in advance.

ground.[a] The method of examining samples of water for numbers of larvæ described on page 31 was employed. It was found to be possible to ascertain from day to day during the spawning season, lasting, roughly, from June 5 to July 17, the number of larvæ per gallon of water at various representative stations in the bay. In this way the points of aggregation of the greatest numbers of larvæ were determined and charted on the map. Beds of shells had been placed at various points in the bay. The quantity of set caught on the different beds substantiated predictions based on the data derived from the study. The heaviest set was obtained from the beds located at the points in the bay where there had been the greatest accumulation of larvæ. To be specific, it was found that the tide caused the larvæ to accumulate along the channel from about Ocean Beach on Fire Island Beach to the inner United States channel buoy, in the direction of Sayville, Long Island. Cultch beds should be placed along this channel where the bottom is or may be made suitable.

By the use of methods such as just described the distribution of oyster larvæ could be worked out for any particular region. The possibilities of this procedure have been discussed above in connection with the recommendation that such lines of investigation be undertaken for the various oyster waters, perhaps by State authorities.

Location of spawning beds.—Oftentimes the catching of set depends as much on the location of the spawning oysters as on the position of the cultch. Both are important, and sometimes the best results can be accomplished only by the providing of the proper relationship between the two. Spawning beds should be placed where conditions are most favorable for spawning, at the same time putting the cultch at a point where the larvæ from the bed will be carried back and forth across it by the tides or be accumulated over it by eddies or cross currents.

For example, in Great South Bay, Long Island, which is large and shallow, the oysters are placed about over the bay at various points where they grow and fatten best, the catching of set from them being a matter of rather secondary importance in this locality. As a matter of fact one place is as favorable as another for the spawning of the oysters, the bay being of fairly uniform depth and salinity. As stated above, the larvæ accumulate in the channel, and cultch should be placed there.

In Long Island Sound a different condition prevails. The catching of set has been a large feature of the oyster industry there. Cultch beds were planted at greater or lesser distances offshore or in the lower part of the mouths of rivers. Owing to a recent failure of the set there, investigations have been made by the United States Bureau of Fisheries during 1917, 1918, and 1919. It has been found that in the past the bulk of the set consisted of larvæ from natural oyster beds in the shallow waters of bays, coves, and river mouths, where the water became warm relatively early in the season and the spawning occurred early enough for the larvæ, carried out by the currents to shell beds in deeper waters, to develop, set, and acquire a fair size before the close of the short summer season

[a] Churchill, E. P. Jr., and Gutsell, J. S. Investigation of Oyster Larvæ in Great South Bay. Forthcoming report, U. S. Bureau of Fisheries.

of that locality. These inshore beds are practically exhausted now, and dependence is being placed for set upon the oysters planted in deeper water offshore. The deeper water warms up slowly, and the oysters spawn so late that the crest of the warm season is over before setting occurs and very little set is obtained from them. In Long Island Sound spawning beds should be placed in the shallow inshore waters to take the place of the original natural beds. Cultch beds should be placed where they have been heretofore, outside or in the lower part of the mouths of rivers outside or alongside the oyster beds.

In this connection, as stated earlier, the fact that certain waters are contaminated with factory trade wastes must be borne in mind. It has been found that the upper waters of certain harbors in Long Island Sound contain such a concentration of trade wastes that oyster larvæ are at once killed by it. No adult oysters are now found in such waters. As these wastes are carried out nearer to the mouths of the harbors they are diluted and are at least not so immediately fatal to the oysters, but ultimately the effect is certainly harmful. Some of the wastes also probably contribute to the green discoloration of the meats of oysters found in certain beds. Vigorous efforts should be made to require the reclamation of trade wastes by the factories and to prevent their discharge into waters otherwise fitted for the maintenance of sea-foods.

General desirability of planting cultch.—The method of oyster culture by means of catching set on planted cultch is the most promising one at present. Small seed oysters may be placed on bottoms where, due to improved conditions, they will grow faster, acquire a more desirable shape, and thus bring a better price. But by putting down cultch in places where there was none before set may be caught which otherwise would have perished. By this method the actual number of oysters in increased. This method should be developed further in some such manner as suggested above and brought into more general use.

At several points on the Atlantic and Gulf coasts no cultch is planted, the shells being burned for lime or used in building roads. In some of these places the oyster beds are becoming seriously depleted. This is especially true of Chesapeake Bay. Investigations carried on there by the United States Bureau of Fisheries during 1919 showed that, while there were abundant free-swimming larvæ during the spawning season, the vast majority of these perished from lack of cultch upon which to attach themselves. It would seem highly desirable to cease disposing of the shells for lime or road building and to clean up the oyster bottoms and plant the shells on them to catch set. The general improvement of the oyster beds and the consequent increase in revenue from them would far outweigh the relatively small amount now received for the shells as at present handled.

PLANTING SEED OYSTERS.

In the method of oyster culture by planting seed the start is made with small or "seed" oysters instead of shells. Such seed oysters may vary in size from set of a few months' growth, about the size of one's finger nail, to oysters of nearly marketable size in some cases.

They are usually, however, small oysters attached to old shells or other material upon which they originally caught. Sometimes, if fairly large, the individual oysters are removed from the old shells or the clusters broken up before planting. Seed may be bought or taken by the planter from his own or natural beds.

Very little seed is now taken from Chesapeake Bay and planted in Long Island Sound, although the importation of "southern" oysters and seed was formerly an extensive practice. The oyster beds of Maurice Cove in Delaware Bay are kept up by the planting of seed taken from the natural beds in the bay. Seed oysters are planted in Chesapeake Bay to some extent and in York River, Va. To a lesser extent the planting of seed oysters is carried on in other States. In many of the Southern States the clusters of small "coon" oysters are broken apart and used for seed. Such coon oysters grow in abundance along the shores and naturally are so thickly crowded together that they acquire a long, narrow shape and are quite indifferent oysters. If the clusters are broken apart and the oysters put down on suitable beds when an inch or two long, they grow into fair-shaped, marketable oysters in about a year in southern waters. Seed oysters are planted at various times of the year, depending on the local conditions, in some places in the fall, in others in the spring.

A number of oystermen make a business of taking shells bearing set from natural beds and selling it to the large planters to be placed on their leased beds as seed. No shells are planted upon natural beds, except by the State in certain cases, the set attaching to shells left by the death of adult oysters, or to rocks, débris, etc. The material bearing the set is taken from such natural beds by the use of tongs (Pl. XI) or by light dredges lifted by hand or hand windlasses on a sailboat (Pl. XV, fig. 1).

In nearly all States it is illegal to use other than a sailing vessel on natural beds and in most instances the dredge must be lifted by hand or by a hand windlass, although sometimes it is lawful to lift the dredge with a donkey engine on deck of a sailing boat. The purpose of restrictions on the use of steam and power in dredging is to limit dredging on natural beds to the use of the less efficient apparatus in order to conserve the supply of oysters. In most States such "natural growth" may not be taken from the beds during certain of the summer months, the purpose being not to disturb the beds during spawning and setting time.

In northern waters it requires from four to five years for an oyster to reach marketable size (a length of from 4 to 5 inches, measured in the shell). In Chesapeake Bay three years is sufficient, while in the South marketable size may be attained in two years. Oysters grow more rapidly in the warmer waters.

In oyster culture by the method of planting seed the main considerations are the kind of seed, character of the water, food supply, bottom, sowing the seed, and caring for the beds.

Seed.—Seed oysters vary in size from the set just caught that season and taken up in the fall, when it is about the size of a finger nail, to oysters which will attain marketable size within a few months after planting. The majority of the seed, however, is not more than $1\frac{1}{2}$ inches long. It is obtained from "natural growthers" who make a business, as stated above, of taking seed oysters from natural beds and selling them to planters, or by the planter himself gathering them directly from the beds. In many places the larger planters buy of the "natural growthers", since steam vessels and heavy dredges, such as are owned by the large oyster companies, are not allowed to work on the natural beds. The "natural growther," with less capital, can afford to maintain a vessel and some hand dredges and profitably sell to the large oyster company, which in turn obtains seed more cheaply than it could by supporting its own sailing vessels and crews. In States where such a system is practiced, the natural beds are set aside by the State for the "natural growther" with limited capital.

The material dredged from the natural beds usually contains old shells, rocks, and débris, in addition to the oysters. Sometimes the whole is bought at a reduced price, but usually the desirable material is culled out and the clustered oysters broken apart as far as possible.

Water.—As a general rule seed oysters should not be obtained from warm waters and put down in those excessively colder. If this be done, it will usually be found that their growth is checked for some time and that a certain percentage die. After a time, however, they become accustomed to the reduced temperature and renew their growth.

In general, the warmer the water the more rapid the growth of the oysters. This is due both to the greater abundance of food material and to the fact that the bodily activities of the oyster proceed more rapidly when the organism is warmed to a relatively high temperature.

The density of the water should be between 1.007 and 1.023. Although oysters are found both in water of lesser and of greater densities, they do best within the limits stated.

Food.—The character of the food of the oyster is discussed on page 19. In order to profit by planting oysters, a sufficient quantity of food for them must be assured. Often certain waters and bottoms are suitable for catching set on cultch, but do not possess a sufficient food supply to enable the oysters to grow and fatten rapidly. Other grounds furnish an abundant food supply, but the water is so loaded with débris that cultch and set are soon covered. Hence in many cases cultch beds are placed in waters of the former character, and the set is caught and later transferred to waters containing more food.

Care must be exercised not to place more oysters on the ground than can be supported by the supply of food present. On the average about 500 bushels of seed are sowed per acre. The food content of the water varies greatly from place to place and from time to time in the same place. It is affected to some extent by the amount of material brought from the land by the streams and rivers. This again is dependent on the rainfall. As previously stated, diatoms make up a considerable part of the oyster's food and diatom growth is affected by materials washed down from the land. A period of excessive drought causes a falling off in the diatom content of the water.

It would be well if a systematic biological study could be made of the food content of the water over prospective oyster grounds. In order to do this samples of water of definite amounts should be strained through No. 20 silk bolting cloth and the number and amount of food organisms and material ascertained microscopically.[a] Estimate is usually made per liter, which is about equal to a quart. If it were found from a series of examinations that the food content of the water were conspicuously low, it is obvious that the grounds in question would not be desirable for the planting of oysters.

Bottom.—The bottom is cleaned of débris by dredging. If firm enough to support the oysters, no further preparation is needed. If soft, the surface is hardened by putting down shells, sand, or gravel, deposited uniformly so that there are no holes in the surface as finally prepared.

Sowing the seed.—The seed oysters are removed from the original bed by the use of tongs or dredges and are planted in much the same manner as shells by being shoveled from boats or scows (Pl. V, fig. 2) towed back and forth over the grounds. About 500 bushels per acre are usually planted, though the amounts vary widely with local conditions. The oysters are spread uniformly, so that they may not lie in heaps and cause some to fail to receive the proper amount of food or to be crowded and thus grow irregularly.

Care of beds.—The beds are generally left untouched after planting, except for combating enemies in some cases (see below) and shifting certain of the oysters, if desired, to other grounds for final preparation for market. The oysters to be shifted or sold directly are taken up by the use of tongs and dredges. After the oysters have been removed from the beds the grounds are cleaned up by dredging, when they may be used again for planting cultch or seed.

PROTECTION AGAINST ENEMIES.

The more important enemies of the oyster will be described briefly and the methods, if any, of combating each set forth.

STARFISH.

There are two species of starfish which may be classed as oyster enemies. These are the common star, *Asterias forbesi*, and the purple star, *Asterias vulgaris*. The starfish opens an oyster by inclosing it with the arms or rays (Pl. VI, fig. 1), which are provided with rows of suckerlike feet on the lower side, and exerting a constant outward pull on the valves of the shell, until the oyster is exhausted and the valves are allowed to gape at the ends. The starfish then protrudes its stomach from the mouth, which is on the lower side of the central disk, inserts it between the valves of the oyster shell, and sucks in and digests the meat. The set and 1 and 2 year old oysters are more subject to the inroads of the starfish, because of their smaller size and weaker adductor muscle; but the larger starfish prey on oysters as much as 3 years old.

In certain waters the starfish are very destructive to oysters, often invading and cleaning out a whole bed before the planter is aware of their presence. This is true of New England waters and those immediately to the southward. They are unknown in Chesapeake Bay and constitute a menace to oysters only in the regions mentioned in the preceding sentence. In Narragansett Bay and Long Island Sound it has been necessary to fight them very vigorously.

[a] This method will suffice to determine the great bulk of the food available in the water and is usually sufficient for practical purposes. The material in actual solution in the water, which probably contributes only a small percentage of the food of the oyster, can be determined only by chemical analysis.

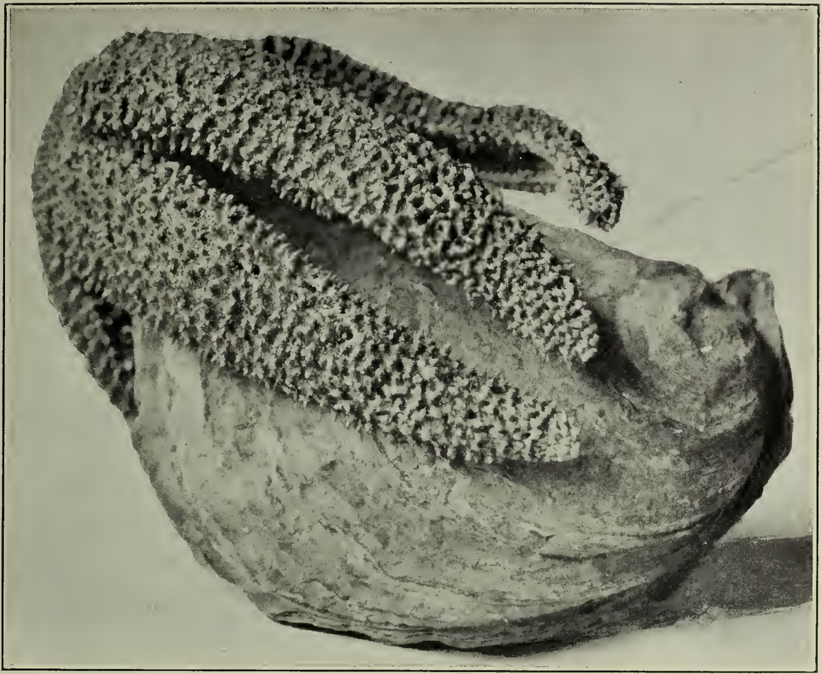


FIG. 1.—STARFISH ATTACKING AN OYSTER.

(Photo from Dr. H. M. Smith.)

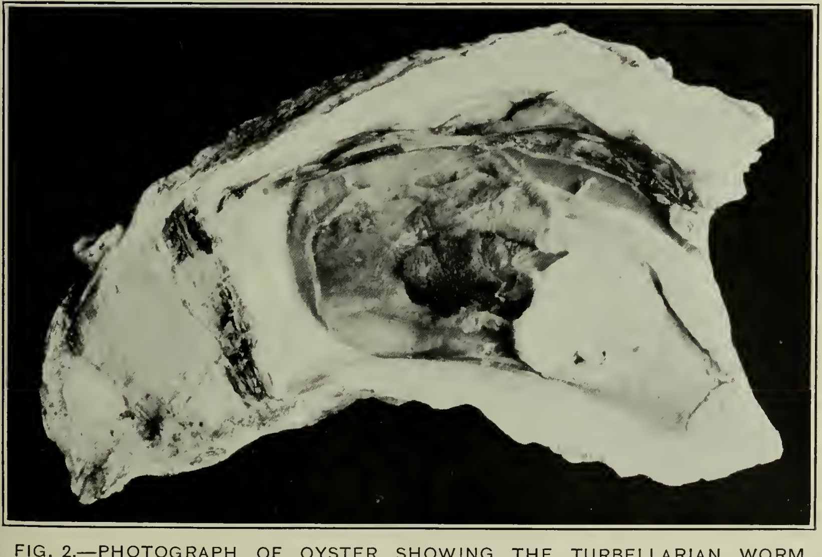


FIG. 2.—PHOTOGRAPH OF OYSTER SHOWING THE TURBELLARIAN WORM KNOWN AS THE WAFER OR "LEECH."

The worm has fastened itself upon the oyster and appears as a dark wrinkled body in about the center of the oyster meat. Natural size. (After Danglade.)

FIG. 1.—USUAL STYLE OF "STAR MOP" USED FOR EXTERMINATING STARFISH IN LONG ISLAND SOUND.

The stars become entangled in the brushes as they are dragged over the bottom. The mops are then raised and plunged into vats of hot water on deck to kill the starfish.

FIG. 2.—"DISH-PAN" FORM OF STAR MOP, USED IN LONG ISLAND SOUND.

The only practical method of destroying the starfish so far devised is by the use of the "star mop" (Pl. VII, fig. 1). This usually consists of an iron bar about 10 feet long, to which are attached 8 or 10 large mops or brushes of heavy rope-yarn about 4 feet long. The bar moves on small wooden iron-tired wheels as it is dragged over the bottom by a chain attached by three drag bars arranged as shown in the figure. The chain passes through a pulley attached to a stout post amidships, and the mop is raised and lowered in the same way as a dredge. The starfish cling to or become entangled in the mops and are brought to the surface when the apparatus is lifted. Two mops are usually used, one on each side of the boat. A long narrow vat is generally placed inside the gunwale on each side of the boat. These vats are kept filled with water which is heated by steam from the boiler circulated through pipes in the vats. Each mop with its burden of "stars" is dropped into the hot water. This is the most rapid and efficient method of killing the starfish and removing them from the mops. Sometimes only one vat is used, placed across the deck before the cabin, and each mop is swung around and lowered into it by means of a small crane.

Fig. 3.—*Urosalpinx cinereus*, the oyster drill of the Atlantic coast. Natural size. (After Moore.)

In Plate VII, figure 2, is shown a special form of star mop, the "dishpan," devised for use on a rocky bottom. The toboggan-shaped body consists of two pieces of boiler iron, the larger one 4½ by 2 feet and attached to the triangular smaller one by four rings bolted on as seen in the figure. This allows some independence of movement of the two parts. The mops are the same as used with the other form of apparatus. This mop slides over the rocks more readily than the wheeled bar, the brushes falling down between the rocks and catching the stars. This style of mop, however, is heavy and awkward to handle and is not extensively used.

"Starring" must be kept up whenever any considerable number of the enemy appears and should be of a cooperative nature. It is of little avail for a planter to attempt to keep his beds free from starfish, unless his neighbor does likewise.

DRILL.

There are at least four species of snail-like molluscs known to oystermen as drills or screw borers. One of these, *Urosalpinx cinereus* (text fig. 3), attaining a length of about an inch, is found abundantly from Massachusetts to the east coast of Florida. The eggs are laid in small, yellowish, vase-shaped, leathery capsules,[a] deposited in clusters on objects in the water. Another species is *Thais lapillus*, about the size of the preceding. It is found from the east end of Long Island northward. Other species of drills (often called borers, snails, whelks, or conchs) are *Thais hæmastoma* (Pl. VIII, top) and *Thais hæmastoma floridana*. These sometimes reach a length of 3 inches. They are found on the Gulf coast, where they are often very destructive to oyster beds. The eggs are laid in tubular capsules about a half inch long, attached by the ends to

[a] Moore, H. F. Proposed revision of "Oysters and Methods of Oyster Culture" (1897).

shells and other objects in the water (Pl. VIII, center). Masses of these capsules are often found covering oyster shells so thickly that there is danger of smothering the oysters. From their reddish-purple color these masses are often referred to as "red grass."

The various species of drill possess a rasplike apparatus which can be protruded from the mouth. With this they bore a hole through the shell of the oyster (Pl. VIII, bottom) and suck out the contents. Drills destroy many young oysters, their thin shells being relatively easily penetrated. After the oyster becomes older its shell is heavy enough to resist the effort of the drill.

In Long Island Sound it has been found that about the most practical method of lessening the numbers of this enemy is the following: The teeth are removed from an ordinary oyster dredge, and a bag with meshes of an inch or less is put on in place of the usual coarser one. After the oysters have been taken off the bed for market or shifting, the specially equipped dredge is used and everything left—shells, drills, débris, etc.—is dredged up

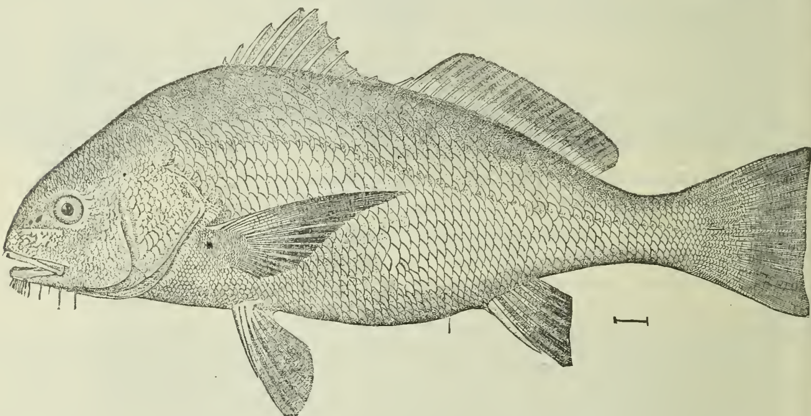


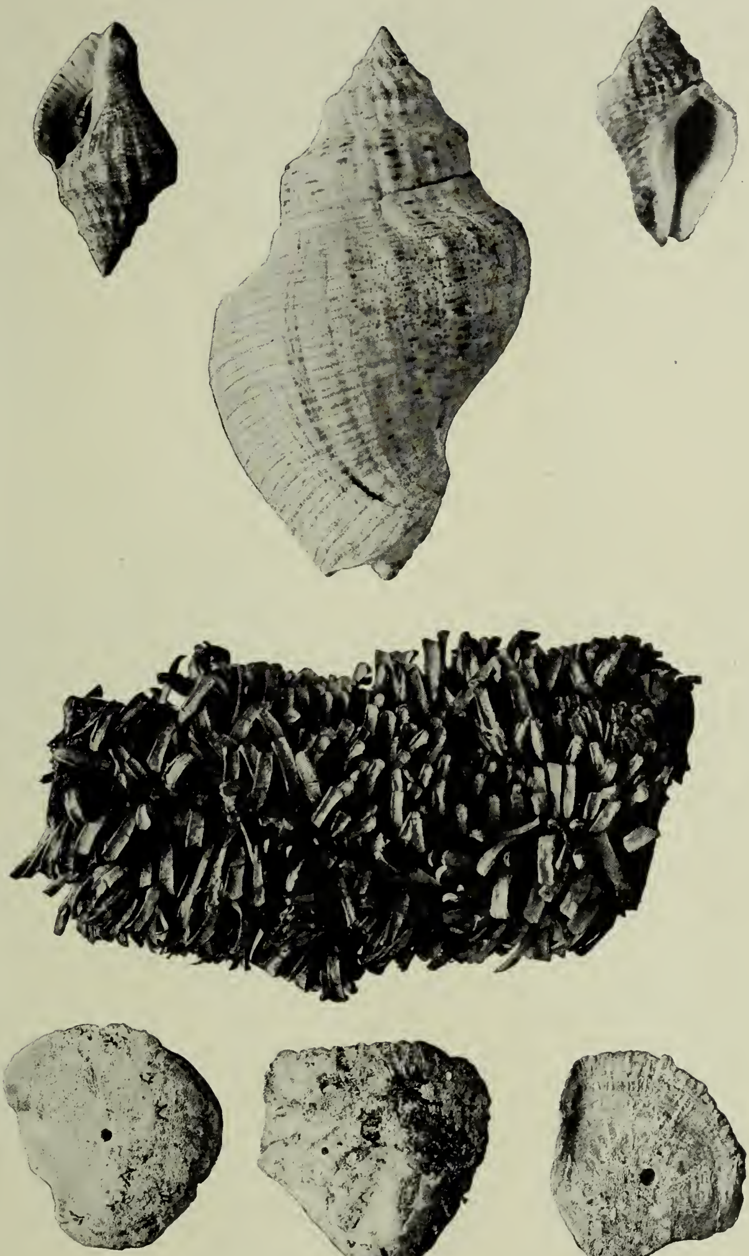
FIG. 4.—*Pogonias cromis*, or drum fish. At times this fish destroys large numbers of oysters. (After Jordan and Evermann.)

and dumped ashore to dry. The drills die, and a good deal of the material may then be used as cultch.

DRUMFISH.

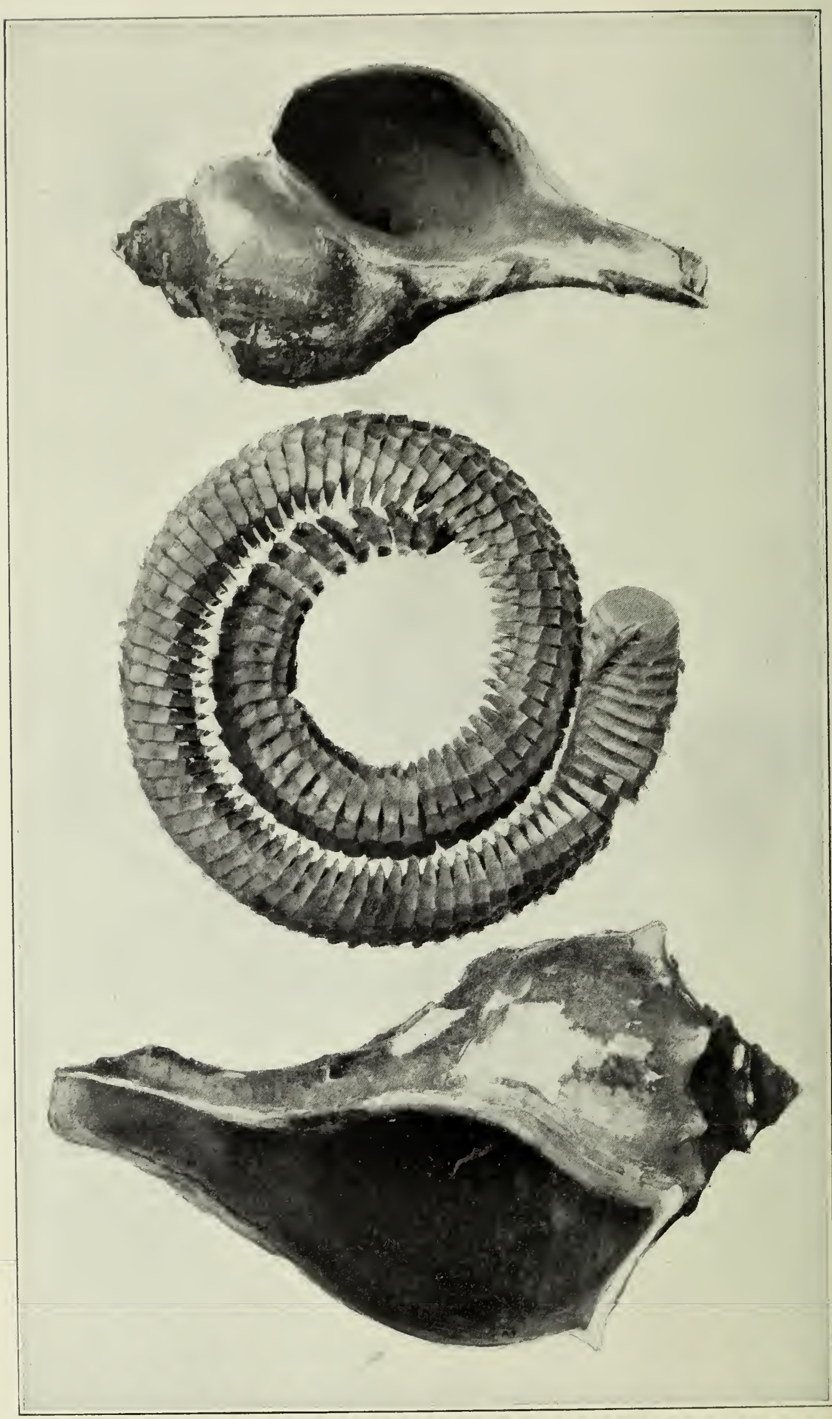
The fish known as the "black drum," *Pogonias cromis* (text fig. 4), is found at intervals of time and place from New Jersey to Texas and is often very destructive to oyster beds. It attains a length of several feet and has a heavy body with large stout teeth. The oysters are crushed, shell and all, by these strong teeth, the younger thin-shelled ones being, of course, especially subject to the depredations of the drumfish. These fish go in schools and their attacks are spasmodic, often whole oyster beds being cleaned out in a short time and then, again, no drumfish being seen for several months or years.

Efforts have been made to kill or frighten away such fish by the explosion of dynamite, but no particular success has been achieved. In southern waters, especially in Louisiana, where oyster beds lie in shallow water and there is not much tide, it has been found practi-



TOP, BORERS OR "DRILLS" (THAIS HAEMASTOMA) OF THE GULF COAST; CENTER, SO-CALLED "RED GRASS," THE EGG CASES OF THE BORERS; BOTTOM, OYSTER SPAT DRILLED BY BORERS.

Natural size. (After Moore and Pope.)



CONCHS. TOP, CHANNELLED CONCH OR WHELK, BUSYCON CANALICULATUM; CENTER, STRING OF CAPSULES CONTAINING EGGS OF KNOBBED CONCH; BOTTOM, KNOBBED CONCH OR WHELK, BUSYCON CARICA.

cable to fence the beds with chicken wire strung on posts set in the bottom.

CONCH.

This is also a snail-like mollusc, comprising several species, some of which attain a length of from 5 to 6 inches. *Busycon carica* and *Busycon canaliculatum* (Pl. IX) are the most common. The eggs are deposited in flat parchmentlike capsules about an inch in diameter and strung together by a cord along the side to form a loosely spiral chain a foot to a foot and a half in length. This is cast free from the animal and left to the mercy of the waves. It has been found[a] that the conch opens an oyster by inserting the edges of its own shell between the valves of the oyster when it gapes (text fig. 5) and then introducing its proboscis and eating the meat. Conchs do not occur, however, in sufficient quantities to destroy many oysters. No definite means of combating them are employed, although those taken when dredging are usually killed.

FIG. 5.—Conch opening an oyster. About one-half natural size. (After Colton.)

MUSSEL.

Mussels, the common edible species, *Mytilus edulis*, and other species, of the Atlantic waters, and *Mytilus hamatus* (Pl. X, fig. 1), of the Gulf coast, are bivalves which, shortly after hatching from the egg, attach themselves to material on the bottom by a slender thread or hair called the byssus. As development goes on the number of hairs is multiplied and they become shorter and stouter until the adult mussel, at a length of 4 or 5 inches, is very firmly attached by these threads. The mussels multiply rapidly, and dense beds are sometimes formed over the oysters, tending to smother the latter. Since the mussels feed upon essentially the same materials as do the oysters, there is always danger of a greater or less exhaustion of the food supply.

In Long Island Sound the mussel is attacked in the following manner: The mussel spawns and "sets"—that is, attaches by the byssus—perhaps a month or more before the oyster. Advantage is taken of this fact, and when evidences are found of an alarming number of young mussels on the oyster beds, they are "harrowed" by dragging over them an ordinary dredge with the bag removed or open at the back. This process crushes and destroys the majority of the tiny mussels without injury to the adult oysters. If this process is carried out on a bed planted with shells to catch a set, no harm is done, as the oysters have not yet spawned, and there is consequently no oyster set on the shells.

[a] Colton, H. S. How Fulgur and Sycotypus eat Oysters, Mussels, and Clams. Proceedings, Academy of Natural Sciences, Philadelphia, Vol. LX, 1908, pp. 3-10, 5 pls. Philadelphia.

BORING SPONGE.

Boring sponge (*Cliona celata*) is the term applied to a yellow sponge which begins its existence by boring (Pl. XXI, lower left figure) in the shell of the oyster, where it forms small tunnels, in which it lives. The shell is gradually honeycombed, and the oyster becomes weak and thin from the effort to seal up the openings where the tunnels penetrate the shell completely. The sponge also spreads over the outside of the shell and often smothers the oyster by its very size. No means of protection against the sponge can be suggested, but fortunately it does not occur in sufficient numbers in most regions to prove a serious menace.

BORING CLAM.

The boring clam (*Martesia cuneiformis*, *M. smithii*, and *M. corticaria*) is a species of clam which enters the shell of the oyster by boring a small round hole and excavating in the substance of the shell, at the inner end of the hole, a hemispherical cavity (Pl. X, fig. 2) in which it then spends its life, often attaining a length of three-eighths of an inch. The clam usually does not penetrate the shell entirely and does not feed upon the oyster. It attains its food through the external opening. It does comparatively little damage to the oyster.

WAFER OR "LEECH."

This is a turbellarian worm (Pl. VI, fig. 2) of undetermined species which on several occasions has destroyed large numbers of oysters in the vicinity of Cedar Keys, Port Inglis, and Tampa, Fla. This worm is nearly flat, more or less circular in outline, and is about three-fourths of an inch long. It finds its way between the valves of the oyster and feeds upon the meat, eventually killing the oyster. It flourishes in water of fairly high salinity, and its ravages are checked by lowered temperatures. No method of combating it can be suggested other than a careful working of the beds and the use of new air-dried cultch and fresh seed stock.

TAKING OYSTERS FROM THE BEDS.

Oysters are commonly taken by the use of hand tongs, patent tongs, dredges lifted by hand or hand windlasses, or dredges raised by engines or hoisters turned by the engine of the boat. These forms of apparatus and the boats on which they are used are described below.

TONGS.

Ordinary hand oyster tongs are shown in Plate XI, figures 1 and 2. There are two long, flat, smooth, wooden handles about 3 inches wide and nearly 1 inch thick, bolted, riveted, or pinned together with a wooden pin, scissors fashion, about 4½ feet from one end (see figures), leaving the long ends for handles. To the short end of each shaft is secured at right angles a light iron bar, about 3½ feet long, bearing teeth, while above this bar are five or six still lighter bars or heavy wires parallel to the bar and attached to the shaft. The ends of the bars or wires are fastened together by short wires. The arrange-

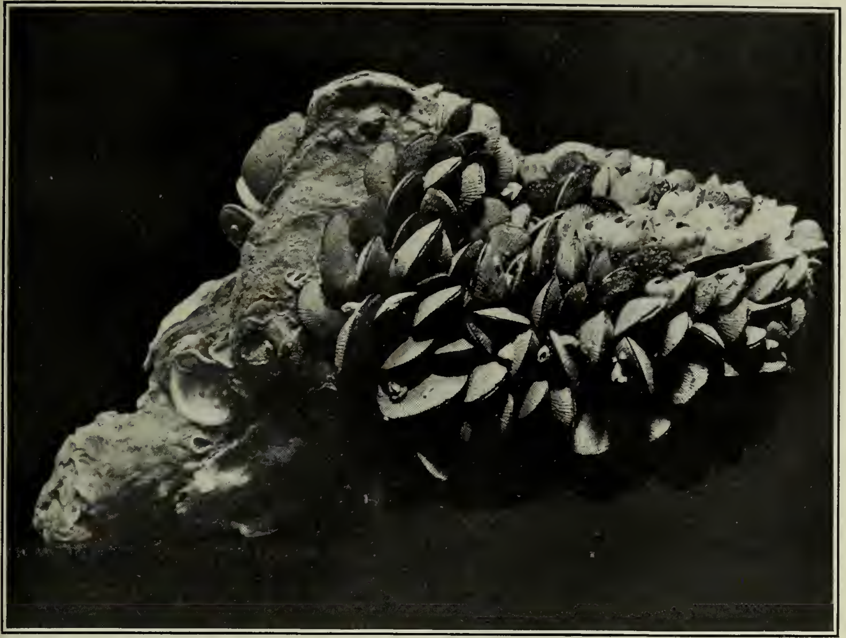


FIG. 1.—MASS OF MUSSELS ATTACHED TO OYSTERS.
(After Moore.)

FIG. 2.—OYSTER SHELLS SHOWING PITS AND CHAMBERS MADE BY BORING CLAM.
(After Moore.)

FIG. 1.—TONGING OYSTERS, WORKING THE TONGS ON THE BOTTOM.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—TONGING OYSTERS, LIFTING AND EMPTYING THE TONGS.

(Photo from Prof. E. N. Cory, Maryland State University.)

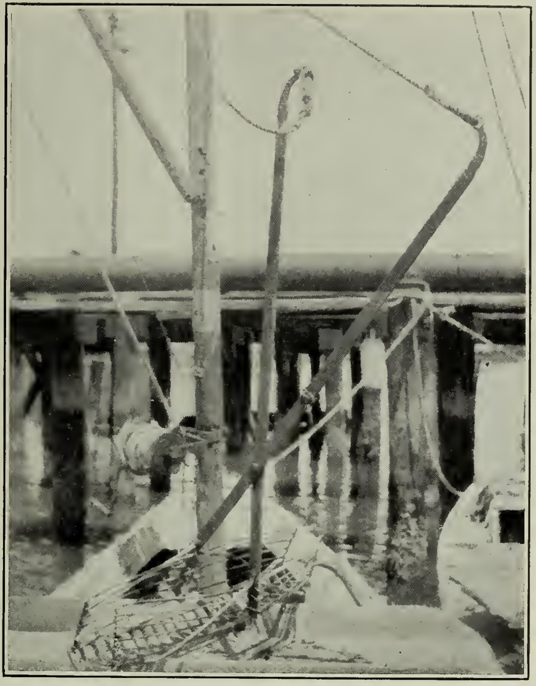


FIG. 1.—PATENT TONGS, USED TO SOME EXTENT IN TAKING OYSTERS IN THE LOWER PART OF CHESAPEAKE BAY.

FIG. 2.—UNLOADING OYSTERS BY MEANS OF A CRANE OPERATED BY A DONKEY ENGINE IN THE SMALL BUILDING AT THE RIGHT.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN QUINNIPIAC RIVER, CONN.

FIG. 2.—SMALL SAILING BOAT USED IN TONGING OYSTERS IN RIVERS ON THE COAST OF ALABAMA.

ment on each shaft is made with the teeth sloping inward, and when the handles are closed the two are brought together, the whole forming a basketlike affair, 3½ feet long by about 8 or 10 inches deep. In operation (Pl. XI, fig. 1), the handles are worked scissors fashion, and the teeth forced under the oysters retained in the basket, which is then lifted (Pl. XI, fig. 2). Oyster tongs vary in length with the depth of water in different localities. In some places, as in the Rappahannock River, oysters are tonged with such apparatus from a depth of at least 20 feet.

PATENT TONGS.

Patent tongs are used quite extensively in Virginia and but very little elsewhere. From Plate XII, figure 1, it will be seen that their general construction is similar to that of hand tongs, except that the handles are of iron, about 6 feet long and provided with an eye at the end for the attachment of ropes for lowering and raising the tongs. The basket of the tongs is of considerably heavier material than in case of the hand tongs. Patent tongs are employed in water too deep to admit of the use of ordinary tongs and are raised and lowered by a spool or windlass, as in Plate XII, figure 1. While being lowered the tongs are locked open by the short hook seen on one of the handles just above the center pin. When they strike bottom, the consequent release of the weight of the baskets on the handles allows the hook to become disengaged. The tongs are then "jigged" by jerking upon the rope several times, causing the teeth to sink more deeply, and then lifted by the windlass.

SMALL TONGS AND NIPPERS.

In very shallow water of perhaps 2 to 4 feet in depth small tongs are often used. These consist of two wooden handles about 7 feet long, arranged as in the case of the ordinary tongs, but with only a single bar on each about 10 inches long, each bar being provided with teeth. This instrument is much lighter and more convenient to use in shallow water than ordinary tongs, especially where only a few barrels of oysters are desired. Such tongs are sometimes called "nippers." In other regions the term "nipper" is applied to a device of a similar nature, except that, instead of ending in a toothed bar, each handle terminates in a narrow blunt blade, thus forming true pincers or nippers, with which single oysters can be taken or dislodged from rocks or pilings.

TONGING BOATS.

In Plate XIII, figures 1 and 2, and Plate XIV, figure 1, are shown various styles of tonging boats. Plate XIII, figure 1, shows a small boat used on Long Island Sound; and Plate XIII, figure 2, a small tonging boat at Bayou Labatre, Ala. Plate XIV, figure 1, shows the type of tonging boat used at Apalachicola, Fla. These boats often carry an auxilary gasoline engine besides the sails. Such a boat with engine is seen in the figure, returning with a load of oysters which have been obtained by tonging. Boats of this sort often have a shallow hold into which oysters are piled until full, after which they are heaped on deck. Plate XII, figure 1, shows a boat equipped with patent tongs.

On the small boats, in compliance with State law, the oysters are culled on a board placed across the boat, as in Plate XI.

DREDGES AND DREDGING BOATS.

The hand dredge is shown in Plate XV, figure 1. It consists essentially of two triangles made of three-fourths inch iron bar, joined at the apices, and the bases separated about 18 inches by curved bars, as seen in the figure at left. It usually measures 4 or 5 feet in width. The base of the lower triangle consists of a bar about $1\frac{1}{2}$ inches thick, to which are welded teeth about 3 inches long, set about 3 inches apart. To a ring at the apex of the dredge a rope or wire cable is attached, by which the dredge is lowered and raised, either by hand or by the hand windlass. Plate XVI, figure 1, shows a small dredging sloop or "skipjack" under sail on Chesapeake Bay, the dredge on the port side being lifted and the hand windlass visible beyond it. In some States, as Maryland, somewhat heavier dredges than this are operated by the use of a donkey engine placed on the deck of a sailing vessel (Pl. XVII, fig. 2). Plate XVI, figure 2, shows such a dredging schooner at work. These vessels are propelled entirely by sails, it being illegal to dredge with other than sails as motive power; the engine merely operates the dredge.

From one to three dredges are usually operated from each side of the boat, each dredge being raised and emptied in turn. Plate XVII, figure 1, shows the dredge being thrown overboard and the roller over which the chain moves in lowering and raising it. After the full dredge is lifted it is allowed to rest on the roller and is emptied by pulling the bag forward (Pl. XVII, fig. 2), thus turning it wrong side out and dumping the oysters on deck. The dredge is then dropped overboard again. The oysters are culled on deck and then shoveled into the hold or onto the pile on deck.

A yet heavier and stouter form of dredge (Pl. XV, fig. 2) is used where dredging with power boats is allowed. It will be seen to resemble the other patterns, except that it is largely made of heavy, flat, iron bars, about 2 inches wide and nearly 1 inch thick and firmly braced. The lower part of the bag is of iron mesh instead of cotton. Dredges of this sort measure from 5 to 7 feet in width and hold 12 to 15 bushels of oysters (one oyster company uses larger ones holding nearly 30 bushels; these are emptied by mechanical means). These dredges are raised and lowered by a heavy chain which passes through a pulley on a stout post in the midline forward and then down to the hoister in the hold. The hoister is turned by the engine of the boat. Plate XIV, figure 2, shows the arrangement of rollers, pulleys, post, and dredges on a gasoline power dredging boat. In Long Island Sound large steamers are often used for dredging on leased beds. One company has two steamers each carrying three dredges on a side, six in all, each with a capacity of nearly 30 bushels. These two steamers are each about twice as large as any other oyster steamer in the world, having a capacity of 8,000 bushels (Pl. XVIII, fig. 2).

FIG. 1.—SMALL SLOOP USED IN TONGING OYSTERS NEAR APALACHICOLA, FLA., RETURNING WITH LOAD OF OYSTERS. SHOWING OYSTER CANNERIES IN BACKGROUND.

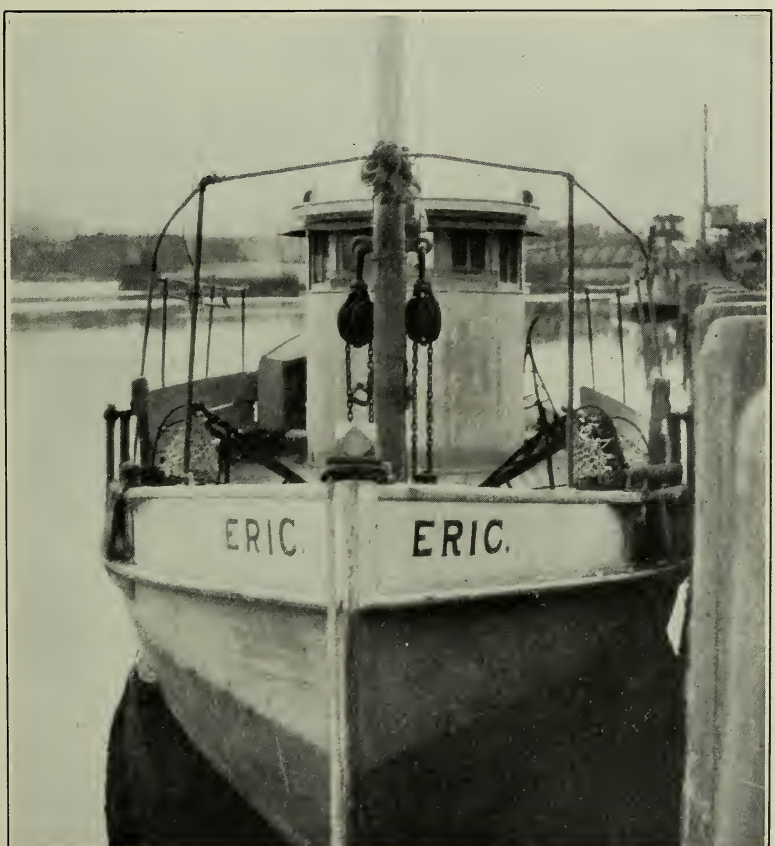


FIG. 2.—GASOLINE BOAT USED IN DREDGING OYSTERS IN LONG ISLAND SOUND.

In the center is the post to which are attached the pulleys through which pass the chains leading to the dredges on each side. When the dredges are being raised and lowered, the chains move over the rollers on the gunwale.

FIG. 1.—HAND DREDGES AND WINCHES FOR HOISTING THEM.
(Photo from Prof. E. N. Cory, Maryland State University.)

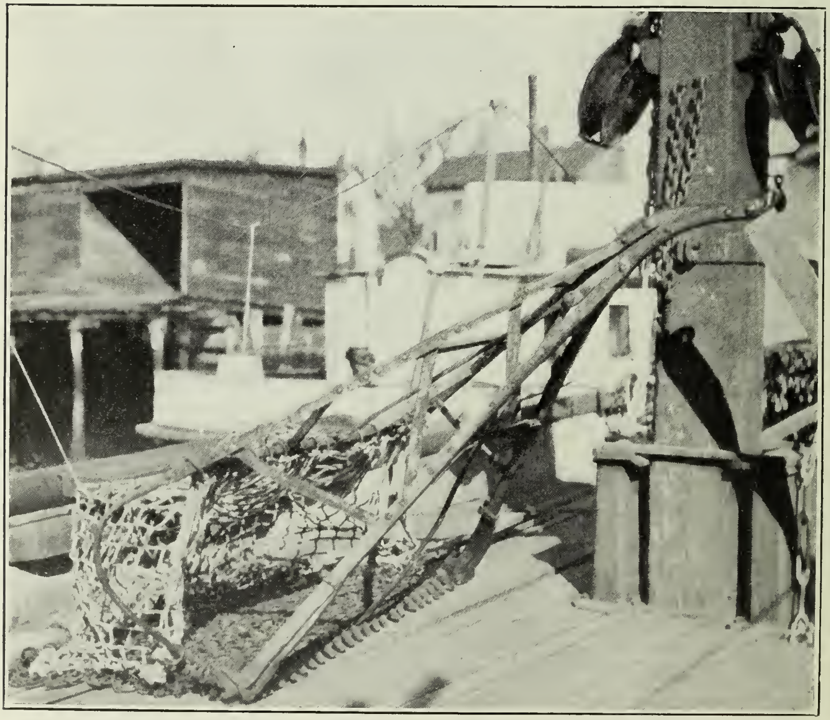


FIG. 2.—MACHINE-HOISTED DREDGE USED IN TAKING OYSTERS.

FIG. 1.—SMALL SLOOP OR "SKIP-JACK" USED IN DREDGING OYSTERS IN CHESAPEAKE BAY.

The dredge shown lying on the roller is raised and lowered by the hand windlass over which the man is stooping. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—OYSTER-DREDGING SCHOONER IN CHESAPEAKE BAY.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—LOWERING THE DREDGE.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—EMPTYING THE DREDGE.

In this case the dredge has been lifted by a donkey engine, part of which may be seen at the right. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 1.—OYSTER FLEET OPERATING FROM CAMBRIDGE, MD., LYING IN HARBOR.

Cambridge is only one of the several important oyster centers on Chesapeake Bay. (Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—ONE OF THE TWO LARGEST OYSTER STEAMERS IN THE WORLD, BOTH OWNED BY A NEW ENGLAND COMPANY.

Three dredges lifting 30 bushels each are operated on each side. The capacity of the steamer is 8,000 bushels per day. (Photo from H. C. Rowe Co.)

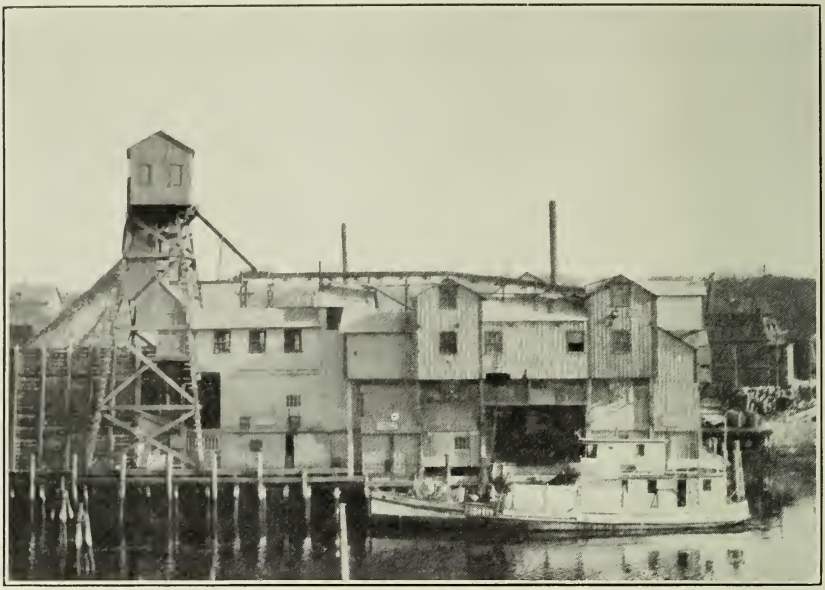


FIG. 1.—LARGE OYSTER HOUSE AT PROVIDENCE, R. I., SHOWING DREDGE BOAT UNLOADING OYSTERS AT RIGHT AND ELEVATOR TO SHELL PILE AT LEFT.

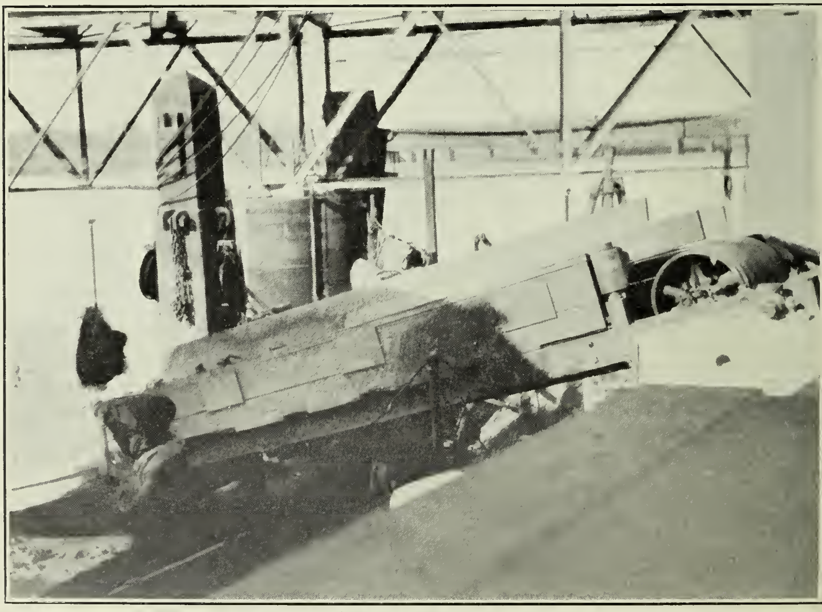


FIG. 2.—UNLOADING OYSTERS FROM THE BOAT AT ONE OF THE LARGE OYSTER HOUSES BY MEANS OF A BELT CONVEYER.

UNLOADING AT WHARF.

In most cases the oysters are shoveled from the hold or deck into large measures or buckets and hoisted to the wharf by a rope passing over a pulley and operated by hand or by a crane with a donkey engine as motive power, as in Plate XII, figure 2. The buckets are emptied onto the wharf and the oysters removed later in wheelbarrows; or into wheelbarrows and the oysters rolled into the shucking room on a level with the wharf, or sometimes to a storage room on an upper floor (Pl. XII, fig. 2). Some large oyster companies have arrangements whereby the buckets are lifted directly into the storage room, and some have an elevator, the end of which may be lowered into the boat and the oysters shoveled onto an endless belt or other carrying device (Pl. XIX, fig. 2).

This carrier transports the oysters directly to the storage room or drops them into another endless bucket-chain carrier which does so. In case the oysters are to be canned they are dumped from the buckets, which have lifted them from the boat, directly into cars, which are then pushed into the steamers inside the cannery.

FLOATING.

Brief mention may be made of the practice whereby, in some localities, oysters, after being taken from the beds, are "floated" for a time before being used. This process is accomplished by spreading the oysters out in a large shallow barge or float so constructed that, while resting at the surface, water may freely circulate through it, the oysters thereby being covered at all times. Such floats vary considerably in structure, often consisting of a rectangular framework some 12 or 15 feet wide by 20 to 30 feet long, made of four large timbers 15 or 18 inches in diameter, with a bottom of boards laid so that cracks are left between them. The float may be towed to the desired point and anchored either before or after the oysters are placed in it.

The floating is usually undertaken for one of two purposes—purification and cleaning of the oysters or temporary storage. In certain regions oysters from beds which are exposed to sewage are floated in waters of a certain degree of saltness designated by the health authorities until any possible impurities contained are thrown off. In such salt water the oysters do not become bloated, as they would if floated in fresh. Oysters are also sometimes floated in order that they may free themselves from sand or dirt contained in the intestinal tract.

Some companies maintain floats such as described in which a temporary stock of oysters may be kept a day or two in order to have a supply on hand to fill extra orders or to tide over a shortage caused by failure to obtain sufficient stock directly from the beds, for any cause, such as the breakdown of a boat or formation of heavy ice over the beds. In this case the floats are placed by the oyster house in water of about the saltness of that over the beds.

The practice of floating oysters in fresh water of creeks and rivers for the purpose of "fattening" has largely died out or been suppressed by health authorities. The oyster did not fatten in such circumstances, but merely enlarged itself by absorbing creek water which the consumer paid for at oyster prices.

PREPARATION FOR MARKET OR SHIPMENT.

Oysters are usually shipped in three general conditions—in the shell; shucked, on ice; and canned.[a] The building where oysters are handled in either or both of the first two conditions is referred to as an oyster house or, in some sections, especially to distinguish it from a cannery, as a "raw house" or "raw-oyster house." If oysters are canned, the plant is known as a cannery. Plate XIX, figure 1, shows the front view of a large oyster house. Oyster houses are provided with a wharf of some sort, so that the boats may be unloaded directly, as described above.

IN THE SHELL.

Oysters are shipped in the shell usually in barrels, sometimes in sacks, without ice, although for long distances a refrigerator car is often used. In many cases, especially for shorter hauls or transportation by river boats, the barrels are not headed, a piece of heavy gunnysack being fastened over the top of the barrel. A considerable export trade in oysters to England is carried on from the waters of New York and New England. These oysters go in barrels holding 3 bushels and one-half peck, headed up. Only the best-shaped, selected oysters are used for the export trade.

A large number of oysters are thus handled in the shell, since oysters on the half shell have found a place on the menu of the leading hotels and restaurants. For this purpose oysters from certain beds have come to be esteemed as most desirable. These have acquired trade names by which they are universally known and which are derived from the locality from which the oysters are taken. The best-known examples are the Blue Points from beds near Blue Point, a cape on the south side of Long Island; Cotuits, from Cotuit Harbor, Mass., and Lynnhavens, from Lynnhaven Bay, Va. There is a growing tendency to look upon these terms merely as trade names and to employ them to designate any oyster answering the requirements of size and shape of these oysters, regardless of the waters from which they were taken.

Blue Points (Pl. I) are small oysters, about 3 to 4 inches long by 2 to 2½ inches in width. They are rather rounded in form and the shells are fairly smooth. The meats are small and of very delicate flavor, making these oysters very acceptable when served raw on the half shell. For this reason Blue Points have acquired a wide reputation. Lynnhavens (Pl. XX) and Cotuits (Pl. XXI) are larger oysters than Blue Points and of more angular shape. Because of their fatness and flavor they have become highly esteemed.

Oysters are shipped in the shell to points on the Pacific coast both for the market and for planting as seed or for fattening. In 1915, over two-thirds of the 156,104 bushels of oysters produced on the Pacific coast were raised from transplanted eastern oysters.[b]

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[a] One firm puts out an oyster powder made by extracting in a vacuum the moisture from oyster meats. This powder is sold in small vials packed in pasteboard cartons and is used in making broths and soups. So far as the writer is aware, only one firm puts such a product on the market.

[b] Radcliffe, L. Fishery Industries of the United States. Report of the Division of Statistics and Methods of the Fisheries for 1918. Appendix X, Report, U. S. Commissioner of Fisheries, 1918, 167 pp. Washington, 1919.

"LYNNHAVENS," FROM LYNNHAVEN BAY, VA.

About one-half natural size.

"COTUITS," FROM COTUIT HARBOR, MASS.

About one-half natural size.

FIG. 1.—SHUCKING TABLE IN LARGE OYSTER HOUSE.

The oysters come down from the storage room above and out the bottom of the V-shaped chute. The worker stands on the bench and places the oyster to be opened on the small block on the edge of the table.

FIG. 2.—WASHING FRESH OYSTER MEATS ON "SKIMMING BOARD."

(Photo from Prof. E. N. Cory, Maryland State University.)

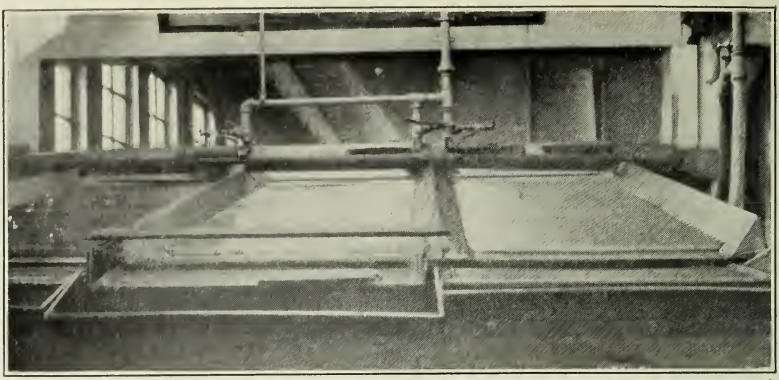

FIG. 1.—"RIFFLE" OYSTER WASHER, ON WHICH FRESH OYSTER MEATS ARE WASHED PREPARATORY TO BEING PACKED ON ICE.

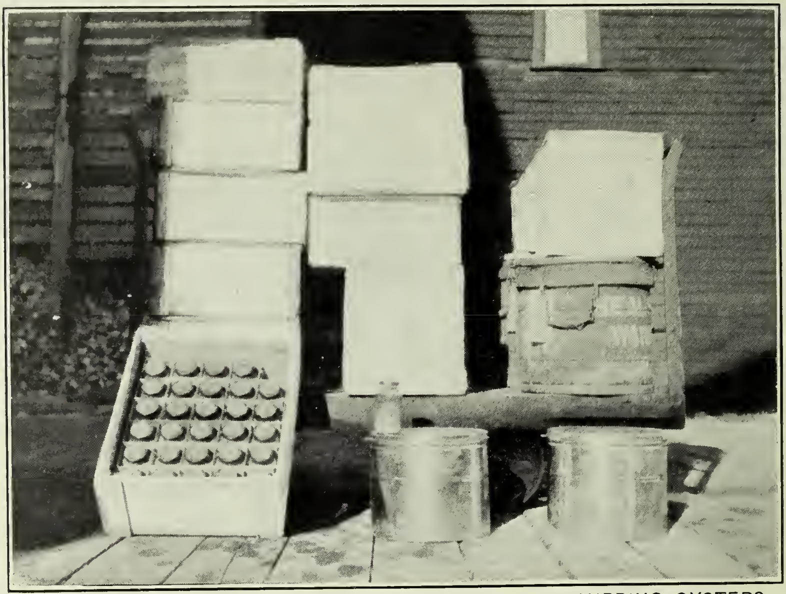

FIG. 2.—SEVERAL STYLES OF CONTAINERS USED IN SHIPPING OYSTERS.

Shucked oysters are placed in metal or glass containers, which are packed in the boxes or tubs with cracked ice about them.

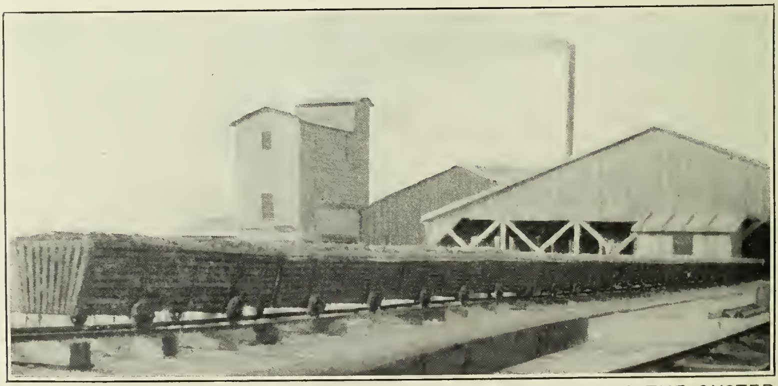

FIG. 3.—FIFTEEN CARS OF OYSTERS READY TO BE RUN INTO THE OYSTER CANNERY.

Each car holds 20 bushels, making 300 bushels in all. The capacity of this cannery is 1,500 bushels per day.

SHUCKED, ON ICE.

The process of opening an oyster and removing the "meat" is known generally as "shucking." For this purpose the oysters are conveyed to tables or stalls of various sorts in the oyster house. In the smaller establishments this is done by wheelbarrow and shovel; in the larger, the oysters are first taken to a storage room, as described above, and then let down through chutes to the individual stalls of the shuckers. Plate XXII, figure 1, represents a shucking table in one of the large oyster houses. The shucker stands on the bench before the table. The oysters fall down the slanting chute to the narrow table along the edge of which are seen the blocks on which the shucker places the oyster to open it. The shells are thrown through small chutes in the table and fall into the trough seen below, whence they are removed by a mechanical carrier.

The process of shucking requires considerable skill and strength of hand and wrist. Various methods are employed and several slightly differing styles of opening knives. Some shuckers first break off the "bill" or tip of the shell with a small hammer, insert the knife into the opening thus made, and cut the large muscle holding the shell together. Others scorn such aid, since it takes longer, and by steady pressure force the knife between the shells at the tips or the side. A skilled shucker moves his hands so rapidly the eye can hardly follow the movements. A heavy mitten is worn on the left hand, which grasps the oyster, the shell being very sharp on the edges. A fair day's shucking is 10 to 12 gallons.[a] If the oysters are in good condition, "fat," 12 gallons or a little more may be shucked. The average yield of shucked oysters from a bushel in the shell varies greatly with the condition and quality of the oysters. If the oyster meats are full and plump, they are spoken of as "fat" and the yield is greater than when "poor"; that is, the meat thin, watery, often semitransparent. A fair average yield is from 6 to 8 pints per bushel.

The "meats" are thrown into a galvanized-iron measure, which in some cases is perforated to allow the drainage of excess liquor. In some houses, however, the measures are not perforated and are partially filled with water into which the oysters are placed as shucked. When the measure is full it is taken to the measuring window and the oysters measured or weighed. The shucker sometimes receives a ticket, but in many cases the individual scores are marked up on a board by the weighing window and payment made weekly. In the smaller oyster houses the shells are thrown by the shucker to the floor and later removed in wheelbarrows. In many such houses each shucker stands in a sort of movable wooden stall placed before the table. This stall is 18 or 20 inches wide and about waist-high, being open at the rear so that the shucker may step in and out readily. Such stalls keep the accumulating piles of shells from encroaching on the space where the worker stands and also afford something against which he may lean while working. In some of the larger houses, where the shells are not thrown on the floor, the stalls are used merely to satisfy the shuckers who have

[a] Many, however, shuck more than this amount. The author knows of one man in particular, at Hampton, Va., who opened 26 gallons a day. Since his score was marked up and pay given for this amount, this record is authentic.

become accustomed to their use in smaller places and find it less tiring to work while standing in such a stall.

Shuckers are paid by the gallon; during the winter of 1919–20 the price was $0.35 to $0.40 per gallon. Some large firms in New England employ Portuguese for shucking; in places farther south many Negroes are used for this work. Both men and women are often employed; especially is this true where colored labor is used.

After being shucked the oysters are spread out on washing tables. These are usually comparatively simple in form, as seen in Plate XXII, figure 2, are made of galvanized iron, and measure about 5 feet long by 2½ wide, the bottom being perforated to allow the water to drain off and supported on a wooden framework, as shown in the figure. Some of the larger firms use more or less elaborate washing tables, some being of the "riffle" style (Pl. XXIII, fig. 1). This consists essentially of a sloping zinc platform with ridges or elevations across it which retard the oysters as they are washed down it. The oysters receive several washings, usually in fresh water from the tap. In some States, however, the law requires that the washing be done with salt water of a certain strength in order that the oysters may not be bloated by the absorption of fresh water. In the larger houses, after receiving a preliminary washing on tables similar to that in Plate XXIII, figure 1, they are carried by a gentle stream of water down narrow runways to tanks on a lower floor (Pl. XXIV, fig. 1). These are made of galvanized iron and are about 5 feet square by 15 inches deep. Here they receive two washings, in some cases compressed air being blown from pipes through the water in which the oysters are standing. This is thought by those using it to remove more thoroughly the fine particles of dirt or bits of shell. The excess water is allowed to drain off in the last tank, and the oysters are then packed in various sorts of containers, as the tin cans in the figure, which are then packed in ice.

Usually the oysters are divided, according to size, into three grades: Standards, the smallest; Selects, the next; and Counts, or Extra Selects, the largest. The usual containers are tin cans, as shown in Plate XXIII, figure 2, of a capacity of 1, 3, or 5 gallons. The oysters are packed into these without any other liquor than that remaining after the excess has been drained off, as stated above. The cover is put on, often secured by a string passed over the top and attached to lugs on each side. The cans are packed in ice singly in boxes (Pl. XXIV, fig. 2), or several together in a barrel. Sometimes metal containers, shown at right in Plate XXIII, figure 2, are used. These are packed in a bucket carrier with ice about them. The figure also shows the 5-gallon size tin can, the bucket carrier, the short boxes containing tin cans, and a bottle container with pasteboard cap, holding one-tenth gallon. Thirty bottles are packed in a flat, wide box (see figure), with ice over their tops, and a wooden cover is nailed on.

CANNING OYSTERS.

Oysters were first canned at Baltimore in 1820, and the expression "cove oyster," which now seems synonymous with canned oysters, was originally given to the small oysters found in the coves on the west bank of Chesapeake Bay between Baltimore and the mouth of the Potomac.[a] The industry has spread rapidly in the last 20 years.

[a] Smith, H. M. Oysters: The World's Most Valuable Water Crop. National Geographic Magazine, March, 1913, p. 258. Washington.

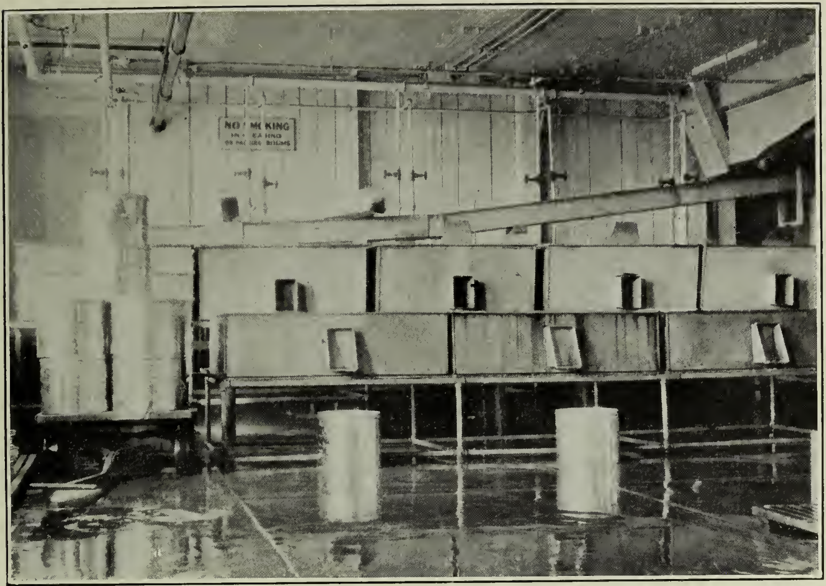

FIG. 1.—TANKS FOR WASHING SHUCKED OYSTERS.

The oyster meats come down the metal trough from the floor above. After washing they are placed in the tin cans.

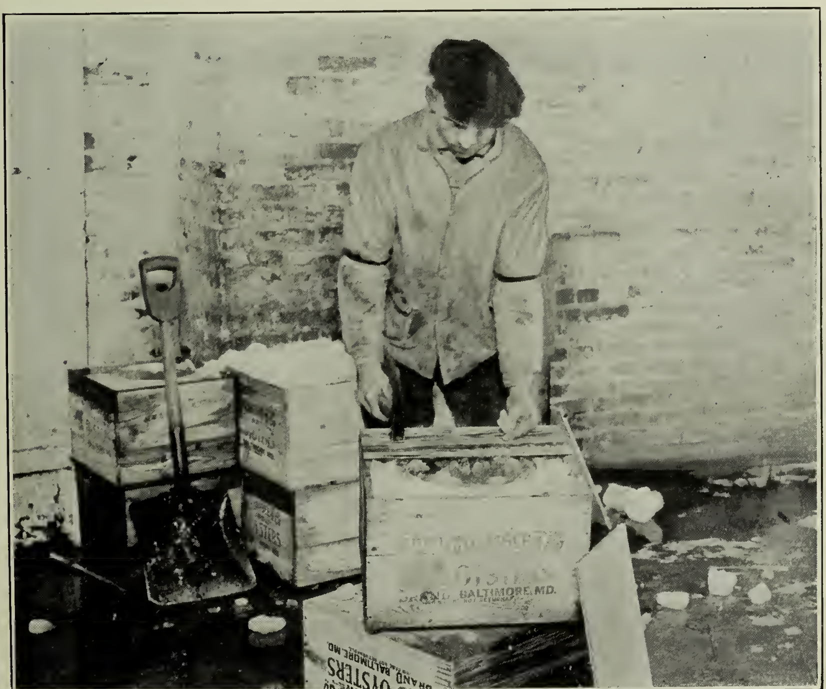

FIG. 2.—PACKING FRESH OYSTER MEATS IN ICE FOR SHIPMENT.

(Photo from Prof. E. N. Cory, Maryland State University.)

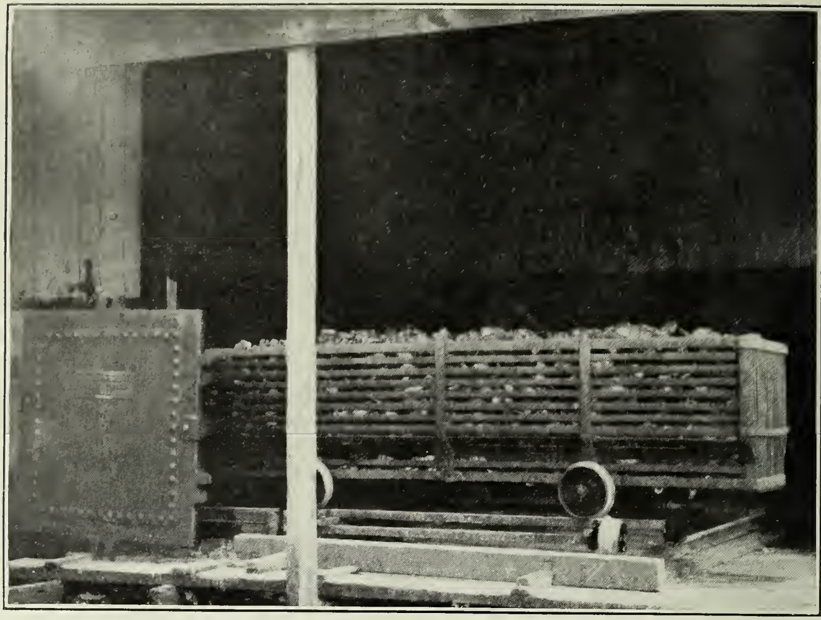

FIG. 1.—CAR OF OYSTERS READY TO BE RUN INTO STEAMER.

FIG. 2.—INTERIOR OF OYSTER CANNERY; OPENING STEAMED OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

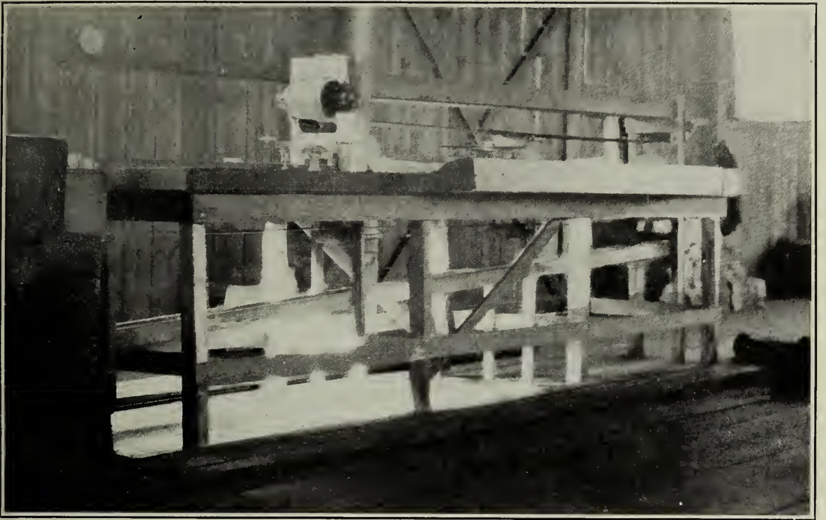

FIG. 1.—INTERIOR OF OYSTER CANNERY, SHOWING TABLE ON WHICH THE OYSTERS ARE PUT INTO THE CANS.

FIG. 2.—INTERIOR OF OYSTER CANNERY, SHOWING PACKING TABLE, CAPPING MACHINE, AND BASKET IN WHICH THE FILLED CANS ARE "PROCESSED."

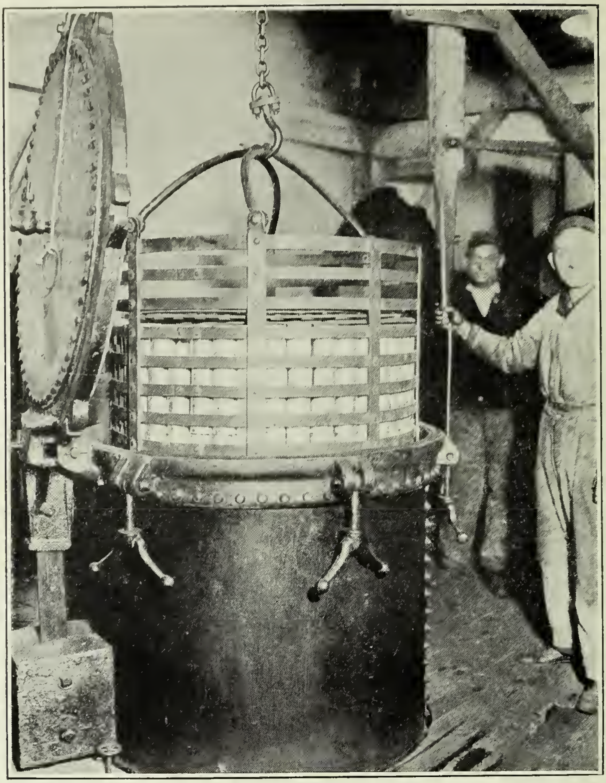

FIG. 1.—LOWERING A BASKET OF CANNED OYSTERS INTO THE KETTLE OR STEAMER TO BE "PROCESSED."

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—BASKET OF CANNED OYSTERS, AFTER HAVING BEEN "PROCESSED," READY TO BE LOWERED INTO THE "COOLER," AT RIGHT, WHERE RUNNING WATER IS PASSED ABOUT THE CANS.

There are now 15 canneries in Baltimore, which city still leads in number of canneries; 16 in Mississippi, 12 being at Biloxi; 18 in Georgia, 4 at Savannah, 4 in and about Brunswick, and others at smaller points; about 12 in South Carolina; 7 in North Carolina; 6 or 7 in Louisiana; and 4 or 5 in Florida.

Oyster canneries, like raw houses, are located on the water front with a wharf at which the oysters are unloaded from the boats. Plate XIV, figure 1, shows a view of an oyster cannery. At most canneries the oysters are unloaded from the boat in large tubs or buckets, as previously described, and dumped directly into cars 10 or 12 feet long, made of iron strips, basket-fashion, as in Plates XXIII and XXV. The cars are then pushed on a track into the building. Plate XXIII, figure 3, shows a line of 15 loaded cars, 20 bushels in each car, 300 bushels in all. The capacity of this particular cannery is 1,500 bushels per day.

The cars of oysters are run into rectangular iron steamers, which are often long enough to accommodate 3 cars at once. Steam is passed through for from 3 to 10 minutes, depending on the thickness of the shells. The cars are then pushed on out the other end of the steamer, sometimes being afterwards switched to another track or another room by the aid of the device shown in Plate XXV, figure 1. The short piece of track upon which the car rests is also provided with wheels, and the whole is rolled onto a lower track running at right angles to the first.

The steamed oysters are then opened directly from the cars by shuckers or openers standing alongside (Pl. XXV, fig. 2). Each worker has a metal bucket, which is suspended by a hook to the side of the car. The buckets are perforated to allow the escape of excess liquor. A knife is used, but no such skill or strength is required as is necessary in the case of raw oysters, since the steamed oysters have been killed by the process and the shells are gaping and easily separated. When a worker's bucket is filled, it is taken to the weighing window, payment being by weight, where either the money or a ticket is received. Both men and women, and often children over the legal age, do this work. In Alabama and Mississippi the workers are largely of the Slavic races. In those States many of the canning firms furnish quarters for their labor, often wood and water being included.

After being weighed, the oysters are washed two or three times with tap water in vats or on tables and then carried in buckets to the packing table (Pl. XXVI, fig. 1). The general construction of such a table is shown in the figure; it is made of wood, of convenient height, and about 12 feet long by 6 wide in the wider part and 3 in the narrower. The packing is usually done by women or girls, who stand along the sides of the table. The empty cans are supplied the packers from boxes behind them, or often a supply is placed along the edge of the table on which the oysters are piled. The packers at the farther end (see figure) of the table fill the cans almost full, placing the oysters in with the hands. They then put the cans in the rack or trough extending along over the table. The bottom of this is an endless belt which moves the cans forward until they are stopped by the crossbar at the nearer end of the trough. One packer stands on each side of the table, which is narrower here, takes the partially filled cans from the trough, one at a time, places them on the balances seen in the figure, and fills them up until the correct weight is reached. So far in the process there is practically no liquor in the can. Cans varying in capacity from 3 to 10 ounces are usually packed. The cans are then placed on another belt, which carries them along the trough to the left under a length of perforated pipe from which hot brine drops into the cans.

The belt then takes them to the capping machine (Pl. XXVI, fig. 2), where the cover is put on. This is commonly done by the crimping process, although some firms still use the method of sealing the cover on with solder. The machine shown in the figure crimps the covers on 58 cans per minute.

After leaving the capping machine the cans are placed in large circular iron baskets, about 4 feet across, and lowered into a cylindrical metal processing tank (Pl. XXVII, fig. 1). In these tanks the cans are heated by steam to a high temperature for a short time, after which they are removed and lowered into a circular wooden tank or cooler (Pl. XXVII, fig. 2), and cooled with running water. The baskets of cans are then wheeled on tracks to the labeling and packing room (Pl. XXVIII, fig. 1), where the labels are pasted on by girls or women. The finished product is then packed in boxes, this work being done by men (Pl. XXVIII, fig. 1).

DISPOSITION OF OYSTER SHELLS.

In the larger oyster houses the shells are usually dropped by the shucker through a chute leading from the table down to a wide endless belt or a trough through which passes an endless scrape carrier. These devices carry the shells outside and up an elevator (Pl. XXIX, fig. 1) or an inclined plane (Pl. XXVIII, fig. 2). The carrier continues over the shell heap, sometimes being inclosed, and drops the shells at certain points, which may be varied as the pile grows (Pl. XXVIII, fig. 2). In other oyster houses, especially the smaller ones, the shells are removed in wheelbarrows, which are rolled on planks up the side or across the top of the pile (Pl. XXIX, fig. 2).

The shells are used for cultch, as previously described; for making lime, which is placed on soil as a fertilizer; for poultry grit; for making shell roads; and for ballast for railroad track beds. In Plate XXIX, figure 1, is shown a kiln in which the shells are being burned to make lime, a pile of the burned shells appearing in the foreground. The interior of the kiln is cone-shaped at the bottom. The shells are deposited in the kiln by the elevator, a certain amount of fine coal being mixed in as fuel. The fire in the lower part of the kiln is kept burning constantly, and the burned shells are shaken out through the grate at the bottom. The shells are then allowed to air-slake, and the lime is sold for fertilizer. The burned shells bring about $8 per ton. About a ton is put on an acre. A ton of burned shells increases in bulk to about a ton and a half during the slaking process. A ton of the slaked lime sells for $6.50.

Crushed shells are used for poultry grit. The shells are first dried in a direct-heat rotary drier similar to that used in factories where fertilizer is made from menhaden. The degree of heat applied depends entirely on the percentage of moisture in the shells; the greater the moisture the higher the temperature required. It is essential that a close observance be kept during the drying process, in order to regulate the temperature, as shells may be damaged by too much

FIG. 1.—INTERIOR OF OYSTER CANNERY; LABELING AND BOXING CANS OF OYSTERS.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—SHELL PILE OF A LARGE OYSTER COMPANY, SHOWING CONVEYER FOR CARRYING SHELLS FROM SHUCKING TABLE TO THE PILE.

(Photo from J. S. Darling and Son.)

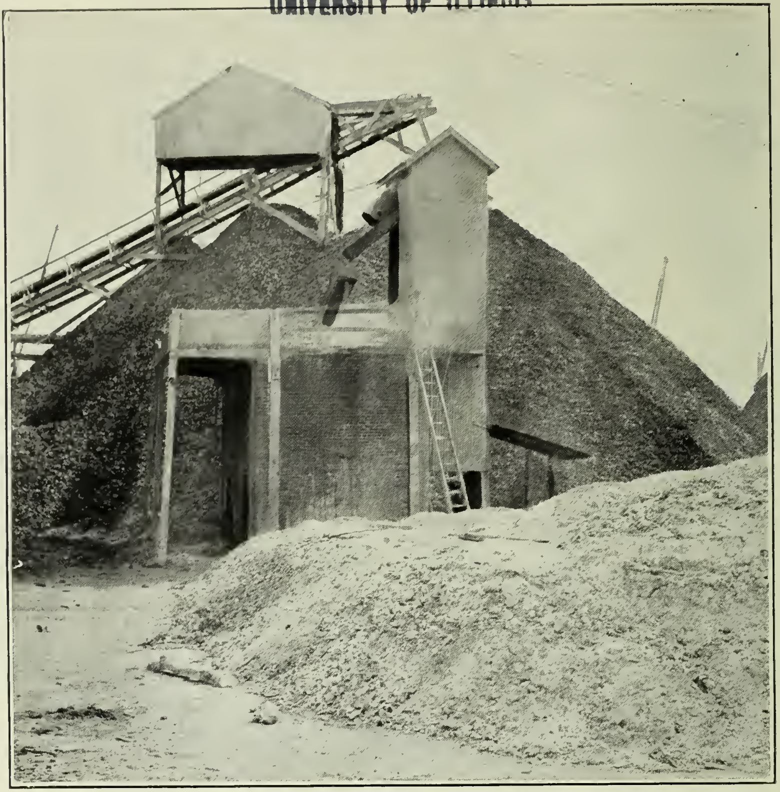

FIG. 1.—KILN FOR BURNING OYSTER SHELLS TO MAKE LIME, SHOWING SHELL HEAP IN BACKGROUND AND PILE OF LIME IN FOREGROUND.

(Photo from Prof. E. N. Cory, Maryland State University.)

FIG. 2.—LOADING OYSTER SHELLS INTO CAR FOR USE IN BUILDING ROADS.

heat. If the temperature is too high, the shells are likely to turn yellow, and if they are not sufficiently dried they may become soft. If they have been sheltered from the weather and are thoroughly dry the drying process may be dispensed with. After passing through the drier they are carried by a conveyer to the crusher and from there to the screen, which is usually of the revolving type and made of various-sized mesh to separate the crushed shells into several grades or sizes.

In Plate XXIX, figure 2, shells are being loaded on cars for road making. In some cases the shells are partially crushed before being put on the roads; in other cases they are put on whole and are worn down by the traffic. Plate V, figure 1, shows shells being loaded on a scow for planting to catch set.

The shell heaps are cleaned up annually. Most of the shells are used for one of the above purposes. The shell piles shown in the figures convey but a faint notion of the actual vast bulk of the oyster crop taken annually from the waters of the United States.

LEGAL REGULATIONS.

In each State in which there is an oyster industry there are certain regulations for its conduct, provided by State law and administered by officers and inspectors, appointed in nearly all cases by a State fish or oyster commissioner or president of a State conservation commission.

The regulations, while necessarily differing widely to meet the varying conditions, usually provide for a system of surveying and staking off with conspicuous buoys or markers the various beds leased or owned by the planters and the "natural" beds, the latter being those which have grown up naturally and which are open to the public. In some States, where there are many leased or privately owned beds, this surveying is very carefully attended to, and accurate maps of the oyster beds are provided. In others, especially those in which there are few or no leased beds, the surveys are poorly cared for, and no maps are kept.

The legal season in which oysters may be taken for market is usually restricted to the months of September to April, inclusive. The oyster is thus not interfered with during the spawning season, which occurs in the summer.

A cull law is usually provided by which oysters under a certain size—$2\frac{1}{2}$ or 3 inches generally—may not be taken except for seed, but must be thrown back on the beds from which lifted. Some States allow only sailboats and hand dredges to work on natural beds, as in Long Island Sound; some forbid dredging of any sort, all oysters being taken with tongs; some allow dredging only on leased beds; some, only in water of a certain depth; and some allow engine-driven dredges to be used on boats propelled by sails.

In most States only a legal resident may take oysters from the waters, and a license fee must usually be paid. In some cases oysters can not be shipped from the State in the shell, except for seed. This compels the establishment of oyster houses within the State and the retention of capital in that State. In others, as Louisiana, the oysters may be shipped out in the shell, but a tax per bushel must be paid to the State by the shipper. Some States require no license fee, but the dealer pays a tax per bushel or gallon for oysters sold. This nominally throws the tax on the dealer instead of the oysterman.

Most States make provision for leasing bottoms for the cultivation of oysters at a small rental, $0.25 to $1 or $2 per acre, for a term of years, the number of acres per person being limited. Provision is usually made that the natural beds may not be leased, but must be left open to the public. In some of the southern States there is very little interest in leasing beds, there being sufficient oysters found on the natural beds. In such States there is little or no planting done, except a limited amount by the State in the effort to build up certain natural beds.

The health authorities of most of the States provide certain regulations requiring that oyster beds be located at safe distances from sources of contamination, such as sewers, etc., and that oysters must pass certain rigid inspection tests for bacterial content before being placed on the market. The Federal Government also inspects oysters which enter into interstate commerce.

There are many other minor regulations peculiar to the different States and growing out of special conditions prevailing in each. The details of these may be secured from the State shellfish commissions of the various States.

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DEPARTMENT OF COMMERCE
BUREAU OF FISHERIES
HUGH M. SMITH, Commissioner

ALASKA FISHERIES AND FUR INDUSTRIES IN 1919

By WARD T. BOWER
Agent, Alaska Service

APPENDIX IX TO THE REPORT OF THE U. S. COMMISSIONER OF FISHERIES FOR 1919

Bureau of Fisheries Document No. 891

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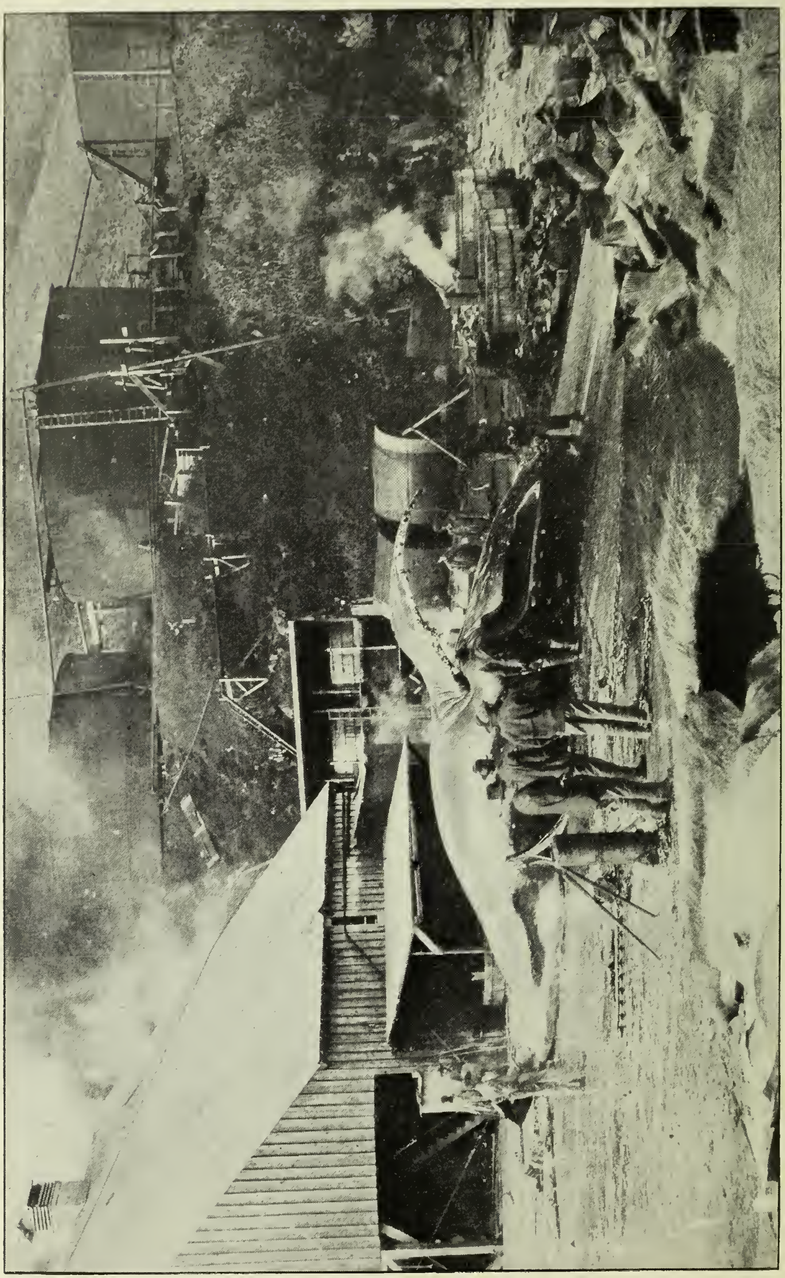

SHORE WHALING STATION, AKUTAN, ALASKA.

ALASKA FISHERIES AND FUR INDUSTRIES IN 1919.

By Ward T. Bower, *Agent, Alaska Service.*

INTRODUCTION.

The activities of the Bureau in Alaska, administered through the Alaska service, paralleled in large degree operations of previous years. There were some notable expansions, however, along certain lines of the work. In this connection mention may be made of the additional attention given to patrol of the fishing grounds for the purpose of enforcing the laws and regulations. Through the detail of certain vessels, the Navy Department cooperated and aided materially in this phase of the work. The number of stream watchmen to enforce the fishery laws at certain important centers was augmented. The success attending this line of work in 1918 warranted its expansion and further application in 1919.

Another phase of the work was the collection and compilation in systematic form of detailed statistics of the various fisheries of Alaska. The annual census of salmon ascending Wood River for spawning was taken. A special investigation of the salmon fishery in central and western Alaska and one of various problems in connection with the Copper River fishery were made. Following hearings held by the Bureau at Seattle in November, 1919, salmon-fishing operations were made subject to an order issued by the Secretary of Commerce under date of December 23, 1919, applicable to most of the salmon streams in Alaska.

The work of indicating by means of markers the areas within which commercial fishing operations are limited or prohibited received considerable attention in 1919. A few markers had been put in place in previous years, but recent departmental orders have increased greatly the number of localities in which fishing operations are limited or prohibited; this means that much additional work in marking stream mouths must be undertaken as soon as possible.

Inspections of the private hatcheries operated in accordance with the act of June 26, 1906, were made. Hatchery operations under the division of fish culture were carried on at the two principal stations of the Bureau located at Afognak and McDonald Lake, the latter formerly having been designated as the Yes Bay station.

The scope and magnitude of the work in connection with the fur-seal fisheries was in keeping with that of 1918 when regular commercial sealing operations on a considerable scale were resumed. The take of fur-seal skins at the Pribilof Islands in 1919 aggregated 27,821 pelts, having an estimated value of about $2,000,000. A census of the fur-seal herd was made and a special investigation was conducted with a view to developing, if possible, improved methods of taking and curing sealskins. The by-products plant erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil was operated rather experimentally in 1919; it will be operated along more extensive lines in 1920.

While the natives of the Pribilofs make return to the Government in services for supplies of food, clothing, fuel, and shelter furnished them, it is necessary that the purchasing, transportation, and distribution of the major part of such supplies be attended to by the Bureau. In the matter of transportation in 1919, the Bureau received great assistance from the Navy Department, also from the Coast Guard. Acknowledgment is hereby made of the courtesies thus afforded.

The enforcement of the law for the protection of fur-bearing animals throughout Alaska received attention. In addition, the collection and compilation of statistics in regard to shipments of furs from Alaska by individuals and companies and the leasing of certain islands in Alaska for fur-farming purposes received appropriate attention.

Two sales at public auction of sealskins and one of fox pelts, taken on the Pribilof Islands, were held at St. Louis in 1919 by the selling agents of the Bureau.

The author of this report is greatly indebted to Assistant Agent E. M. Ball for compilation of statistics of the fisheries and preparation of accompanying text. Acknowledgment is also made to H. D. Aller for assistance in the preparation of text for the section regarding the Pribilof Islands, and to H. J. Christoffers for work on statistics regarding the seal herd.

REGULAR EMPLOYEES, ALASKA SERVICE.

During the year 1919 the following regular employees have been identified with the Alaska service of the Bureau:

Regular Employees Identified with the Alaska Service in 1919.

Name.	Position.	Headquarters or chief place of duty.
Ward T. Bower	Chief agent	Washington, D. C.
Edward M. Ball	Assistant agent	Cordova.
Harry J. Christoffers	do	Seattle.
Ernest P. Walker	Inspector	Juneau. (Resigned Dec. 15, 1919.)
Calvin F. Townsend	do	Fairbanks. (Promoted Dec. 20, 1919, from assistant agent.)
Shirley A. Baker	Assistant agent	Dillingham. (Reinstated Feb. 20, 1919, after military duty. Promoted Dec. 20, 1919, from warden.)
Harry C. Fassett	Agent and caretaker	St. Paul Island. (Resigned Aug. 15, 1919.)
A. H. Proctor	do	St. Paul and St. George Islands.
Charles E. Crompton	do	St. George Island. (Promoted Aug. 16, from school-teacher, St. George Island.)
Henry D. Aller	Storekeeper	St. George and St. Paul Islands.
G. Dallas Hanna	do	St. Paul Island.
Henry H. Stromberger	Physician	St. Paul Island. (Resigned July 5, 1919.)
Charles E. Johnson	do	St. George Island. (Resigned July 15, 1919.)
Frank H. Gunn	do	St. Paul Island. (Appointed July 6, 1919. Services discontinued Nov. 1, 1919.)
John J. Richstein	do	St. Paul Island. (Appointed Nov. 6, 1919.)
William M. Murphy	do	St. George Island. (Appointed July 27, 1919.)
Herschel Silverstone	Assistant to agent	St. Paul Island. (Appointed Aug. 12, 1919.)
George Haley	School-teacher	St. Paul Island.
Cora Giles Haley	do	St. Paul Island. (Resigned Sept. 30, 1919.)
Lois L. Proctor	do	St. Paul Island. (Appointed Oct. 1, 1919.)

REGULAR EMPLOYEES IDENTIFIED WITH THE ALASKA SERVICE IN 1919—Continued.

Name.	Position.	Headquarters or chief place of duty.
Edward C. Johnston	do	St. George Island. (Appointed Aug. 16, 1919.)
Henry C. Scudder	Warden	Juneau. (Reinstated Jan. 1, 1919, after military duty.)
Fred H. Gray	do	Wrangell.
Christian L. Larson	do	Chicken. (Resigned June 30, 1919.)
Lemuel G. Wingard	do	Naknek.
Philip R. Hough	do	Juneau. (Appointed Apr. 15, 1919.)
Michael J. O'Connor	do	Haines.
Hans Bierd	Master steamer Roosevelt	Seattle. (Resigned June 18, 1919.)
Edwin Hofstad	Master steamer Osprey	Cordova.
Jesse L. Nevill	Master patrol vessel	Auklet.
George Naud	do	Murre.
Albert K. Brown	Clerk	Washington, D. C.
Mary S. Haines	do	Do.
William P. Rasin	do	Do.
Marguerite McBride	do	Do.
E. Elaine Bell	do	Seattle.
Gladys M. Gamlen	do	Do.

REGULAR EMPLOYEES AT GOVERNMENT HATCHERIES IN ALASKA IN 1919.

Location and name.	Position.
Afognak:	
Edwin Wentworth	Superintendent.
Harry J. Heuver	Foreman.
Russell Noyes	Fish-culturist.
Fred R. Lucas	Do.
Albert L. Carlton	Apprentice fish-culturist. (Transferred Nov. 15, 1919, to McDonald Lake station.)
Alfred Nelson	Apprentice fish-culturist.
William M. McFarland	Apprentice fish-culturist. (Promoted Jan. 27, 1919, from apprentice fish-culturist, Clackamas, Oreg. Transferred July 15, 1919, to Puget Sound stations.)
Thomas H. Morton	Apprentice fish-culturist. (Transferred Sept. 15, 1919, from McDonald Lake station.)
F. J. Stewart	Cook.
McDonald Lake:	
C. H. Van Atta	Superintendent.
Calvin D. Ryan	Foreman.
C. N. Blystad	Fish-culturist. (Promoted Feb. 28, 1919, to scientific assistant, Homer, Minn.)
William L. Stiles, jr	Fish-culturist. (Promoted May 16, 1919, from apprentice fish-culturist, Baird, Calif.)
J. H. Tierney	Fish-culturist. (Resigned Oct. 20, 1919.)
Albert L. Carlton	Fish-culturist. (Promoted Nov. 16, 1919, from apprentice fish-culturist. Afognak, Alaska.)
William A. Cagle	Apprentice fish-culturist. (Transferred May 15, 1919, to apprentice fish-culturist, Clackamas, Oreg.)
Clarence Houts	Apprentice fish-culturist. (Appointed Aug. 1, 1919.)
William O. C. Owen	Apprentice fish-culturist. (Transferred Mar. 15, 1919, from fish-culturist, Leadville, Colo. Resigned Apr. 30, 1919.)
Thomas H. Morton	Apprentice fish-culturist. (Reinstated June 20, 1919. Transferred Sept. 14, 1919, to apprentice fish-culturist, Afognak, Alaska.)
Everett V. Campbell	Apprentice fish-culturist. (Appointed Sept. 27, 1919.)
Hugh Coppinger	Apprentice fish-culturist. (Appointed Jan. 27, 1919. Resigned Sept. 30, 1919.)
M. T. Tierney	Cook. (Resigned Oct. 6, 1919.)
Stella A. Campbell	Cook. (Appointed Oct. 7, 1919.)

FISHERY INDUSTRIES.

As in corresponding reports for previous years, the Territory of Alaska is here considered in the three coastal geographic sections generally recognized as follows: Southeast Alaska, embracing all that narrow strip of mainland and the numerous adjacent islands from Portland Canal northwestward to and including Yakutat Bay; central Alaska, the region on the Pacific from Yakutat Bay westward, including Prince William Sound, Cook Inlet, and the southern coast of the Alaska Peninsula, to Unimak Pass; and western Alaska, the north shore of the Alaska Peninsula, including the Aleutian Islands and Bristol Bay and the Kuskokwim and Yukon Rivers.

Detailed reports and statistical tables dealing with the various fishery industries are presented herewith, and there are also given the important features of certain subjects which were the objects of special investigation or inquiry.

WATERS CLOSED TO COMMERCIAL FISHING.

Section 6 of the act approved June 26, 1906, for the protection and regulation of the fisheries of Alaska, is as follows:

SEC. 6. That the Secretary of Commerce may, in his discretion, set aside any streams or lakes as preserves for spawning grounds, in which fishing may be limited or entirely prohibited; and when, in his judgment, the results of fishing operations in any stream, or off the mouth thereof, indicate that the number of salmon taken is larger than the natural production of salmon in such stream, he is authorized to establish close seasons or to limit or prohibit fishing entirely for one year or more within such stream or within five hundred yards of the mouth thereof, so as to permit salmon to increase: *Provided, however*, That such power shall be exercised only after all persons interested shall be given a hearing, of which due notice must be given by publication; and where the interested parties are known to the Department they shall be personally notified by a notice mailed not less than thirty days previous to such hearing. No order made under this section shall be effective before the next calendar year after same is made: *And provided further*, That such limitations and prohibitions shall not apply to those engaged in catching salmon who keep such streams fully stocked with salmon by artificial propagation.

Pursuant to the provisions of this section, action was taken in 1919 in regard to the waters of southeast and central Alaska, and also in regard to certain waters tributary to Bering Sea.

Under date of September 24, 1919, announcement was made of a hearing to be held in respect to the district extending from Cape Spencer on the east to Cape Sarichef on the west, and northward on Bering Sea to Cape Newenham. The text of the announcement was as follows:

It having been recommended that the Secretary of Commerce set aside all lakes and streams as preserves for spawning grounds and limit or prohibit commercial fishing for salmon and other commercial fishing in the prosecution of which salmon are taken or injured in all such streams and lakes and all waters tributary thereto and within 500 yards of the mouths of such streams, in all waters of Alaska flowing into the Pacific Ocean between the longitude of Cape Spencer on the east and the longitude of Cape Sarichef on the west; also in all such waters tributary to Bering Sea between Cape Sarichef and Cape Newenham, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of limiting or prohibiting fishing operations in the above-described waters will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 20, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Under date of October 24, 1919, announcement was made of a hearing to consider the desirability of amending the order of December 21, 1918, affecting waters of southeast Alaska east of the longitude of Cape Spencer. The text of the announcement is as follows:

It having been recommended that the Secretary of Commerce amend the order of December 21, 1918, effective January 1, 1919, limiting and prohibiting fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in certain waters of southeastern Alaska east of the longitude of Cape Spencer, to include all streams more than 500 feet in width, notice is hereby given, under the provisions of section 6 of the act of Congress approved June 26, 1906, entitled "An act for the protection and regulation of the fisheries of Alaska," that a hearing to determine the advisability of further limiting fishery operations, or of modifying existing limitations on such operations, in the waters in question will be held at the office of the Bureau of Fisheries, 1217 L. C. Smith Building, Seattle, Wash., on November 25, 1919, at 10 o'clock a. m., at which time and place all persons interested will be heard.

Following the two hearings on November 20 and 25, 1919, the Department, under date of December 23, 1919, promulgated the following order:

Hearings having been given at Seattle, Wash., November 20, 1919, and November 25, 1919, respectively, after due notice in accordance with law, for the purpose of determining the advisability of limiting or prohibiting fishing in certain waters in Alaska, and to amend or modify the order of December 21, 1918, and all persons having had full opportunity to be heard, it is hereby ordered, by virtue of the authority vested in me by section 6 of "An act for the protection and regulation of the fisheries of Alaska," approved June 26, 1906, that until further notice all fishing for salmon, or other fishing in the prosecution of which salmon are taken or injured, in all hereinafter-described waters of Alaska be and is hereby made subject to the following limitations and prohibitions in addition to the general restrictions already applicable by virtue of existing laws and regulations:

1. Waters east of the longitude of Cape Spencer.

(*a*) All fishing is prohibited in all salmon streams and their tributaries and lakes.

(*b*) All fishing, except with purse seines and drift gill nets, is prohibited within 500 yards of the mouths of all salmon streams.

(*c*) All fishing with purse seines and drift gill nets is prohibited within 200 yards of the mouths of all salmon streams, and all fishing with purse seines and drift gill nets as well as with all other apparatus is prohibited within 500 yards of the mouths of Chilkat River, Chilkoot River, Anan Creek, Hetta Creek, Sockeye Creek, and Naha Stream.

2. All fishing is prohibited in all salmon streams, their tributaries and lakes, and within 500 yards of the mouths of such streams, flowing into the Pacific Ocean or Bering Sea between Cape Spencer and Cape Newenham, except as follows:

(*a*) Fishing is permitted in Bering River below a line extending at right angles across Bering River from a point approximately 800 feet northwesterly from the mouth of Gandil River.

(*b*) Fishing is permitted in Copper River and its tributaries in accordance with the terms of the order promulgated December 20, 1918, which order is continued in full force.

(*c*) Fishing is permitted at Karluk beyond the zone 100 yards outside the mouth of Karluk River where it breaks through Karluk Spit into Shelikof Strait.

(*d*) Fishing is permitted in Ugashik River below a line extending at right angles across the Ugashik 500 yards below the mouth of King Salmon River.

3. The driving of salmon downstream and the causing of salmon to go outside the protected area at the mouth of any salmon stream are expressly prohibited.

4. This order does not apply to persons taking salmon with rod, hand line, or spear for their personal or family use and not for sale or barter.

5. The waters of the Afognak Reservation are covered by Presidential proclamation of December 24, 1892, and the regulations promulgated by authority thereof are not modified or affected by this order, but remain in full force.

6. All previous orders of the Secretary of Commerce imposing limitations or prohibitions upon fishing in the waters covered by this order, except as hereinbefore indicated, are hereby superseded.
7. This order became effective January 1, 1920.

Limitations and prohibitions upon fishing are applicable in the waters of the Yukon and Copper Rivers by virtue of previous orders of the Secretary of Commerce. Limitations have been placed upon fishing by Executive order or proclamation in the following additional waters: Afognak Reservation, Aleutian Islands Reservation, Yes Bay and Stream, and the Annette Island Fishery Reserve.

STREAM IMPROVEMENT.

In recent years the Bureau has done some work in regard to the removal of obstructions and natural barriers from streams in Alaska to permit breeding salmon to reach previously inaccessible spawning grounds. Not much was done along this line in 1919, as there was a shortage of funds and personnel, and for the further reason that the Alaska Legislature had provided for a Territorial fish commission, one of the functions of which was the removal of natural obstructions from salmon streams. The Bureau has been glad to relinquish this phase of the work to the Territory. It is hoped that efforts may be pushed vigorously, as there is a splendid field which promises big returns in the way of conserving the supply of salmon. Employees of the Bureau have been directed to cooperate with the Territorial fish commission in these operations.

STREAM WATCHMEN.

Supplemental to the patrol work of the Bureau as carried on by the regular employees stationed in Alaska, temporary employment was given to a few men in the southeast and central districts as stream watchmen. The general plan was to place these men at certain important streams or localities during the salmon season to prevent encroachments upon areas closed to commercial fishing. As far as means permitted this was done in 1919. The greatest merit of the service lies in the prevention of raids on the schools of salmon as they congregate at the mouths of the streams. It will grow in value in proportion to the number of streams which may be thus guarded.

Stream watchmen were employed in southeast and central Alaska as follows: In southeast Alaska, A. Burks Summers, Cyrus B. Johnson, Ernest F. Goodner, C. C. Combs, Edward Fay, Walter Campen, Lester Campen, George W. Mock, and E. J. Hunsacker; in central Alaska, Kenneth C. Cole on Prince William Sound and Cook Inlet, Newt Casperson at Miles Lake and Abercrombie Canyon, Kristof Lahz at Eshamy Bay, W. E. Baumann at Afognak, and John J. Folstad at Karluk. In addition, Joseph A. Bourke, a Territorial officer, detailed through courtesy of Governor Riggs, assisted in the work on the Copper River and Prince William Sound.

The fifteen persons above named, together with the regular employees of the Bureau, constituted a larger force than had been engaged any season previously in fishery protective work in Alaska.

ALASKA FISHERY INTELLIGENCE SERVICE.

This service, inaugurated in 1917, whereby the prices paid for fish at Seattle and Ketchikan were supplied by telegraph to a number of towns in Alaska, was continued through the year 1919. Expressions of appreciation have been received, and the information is believed to be of value to the fishermen. It is planned to continue the service.

FISHERY PATROL.

BUREAU PATROL BOATS.

A successful patrol of the waters of Alaska in the interest of the fisheries is contingent upon the ability of the officers of the law to reach any region at any time. Suitable boats are the means by which such work can be accomplished. To meet the situation, the Bureau maintains and operates a small fleet of vessels in Alaska, admittedly inadequate for the work, but being enlarged as rapidly as possible with funds available. This fleet is supplemented by the charter of privately owned boats for occasional trips and short periods.

Of the Bureau's vessels, the steamer *Osprey* has long been the mainstay of patrol work in southeast Alaska. In June, it was transferred to the central district, where the growing needs of the service demanded the presence of such a boat.

The *Murre* and *Auklet* remained in the southeast district and were regularly employed during the active fishing season from June to October. The *Puffin*, formerly attached to the *Roosevelt* as ship's launch, rendered some service in the vicinity of Juneau and the Taku River. It was sent north from Seattle under its own power early in July, but owing to engine trouble did not reach Ketchikan until almost a month later and then only by shipment on a freight steamer from a Canadian port. After certain alterations are made the *Puffin* can be used to advantage in stream-protective work.

Three small launches were chartered for a few days in central Alaska for patrol work in the Copper River and Cook Inlet sections.

The *Swan* was used on the Yukon River, particularly in patrolling the waters of the delta where Yukon commercial fishing was centered in 1919. Assistant Agent Townsend covered about 4,000 miles with the *Swan*, from Fairbanks to the mouth and return to Nenana, where the vessel was hauled out for the winter.

Under authority of Executive order of May 24, 1919, in regard to the disposition of vessels no longer needed by the Navy Department, three vessels which had been used as scout patrols off the New England coast, were transferred to the Bureau for service in Alaskan waters. Two of these vessels, the *Cobra* (S. P. 626) and the *Calypso* (S. P. 632), were turned over to the Bureau at Quincy, Mass., in July. In October the *Wachusetts* (S. P. 548) was also secured at the same place. All of these vessels were towed by the Bureau's steamer *Phalarope* to the Woods Hole station. Subsequently the *Cobra* and *Calypso*, renamed *Petrel* and *Merganser*, respectively, were towed by the *Phalarope* to the Norfolk Navy Yard, where on October 3 they were placed aboard the U. S. S. *Neptune* for transportation to the Pacific coast. The vessels reached the Puget Sound Navy Yard early in

1920. The *Wachusetts*, since named the *Fulmar*, is still at the Woods Hole station.

The *Petrel* was built in 1917, is 53 feet in length, and is equipped with a 350-400-horsepower Dusenberg motor, which is said to give a maximum speed of 25 miles. Fuel capacity is 600 gallons. The vessel originally cost $14,000.

The *Merganser*, which was built in 1909, is 43 feet in length, and is equipped with a 20-horsepower Alco engine. Fuel capacity is 100 gallons and speed 9 miles an hour.

The *Fulmar* was built in 1914 and is 101 feet in length and 17 feet in breadth. It is equipped with a 120-horsepower Nlsco Diesel engine. The vessel measures 65 tons gross burden.

It is planned to detail the *Petrel* and *Merganser* for duty in southeastern Alaska, and the *Fulmar* for service in the more exposed waters of central Alaska. It will be necessary to make alterations on all of these vessels before they are ready for service. The work will be undertaken as soon as funds are available. It is anticipated that the *Petrel* and *Merganser* will be available for duty before the end of the fishing season of 1920.

MILES CRUISED AND COST OF OPERATION OF CERTAIN FISHERY PATROL BOATS OF THE BUREAU.

Name.	Miles cruised.	Cost of fuel.	Cost of repairs, etc.	Subsistence of crew.	Total cost.
Auklet [a]	6,444	$812.10	$1,404.41	$344.50	$2,561.01
Murre [a]	5,436	782.65	1,261.75	336.60	2,381.00
Osprey [b]	4,303	2,188.60	1,354 03	1,027.20	4,569.83
Total	16,183	3,783.35	4,020.19	1,708.30	9,511.84

[a] In commission about 6 months. [b] In commission about 10 months.

NAVAL VESSELS.

In 1918 the National Council of Defense through its representatives in Juneau requested the Secretary of the Navy to send vessels to Alaska to assist in enforcing the fishery laws of the Territory. In the same year, after an extended cruise in Alaskan waters, Lieut. Commander Driggs, United States Navy, commanding officer of the U. S. S. *Brutus*, in a report to the Secretary of the Navy, pointed out that wastes of salmon had occurred in western Alaska, particularly Bristol Bay, and that the present law was inadequate to protect the fisheries properly. To meet the situation as thus represented the Secretary of the Navy ordered the U. S. S. *Vicksburg* and two submarine chasers to Alaska in 1919 to patrol the fishing grounds during the period of greatest fishing activity. The *Vicksburg* with subchasers *No. 309* and *No. 310* proceeded to Juneau early in the season. Toward the end of May subchaser *No. 309* was detailed to patrol duty in southeast Alaska, while subchaser *No. 310* accompanied the *Vicksburg* to Cordova for similar duty in central Alaska, arriving there shortly after the 1st of June.

In accordance with arrangements made with the Navy Department for the placing of fisheries agents on these boats, Warden H. C. Scudder, of the Bureau's force in southeast Alaska, was detailed to the *Vicksburg* and was transported to Ikatan, where he remained while the vessel went on to Bristol Bay. The *Vicksburg's* stay in western Alaska was comparatively short, due to the small run of salmon and the early closing of the canneries. The return voyage began early in July and Mr. Scudder was picked up and brought back to Juneau. En route the *Vicksburg* called at Cordova on July 18 to convoy subchaser *No. 310* back to Juneau. Subchaser *No. 310*, which was detailed to central Alaska, made one short inspection trip around Prince William Sound and into Valdez for the Bureau and afforded transportation to Assistant Agent E. M. Ball to Kodiak, but from there was at once ordered to Yakutat in the matter of a disturbance over fishing rights of the Indians and was of no further assistance to the Bureau in the central district. Representatives of the Bureau in southeast Alaska were on a number of occasions afforded transportation on the subchasers *No. 309* and *No. 294*. The latter replaced *No. 309* late in July. The U. S. S. *Marblehead* was also in the southeast district for a short time in connection with the fish-trap piracy situation.

VIOLATIONS OF FISHERY LAWS AND REGULATIONS.

The case against the Alaska Pacific Fisheries, which company was indicted in October, 1918, on 15 counts for failing to close properly several of its traps during weekly close seasons in July and August, 1918, was called for trial at Juneau on June 14, 1919. Motion by the defense for a continuance being denied, evidence was presented by the Government on five counts of the indictment in respect to traps at Grindall Point, Cleveland Peninsula, South Vallenar Point, Stone Rock Bay, and Cape Chacon. The jury returned a verdict of guilty. The court thereupon imposed a fine of $1,000 for each of the five counts, which with the costs of $177.20 made a total of $5,177.20 paid by the Alaska Pacific Fisheries for the unlawful operation of the traps in question. The remaining 10 counts were dismissed owing to the absence of an important witness for the Government.

Another case against the Alaska Pacific Fisheries involving the construction in 1917 of a floating trap within the prohibited lateral distance of a trap at Village Point, Icy Strait, belonging to the Thlinket Packing Co., was also brought to trial on June 14, 1919, after many postponements. The company, being denied a further continuance, pleaded guilty to the charge and paid a fine of $100 plus costs amounting to $753.80.

During the weekly close season on August 23, 1919, a trap of the Alaska Pacific Fisheries on Chichagoff Island was found in full fishing order. Complaint being entered before the United States commissioner at Juneau on September 15, the company pleaded guilty and was fined $200 and costs.

On September 22, 1919, Hugh Whitelaw and Gus Starkloff were found fishing in Staney Creek on the west coast of Prince of Wales Island. Whitelaw was brought before the United States commissioner at Ketchikan on October 23, when he pleaded guilty and paid a fine of $10 and costs of $3.13. Starkloff was indicted but not apprehended during the year.

On October 15, 1919, a complaint was filed in the United States commissioner's court at Juneau, charging the Deep Sea Salmon Co. with the operation of two floating traps on the west shore of Port Althorp on Sunday, August 24, 1919. The company pleaded guilty and paid a fine of $400 and costs.

The grand jury sitting at Juneau in September, 1919, indicted William Brady, Pat Brady, George Paul, and Sam Goldstine for unlawful fishing with a seine in a creek flowing into Gambier Bay. On December 9 the case was dismissed by the court, as it was shown that the fishing was on the tide flats outside the stream.

The Petersburg Packing Corporation was fined $200 and costs in the United States commissioner's court at Ketchikan on October 23 for failure to close properly its trap at Point Colpoys on Sunday, August 17, 1919.

On Sunday, August 3, a trap of the Sunny Point Packing Co. was found only partially closed. A true bill was returned against the company on October 23 at Ketchikan, to which a plea of guilty was entered on October 29. A fine of $100 and costs was imposed.

During the weekly close season on the night of August 2 a trap of the Anacortes Fisheries Co. at Lemesurier Point was found fishing. The matter was reported to the grand jury at Juneau, which on September 15 indicted the company and both trap watchmen. The case was tried at Ketchikan on October 20 and resulted in a conviction. A fine of $150 was imposed against the company and $25 against each of the two watchmen.

An indictment was returned at Juneau on September 15 against the Alaska Herring & Sardine Co. for constructing a trap in Wilson Cove, Chatham Strait, within 500 yards of the mouth of a stream, this being contrary to the closing order of December 21, 1918. The case was dismissed upon transfer to Ketchikan, the company agreeing not to reconstruct the trap.

On July 30 Pete Knutsen and Ole Knutsen were fishing in Petersburg Creek with a gill net set almost entirely across the stream. They were indicted at Juneau September 15 on two counts, one for fishing within the creek and one for fishing in the estuary at the mouth of the creek. The case was tried at Ketchikan and resulted in a conviction on the second count. On November 15, 1919, a motion for a new trial was filed.

Complaint was filed on October 10 in the United States commissioner's court at Ketchikan against Chris Selness, an alien, for fishing in violation of the law. In the course of the trial it was shown that Selness avoided the draft for military service by surrendering his declaration papers and that he was being paid wages as a fisherman at the time of the alleged unlawful fishing. The jury regarded him as a partner in the fishing business and accordingly found him guilty as charged. He was fined $500. The case was taken to the district court on appeal and set for trial at Ketchikan on October 23. After the court ruled that the defendant could fish for wages, the case was dismissed on motion of the United States attorney.

On Sunday, August 3, a fish wheel, marked "McBride & Co. No. 2," was found in operation on the Taku River. Complaint was filed before the United States commissioner at Juneau on September 10 against H. C. McBride, A. H. Humphries, and William Strong.

Humphries, appearing for all defendants, pleaded guilty and paid a fine of $100 and costs.

On September 13 William Strong was also indicted as an alien, it being alleged that he was a Canadian who had not declared his intention of becoming a citizen. This case is still pending.

On September 16 the grand jury indicted the George T. Myers Co. for fishing with a trap near Pinta Cove on Sunday, July 20. On September 17 the company pleaded guilty and was fined $250 and costs.

On September 15 the same grand jury indicted the Sanborn-Cutting Co. for fishing on Sunday, August 10, with a floating trap north of Mole Harbor on the west shore of Seymour Canal. When the case was called for trial on September 22 the company was convicted and fined $150 and costs.

Three traps belonging to P. E. Harris & Co. on the west shore of Admiralty Island were found in fishing order on Sunday, July 20. One of the same traps was also fishing during the close period on Monday, August 18. A complaint, covering four offenses, was filed against the company in the United States commissioner's court at Juneau. A plea of guilty was entered and a fine of $800 and costs was paid.

In June, 1919, Jacob Hollingstad, John Saarikoski, Kusti Joki, and Peter Peterson were accused as aliens of a violation of the act of June 14, 1906. Hollingstad, Saarikoski, and Peterson had taken out their first naturalization papers more than seven years before, but had made no subsequent attempt to attain full citizenship. Saarikoski and Joki were each fined $100 and costs, amounting to $6.20. Hollingstad, having claimed exemption from military duty as an alien, was fined $150 and costs of $9.20; Peterson pleaded guilty and was fined $100. Another alien named Dahl was also apprehended for fishing after the expiration of his first papers. Upon entering a plea of guilty at Ketchikan he was fined $5 and sentenced to purchase thrift stamps to the value of $100 before September 1.

Nels Peterson was found fishing with a gill net in Chilkat Inlet during the weekly close season on September 1. His boat and net were seized and turned over to the United States marshal. On September 10 a complaint was filed before the United States commissioner at Juneau, to which Peterson pleaded guilty; he was thereupon fined $200 and costs, which being paid, his boat and net were returned to him.

On September 10 a complaint was executed before the United States commissioner at Juneau, charging the Pacific American Fisheries with failure to close one of its traps on Chichagoff Island on July 20 and August 17, failure to close two traps on the east shore of Excursion Inlet on August 17, and further, for having constructed a trap on the east shore of Excursion Inlet within 500 yards of the mouth of a salmon stream. The company pleaded guilty to all five counts and paid a fine of $750 and costs.

On September 15 the Northwestern Fisheries Co. was fined $200 and costs for the faulty closing of a trap on the south shore of Icy Strait west of Point Augusta on Sunday, August 17.

The Astoria & Puget Sound Canning Co. was charged on September 15 in the United States commissioner's court at Juneau with not properly closing two traps in operation on the shore of Icy Strait on July 20 and August 17, and for having constructed a trap in False Bay, Chatham Strait, within 500 yards of the mouth of a salmon stream. The company pleaded guilty and paid a fine of $600.

In answer to a complaint filed before the United States commissioner at Juneau, Libby, McNeill & Libby pleaded guilty to having failed, on July 20, to close its trap located on the south shore of Icy Strait, and paid a fine of $200 and costs.

In September the Hidden Inlet Canning Co. was indicted for constructing a trap in Peril Strait near False Island, within the prohibited distance of a salmon stream. The case had not been disposed of at the close of the year.

The cases against the Carlisle Packing Co. and the Canoe Pass Packing Co., indicted at Valdez in October, 1918, for having driven and constructed certain fishing appliances on the tide flats between Mountain Slough and Cape Whitshed on the western side of the Copper River delta, came on for trial at a term of the district court at Cordova the latter part of September, 1919. The Government alleged that the Carlisle Packing Co. had driven three fish traps along the shore indicated, and to each of them a similar appliance was constructed and attached leaving no endwise space between the two structures; and that the Canoe Pass Packing Co. had driven one such appliance. The companies set up a defense that each of these structures as thus joined constituted but a single trap. Trial by jury being waived by both companies, the testimony was heard on September 25 by District Judge Charles E. Bunnell, who found them guilty as charged in the indictment. On September 30, the Carlisle Packing Co. was fined $450, or $150 for each double trap, and the Canoe Pass Packing Co. paid a fine of $150. The costs of the trials followed the judgments in both cases.

At the Valdez term of the district court in October, 1919, the cases of the Alaska Packers Association and the Alitak Packing Co. came up on appeal from the court of the United States commissioner at Kodiak. Each company was tried at Alitak in September, 1918, for the construction of a trap on Moser Bay within the prohibited lateral distance of another trap, the two traps in controversy being owned by the companies named. Trial in the lower court resulted in a fine of $1,000 and the costs against each company. The case of the Alitak Packing Co. was tried first at Valdez and resulted in a conviction. It was fined $500, or one-half of the amount of the fine imposed at Kodiak; costs of the trials in both courts were added, amounting to $563.90. The Alaska Packers Association was acquitted, the testimony in the case clearly showing that at the time the construction of its trap was begun there was not then any other fixed fishing appliance within 600 yards laterally of its structure nor was any in process of construction. A memorandum decision was given in the Alitak case on October 24, 1919, by Judge Bunnell which, because of its peculiar interest to all operators of fish traps, is quoted here in full.

The evidence in this case as per stipulation filed for and on behalf of the United States by the district attorney and for and on behalf of the defendant corporation by its attorney of record consists of all the testimony taken before H. H. Beck, commissioner and ex-officio justice of the peace at Kodiak, Kodiak Precinct, in the case of the United States of America *v.* Alitak Packing Co., No. 563 in the lower court, and the United States of America *v.* Alaska Packers Association, No. 539 in the lower court; also the testimony of E. M. Ball, called by the Government upon trial had in the district court. Both the Government and the defendant waive trial by jury and the defendant admits its corporate existence.

The facts in the case are easily determined. Moser Bay is an arm of Alitak Bay on the southwesterly shore of Kodiak Island. At the place where the Alaska Packers Association constructed its trap the distance from shore to shore is about 2 miles. On the 4th day of May, 1918, the Alaska Packers Association began driving a trap off the north shore of Moser Bay at a point about 3,000 feet from the shore and on a line nearly at right angles with the shore or beach line. The "heart," "pot," and "spiller" were first completed and several hundred feet of the "lead" were driven before the defendant corporation began the construction of a trap easterly from the Packers' trap. The defendant began the construction of its trap at a point about 900 feet from the shore and on a line nearly at right angles with the shore or beach line. Construction work was begun by the defendant on the 4th of June. The same general plan of construction was adopted by both the Packers and the defendant and both drove from deep water toward the shore. The defendant's trap was completed on about the 15th day of June. The Packers' trap with the exception of about 600 feet of the lead nearest the shore was completed on the 7th of June. The work was not continuous, though practically so, the witness Seaborg, "the boss trap man," testifying:

"We drove pretty much every day, that is, after the ship was discharged. That is, that when we got through with the lighter I drove a few piles, working at it every day a little."

The work of driving the last 600 feet of the "lead" was completed on the 18th of June. This 600 feet of "lead" swings to the east, toward the defendant's trap, and the shore end is about 150 feet nearer the shore end of defendant's "lead" than it would have been had it continued to the shore on the same line with the rest of the "lead." The distance between the shore end of the Packers "lead" and the shore end of the defendant's "lead" is 952 feet. The distance from the westerly side of the "pot" of defendant's trap to the "lead" of the Packers' trap calculated by a line running at right angles to the "lead" of the defendant's trap is considerably less than 600 yards.

The defendant defends on the theory that when it began the construction of its trap it was not within 100 yards endwise of any other trap or fixed fishing appliance and therefore when the Packers' "lead" was driven to a point 100 yards distant from a line drawn from the outside end of defendant's trap at right angles to defendant's "lead" and extending westerly across the course of the Packers' "lead," the Packers must cease further construction in order to keep wthin the provisions of section 262 of the Compiled Laws of Alaska. Section 262 provides:

"It shall be unlawful to lay or set any drift net, seine, set net, pound net, trap, or any other fishing appliance for any purpose except for purposes of fish culture, across or above the tide waters of any creek, stream, river, estuary, or lagoon, for a distance greater than one-third the width of such creek, stream, river, estuary, or lagoon, or within 100 yards outside of the mouth of any red-salmon stream where the same is less than 500 feet in width. It shall be unlawful to lay or set any seine or net of any kind within 100 yards of any other seine, net, or other fishing appliance which is being or which has been laid or set in any of the waters of Alaska, or to drive or construct any trap or any other fixed fishing appliance within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance."

The position taken by defendant is unique, but it is not tenable. Congress has said that the waters of any creek, stream, river, estuary, or lagoon shall not be fished with a fixed fishing appliance for more than one-third of the distance across or above the tide waters of such creek, stream, river, estuary, or lagoon; that a trap or fixed fishing appliance shall not be driven or constructed within 600 yards laterally or within 100 yards endwise of any other trap or fixed fishing appliance. It is argued that no right to continue to drive or construct is initiated by beginning to drive or construct. It is true that the statute specifies no period of time within which the trap or fixed fishing appliance must be completed, but the failure to so specify can not be held to mean that no time shall be given. The very nature of the language employed, "to drive or construct," as applied to the thing to be driven or constructed does not contemplate a completed structure by a single act. Construct means to put together the constituent parts of (something) in their proper place and order; to build; to form; to make, as to construct an edifice; and the spirit and intent of the statute is fully complied with when a trap or fixed fishing appliance once begun and under process of construction is being driven and constructed with such speed as existing conditions reasonably permit. To have fixed a definite period of time irrespective of weather conditions and unavoidable delays would have been equally as objectionable. I take it Congress was not attempting to place a bonus upon specially adapted equipment and speed in trap construction. No time is fixed for beginning work, nor when it must be finished. In this case it probably would not make much difference, for the defendant and the Packers are both undoubtedly able to enter a race on "trap" construction on equal terms, but if it is determined that the statute looks forward to, in fact invites, a race in trap construction, it is easy to be seen that an independent fisherman will never be able to construct a trap if formidable competition seeks to render his efforts useless.

Time, however, is not the only yardstick by which the rights of the trap builder are to be measured. Under the provisions of the statute the length of a trap or fixed fishing appliance must not be greater than one-third of the width of the creek, stream, river, estuary, or lagoon across which it is driven or constructed, and when the builder of a trap begins his trap at a point offshore and at a distance therefrom less than one-third of the width of the stream or estuary across which he is driving or constructing his trap, it must be held that within a reasonable limit of time he alone has the right to determine how far he will continue to drive and construct his lead toward the shore. I find the defendant guilty as charged in the complaint.

The Canoe Pass Packing Co. and the Northwestern Fisheries Co., jointly indicted at Valdez in October, 1918, were tried before the district court at that place in October, 1919. These companies were accused by the grand jury of unlawful fishing in Miles Lake by the use of set nets at less than the distance interval prescribed by the regulations affecting fishing in the Copper River, the indictment covering four counts against each company. The trial began October 20, and two days later the jury returned a verdict of guilty on all counts of the indictment. Motion for a new trial being made and denied on October 24, the court imposed a fine of $1,000 against each company, or $250 for each count. The costs of the trial, amounting to $307.30, were paid by the two companies.

The Abercrombie Packing Co., similarly indicted in 1918, was put on trial October 23. It was alleged in the indictment that the nets of this company were set within the prohibited lateral distance of those nets of the Northwestern Fisheries Co. and the Canoe Pass Packing Co., which were proved by the preceding trial to have been unlawfully placed. It therefore followed that the conviction of those companies virtually amounted to an acquittal of the Abercrombie Packing Co., which, from all the evidence presented, was the first to set its nets at the three points in question. Accordingly the court instructed the jury to return a verdict of not guilty on three counts of the indictment, whereupon the remaining count was dismissed upon motion of the United States attorney, as the evidence was insufficient to convict.

On Sunday, June 15, a trap of the Moore Packing Co., at Knowles Head, Prince William Sound, was found in full fishing order, and on the following day complaint was filed before the United States commissioner at Valdez against the company and the trap watchman. When the matter came to trial the company pleaded guilty solely on the ground that it was responsible for the acts of its employees. In this case the watchman was uncertain about the day of the week, having once closed the trap and then reopened it. A fine of $100, and costs amounting to $46.30, was imposed against the company. The case against the watchman was dismissed.

On July 10, John Roach, Harry Hendrickson, E. Carlson, and W. T. Wiseman, all fishermen of the Alaska Salmon Co., were caught fishing in Wood River, a stream closed to commercial fishing. They were arrested and brought before the United States commissioner at Dillingham on July 30 for trial. Roach and Carlson, fishermen from San Francisco, pleaded guilty, and a fine of $250 and costs of $20 was imposed against each. Hendrickson, a local fisherman, also pleaded guilty and was fined $100. Wiseman, a prospector in Alaska who sometimes earned a grubstake by fishing, demanded a trial by jury. The case against him was dropped, as it would have been difficult to have found 12 men in that section who could qualify as jurors. This is the second time that any prosecutions have been made in the Bristol Bay district. The first occurred in 1914.

FISH PIRACY.

In the fishing season of 1919 southeast Alaska was the scene of an attempt by a lawless element to carry on salmon-trap piracy. Some traps were raided and robbed during the absence of the watchmen, or through their intimidation, but these depredations were mainly unsuccessful, though one company reported the loss of 60,000 salmon from this cause. The situation was sufficiently serious to occasion the operators no little concern and also to engage the active attention of the law-enforcement agencies in the Territory. Vessels of the Navy, Coast and Geodetic Survey, Forest Service, and Bureau of Fisheries were authorized by the several departments represented to take summary action in dealing with the evil. The governor of Alaska and the Department of Justice, through the United States marshal and his deputies, took a large part in the suppression and punishment of this lawlessness. Some prosecutions were made and convictions secured, but piracy was brought to an end chiefly by an organized patrol under Federal and Territorial authorization and the cooperation of several packing companies.

It would seem that the companies operating traps might evolve a plan of self-protection to prevent a recurrence of this disorder, for the theory is fundamentally correct that if the salmon obtained through piracy can not be sold or disposed of at a profit, the raiding and robbing of traps will cease.

TERRITORIAL LEGISLATION.

By an act approved May 1, 1919, the Legislature of the Territory of Alaska amended sections 1 and 2 of the Territorial revenue act of May 3, 1917, chapter 74, Laws of Alaska, 1917. The changes include the imposition of a tax on the output of clam canneries, herring canneries, and whale-oil plants; an increase of 1 cent a case on all species of salmon canned and in addition a tax on the net income of salmon canneries; and increased rates on various salted products. The act as it applies to fisheries is as follows:

SECTION 1. That any person, firm, or corporation prosecuting, or attempting to prosecute, any of the following lines of business in the Territory of Alaska shall apply for and obtain a license, and pay for said license, for the respective lines of business, as follows:

*   *   *   *   *   *   *

6th: Fisheries:

(a) Clam canneries: Two cents per case;

(b) Herring canneries: Two cents per case;

(c) Salmon canneries: Five and one-half cents per case, on Kings and Reds or Sockeyes; three and one-half cents per case on Medium Reds; and three cents per case on all others.

In addition to the above tax, salmon canneries shall pay one per cent of their net annual income. By "net" income is meant cash value of the pack of the cannery, less operating expenses, and repairs and betterments actually made. No deduction shall be made as an operating expense on account of depreciation of machinery, interest on bonds or money borrowed, or other taxes paid.

(d) Fish traps, fixed or floating: one hundred dollars per annum, so-called dummy traps included;

(e) Salteries: Ten cents per one hundred pounds on mild cured Red King Salmon;

Five cents per one hundred pounds on mild cured White King Salmon;

Ten cents per one hundred pounds on salted Codfish;

Two and one-half cents per one hundred pounds on all other salted and mild cured fish, except Herring.

7th: Cold Storage Plants: Doing a business of one hundred thousand dollars per annum or more, five hundred dollars per annum; doing a business of seventy-five thousand dollars per annum and less than one hundred thousand dollars, three hundred and seventy-five dollars per annum; doing a business of fifty thousand and less than seventy-five thousand dollars per annum, two hundred and fifty dollars per annum; doing a business of twenty-five thousand and less than fifty thousand dollars per annum, one hundred and twenty-five dollars per annum; doing a business of ten thousand dollars and less than twenty-five thousand dollars per annum, fifty dollars per annum; doing a business of four thousand and less than ten thousand dollars per annum, twenty-five dollars per annum; doing a business of under four thousand dollars per annum, ten dollars per annum.

The "annual business" under this section shall be considered the gross amount received for the product and for storage of produce for others.

8th: (a) Fish oil works using herring in whole or in part in the manufacture of fish oil, two dollars per barrel. (b) Fertilizer and fish meal plants manufacturing fertilizer and fish meal in whole or in part from herring, two dollars per ton.

* * * * * * *

17th: Whale Oil Plants or Stations: One dollar per barrel.

TERRITORIAL LICENSE TAX.

Information has been received from the Territorial treasurer of Alaska in respect to tax collections made for the fiscal year ending December 31, 1919, under the several fisheries schedules of the Territorial tax law. The following statement is of date of May 22, 1920:

Fishery License Taxes Collected by Territory for the Fiscal Year Ended Dec. 31, 1919.

Schedule.	Division No. 1.	Division No. 2.	Division No. 3.	Total.
Salmon canneries	$96,592.52	$2,442.03	$68,228.57	$167,263.12
Herring canneries	1,288.44		683.58	1,972.02
Clam canneries			288.56	288.56
Salteries and mild-cure plants	3,431.90	50.30	3,191.47	6,673.67
Fish traps	52,600.00		23,000.00	75,600.00
Cold-storage plants	1,525.00		510.00	2,035.00
Fish-oil works and fertilizer and fish-meal plants	2,287.55			2,287.55
Whale-oil plants	7,731.00		16,680.00	24,411.00
Total	165,456.41	2,492.33	112,582.18	280,530.92
Additional tax [a]				20,770.67
Grand total				301,301.59

[a] Additional tax of 1 per cent of their annual net incomes collected from salmon canneries (not possible to segregate by divisions).

The Territorial treasurer, in reporting collections as above, made the following comment:

Several of the smaller salmon-cannery concerns have not yet made payment of their 1919-pack taxes; however, as the amount involved is not large and as it may be some time before payment is made, it is not deemed advisable to longer delay in furnishing your department the desired data.

Referring to collections under Schedule "Clam canneries," same are not yet complete for the year, but the amount involved is only a matter of possibly $200 or thereabouts. Fish-saltery taxes will continue to come in for some time yet, but any such taxes now delinquent are all for small sums.

In addition to amount reported in above statement under Schedule "Fish-oil works and fertilizer and fish-meal plants," the sum of $6,492 was also collected under said schedule; however, such item is not included in statement for the reason that it is being held on special deposit owing to unsettled litigation regarding the schedule in question.

TERRITORIAL FISH COMMISSION.

At the session of the legislature early in 1919 provision was made for a Territorial fish commission to consist of five members. The sum of $80,000 was appropriated for its work. The governor is chairman of the commission and the remaining four members are appointed by him for terms of two years, subject to confirmation by the Territorial Senate.

The work of the commission in 1919 was more or less preliminary in nature. A superintendent of hatchery operations was appointed and other employees secured, and fish-cultural operations were capably conducted at Juneau. This work was largely the outgrowth of operations of the Alaska Fish & Game Club, an organization made up of local sportsmen and persons interested in the conservation of the fisheries, both from the point of view of the angler and the commercial producer. Other plans of the commission include the improvement of salmon streams for spawning purposes by the removal of obstructions; allotments of funds were made for this work in the southeast, central, and western districts.

Late in the year members of the Territorial fish commission participated in a conference at Seattle to consider the advisability of framing additional legislation in respect to the fisheries of Alaska.

PREDATORY BIRDS.

From time to time it has been reported that certain birds in Alaska feed very largely on the eggs and fry of salmon and other food fishes and that their depredations are of such magnitude as to threaten seriously the supply of fish, especially salmon. Practically all birds in this category are protected by international agreement under the Migratory Bird Treaty and therefore can not be killed lawfully except by specific order. After due consideration of the facts, the Secretary of Agriculture issued an order on October 24, 1919, authorizing the killing of certain birds at fish hatcheries. The order is as follows:

ORDER PERMITTING THE KILLING OR TRAPPING OF CERTAIN BIRDS, AT FISH HATCHERIES, FOUND TO BE INJURIOUS TO VALUABLE FISH LIFE.

Information having been furnished the Secretary of Agriculture that grebes, loons, gulls, and terns, mergansers, and certain species of the heron have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and an investigation having been made to determine the nature and extent of the injury complained of, and whether the birds alleged to be doing the damage should be killed; and, if so, during what times and by what means, and it having been determined by the Secretary of Agriculture that the birds above mentioned have become, under extraordinary conditions, seriously injurious to and destructive of fishes at fish hatcheries in the United States and Alaska, and that such birds found committing the damage should be destroyed;

Now, therefore, I, D. F. Houston, Secretary of Agriculture, pursuant to authority in me vested by the Migratory Bird Treaty Act of July 3, 1918, and agreeably to Regulation 10 of the Migratory Bird Treaty Act Regulations approved and proclaimed July 31, 1918, do hereby order that the owner or superintendent, or a bona fide employee of a public or private fish hatchery in the United States or in Alaska, for the purpose of protecting the fishes at such hatchery, may shoot or trap the following birds at any time on the grounds and waters of such hatchery:

Grebes (Colymbidæ), locally also called water-witches or hell divers.

Loons (Gaviidæ).

Gulls and terns (Laridæ), the latter commonly also called sea swallows.

Mergansers (Merginæ), commonly also called sheldrakes or fish ducks.

The following species of the heron family (Ardeidæ)—

Bittern (*Botaurus lentiginosus*), locally also called shitepoke, stake driver, thunder pump, etc.

Great blue heron (*Ardea herodias*), locally also called blue crane, Poor Joe, cranky, etc.

Little blue heron (*Florida cærulea*), locally also called scoggins.

Green heron (*Butorides virescens*), locally also called shitepoke, fly-up-the-creek, scouck, etc.

Black-crowned night heron (*Nycticorax nycticorax nævius*), also known as gros bec, quawk, qua-bird, etc.

Every bird killed or trapped pursuant to the permission contained in this order, and every part thereof, including the plumage and feathers, shall be totally destroyed as promptly as possible, and shall not be possessed, transported, or shipped in any manner outside of the grounds and waters of the hatchery where killed or trapped except for the purpose of destruction as herein directed: *Provided, however*, That such birds or parts thereof may be shipped or transported, as a gift but not for sale, to public museums and public scientific and educational institutions, and all packages containing such birds or parts thereof so shipped or transported shall be plainly and clearly marked so that the name and address of the shipper and the nature of the contents may be readily ascertained on an inspection of the outside thereof.

ALEUTIAN ISLANDS RESERVATION.

Permits for fishery operations in the Aleutian Islands Reservation, which were effective at the end of 1918, continued through the season of 1919, with the exception that permit No. 23, granted November 1, 1917, to the Kuskokwim Fishing & Transportation Co., for cod and salmon operations at Trident Bay, was canceled on May 12, 1919. The company advised that its efforts had been a failure and it had abandoned the location. Six additional permits were issued during the season of 1919, which, with the 20 granted previously which remain effective, make a total of 26 permits outstanding at the end of the calendar year 1919.

Permits for Fishery Operations in Aleutian Islands Reservation Granted During Calendar Year 1919.

No.	Date.	Grantee.	Location and scope of operations.
36	Jan. 13	O. K. Quean	Commercial fishery operations; erection of cannery prohibited.
37	Feb. 7	H. O. Wick	Tigalda Island. Cod station.
38	Mar. 25	T. R. Gawley	Dora Harbor, Unimak Island. Cod station.
39	Apr 12	Standard Fish Co	Bay of Islands, Adak Island, and Chernofski Harbor, Unalaska Island. Commercial fishery operations; erection of cannery prohibited.
40	Sept. 5	Buckley Livestock, Fisheries & Transportation Co.	Chernofski Harbor and Kuliliak Bay, Unalaska Island, Cod and salmon operations; erection of cannery prohibited.
41	Sept. 6	Lars Mikkelsen	Six locations on Unalaska Island, Akun Island, and Tigalda Island. Cod stations.

Two permits for grazing purposes within the Aleutian Islands Reservation were granted jointly by the Departments of Agriculture and Commerce in 1919. The permit granted to Andrew C. Smith on July 5, 1917, for grazing on Umnak Island was canceled, and a similar permit issued to the Buckley Livestock, Fisheries & Transportation Co., which company has taken over his interests in the reservation. The two permits previously granted the Buckley Livestock, Fisheries & Transportation Co. and Emil Ittner for grazing on Unalaska Island and Amaknak (Dutch Harbor) Island, respectively, remained effective in 1919.

JOINT PERMITS IN ALEUTIAN ISLANDS RESERVATION GRANTED IN CALENDAR YEAR 1919.

Date.	Grantee.	Purpose and location.
Mar. 8	H. O. Wick	To graze stock and sheep on Tigalda Island.
Oct. 13	Buckley Livestock, Fisheries & Transportation Co.	To graze live stock on Umnak Island.

AFOGNAK RESERVATION.

The Afognak Fishery Reservation was established in 1892 by proclamation of President Harrison. All commercial fishing in the Territorial waters of Afognak Island was terminated, and the two salmon canneries in operation on Litnik Bay were closed and finally removed from the island. During the next 20 years unauthorized commercial fishing was carried on by resident whites and natives, who sold their catches to merchants at Afognak and Kodiak. Every locality about the island which produced an appreciable run of salmon was fished. The catch was used chiefly in the preparation of pickled bellies and dried and smoked backs.

Early in 1912 information was laid before the Department to the effect that the natives of Afognak were largely dependent upon the salmon fisheries of the island for a livelihood. To properly conserve the fisheries and to assist the natives, an order was issued by the Department whereby the natives and white men married to native women were permitted to fish in the reservation for commercial purposes after first obtaining a license. Accordingly, in the spring of 1912, more than 100 licenses were issued to these people, and in each season since then the same privilege has been granted. Necessary restrictions have been imposed in order that the salmon runs may be protected from close fishing, which might otherwise ensue. These restrictions applied to the kind and amount of gear which could be used and to the seasons when operations might be carried on. Each locality was given special consideration by the establishment of close seasons during the summer, for which the general law made no provision, the object being to insure some escapement of salmon to the spawning grounds.

The conduct of the work thus begun in 1912 has been continued without much change to the present writing. The runs of salmon have varied somewhat in the eight seasons which have passed, yet there appears to be no striking difference in the situation to-day from that in 1911. The fisheries have survived the disaster of 1912, when the eruption of Mount Katmai filled all streams of the island with volcanic ash, and salmon are now about as plentiful as before that catastrophe. Taking the streams separately, it is observed that those on the west side of the island are not producing as many red salmon as they did before the eruption, but the island as a whole shows a rather uniform production if some allowance is made for the lean years immediately following 1912. The present condition is neither particularly encouraging nor discouraging.

The streams on the east side of the island show a general improvement in the runs of salmon as compared with several years ago, and it seems probable that they will continue to improve under the increased liberation of fry from the hatchery on Litnik Lake. It is of special interest to record in this connection that red salmon appeared in greater numbers in 1919 than ever before in Litnik Bay, and that the collection of red salmon eggs at the hatchery was the largest ever made. In round numbers 78,000,000 eggs were taken, and it was estimated that there remained on hand a supply of unspawned salmon sufficient to have refilled the hatchery with eggs had opportunity been available.

The commercial catch of salmon in Afognak waters is shown in the following table:

CATCH OF SALMON BY APPARATUS AND SPECIES, AFOGNAK RESERVATION, 1919.

Locality.	By seines.					By gill nets.	Total.
	Coho.	Chum.	Humpback.	King.	Red.	Red.	
Little Afognak	5,179	119	2,112		19,830	3,505	30,745
Litnik Bay	5,203						5,203
Paramanof Bay	35	235	12,344		14,854	3,714	31,182
Malina		248	1,098	22	18,430	4,607	24,405
Danger Bay			5,871		27		5,898
Seal Bay			1,573	27	11,634		13,234
Izhut Bay					754	1,219	1,973
Pauls Bay					523		523
Total	10,417	602	22,998	49	66,052	13,045	113,163

The customary patrol of the fishing grounds in the Afognak Reservation was again followed in 1919, William E. Baumann, of Afognak, being employed temporarily to carry on the work, which, as heretofore, included general supervision of all commercial fishing in the reserved waters.

Litnik Bay was not open to commercial fishing except for silver salmon; this accounts for the fact that but the one species was taken there. All the red salmon were wanted for purposes of propagation, while the run of humpbacks was inconsequential.

In comparison with the catch of 1918, it appears that cohos increased 102 per cent; humpbacks decreased from 70,791 to 22,998, a decline of 67½ per cent; and reds increased from 50,662 to 79,097, an advance of 56 per cent. Chums and kings were taken in negligible quantities. The entire catch was sold to the Kadiak Fisheries Co., at Kodiak.

Approximately 90 per cent of the catch was made by means of beach seines, the remainder being taken with gill nets. The streams are small and clear, hence gill-net fishing is not practicable off their mouths. Traps are not permitted, and purse seines are not used for the reason that the natives are not prepared to operate them.

ANNETTE ISLAND FISHERY RESERVE.

The Annette Island Fishery Reserve, in southeastern Alaska, was created by a Presidential proclamation dated April 28, 1916, for the benefit of the Metlakatla Indians and any other natives of Alaska who might care to take up their abode on Annette Island. The reserve includes Annette Island and a number of smaller adjacent islands, together with the surrounding waters, and is administered by the Bureau of Education, Department of the Interior, in the interests of the resident natives.

The season of 1919 was the second in which fishery operations within the reserve were carried on in accordance with the five-year contract entered into with the Annette Island Packing Co. By the terms of this contract the contracting company pays a fee of $100 a year for each fish trap operated and a royalty of 1 cent for each fish taken from these traps. In addition the company pays the natives for fish taken in seines. The natives also receive payments for other services and materials furnished by them. In 1919 the fees from the seven fish traps operated amounted to $700; 794,625 fish were taken from the traps, providing a royalty of $7,946.25; and the amount paid the natives for fish taken by purse seines amounted to $25,231.85. The total income to the natives, including the Metlakatla Commercial Co., from the Annette Island Packing Co. for the season of 1919 was $90,032.88.

COPPER RIVER FISHERY.

At the close of the fishing season of 1918, it was found that the regulations of December 29, 1917, affecting fishing for salmon in the Copper River had failed to accomplish the purposes sought by their promulgation, namely, an escapement of salmon sufficient to provide for the ample seeding of the spawning beds and to supply the needs of the natives and other inhabitants of the region. Furthermore, it was repeatedly alleged that the regulations were discriminative in effect for the reason that operations in the delta district were materially restricted while those at Abercrombie Canyon and Miles Lake were almost unaffected. It was expedient, therefore, that appropriate action be taken looking toward a revision of the regulations in order that the original objects in view should be attained.

On September 16, 1918, announcement was made of a hearing to be held at Seattle, Wash., November 22, 1918, to consider the matter of changing the existing Copper River regulations. As a result new regulations were promulgated on December 20, 1918, effective January 1, 1919. The important changes in the new order were the extension of the weekly close season by 10 days in all parts of the river, the omission of the weekly close period of 36 hours, the prohibition of all stake nets, a reduction of 1,200 feet in the lateral distance interval and of 200 feet in the length of all nets the use of which was authorized in the waters of the delta over which the Secretary of Commerce has jurisdiction, an extension of 200 feet in the length of all nets whose use is permitted in Miles Lake, the closing of the west and north shores of Miles Lake and the east side of the river through Abercrombie Canyon, and a redefining of the delta by the exclusion of all areas not strictly in the river or its outlets or within 500 yards outside the mouth of each.

Under the new definition of the Copper River delta, fishing on the tide flats between the grass banks and the sand islands 3 or 4 miles offshore was unaffected, except as the prohibitions of the general law were applicable. By reason of that fact, the packing companies having canneries at Cordova and near the delta put their fishing gear in operation in this open field as soon as salmon began to run, and they made a very considerable catch before fishing could be commenced in the protected waters. Even after the close season had elapsed and all waters of the delta were open to commercial fishing, the flats were the preferred grounds and the bulk of the catch was made there. When the season was at its height there were approximately 65,000 fathoms of gill nets in operation on the delta. The greater part of this gear was used in the form of stake nets, though a small quantity was used as set nets in the sloughs, leaving the remainder for drift fishing in the channels crossing the tide flats.

Fishing in the delta district began about the middle of May and was diligently prosecuted until early in July, about which time all of the companies except the two nearest the field withdrew their men for the humpback fishing in Prince William Sound. The excepted companies did not stop fishing on the delta until late in August. The total catch of salmon in the waters of the delta was 1,129,934. Of this number 1,096,090 were red salmon; 8,972, kings; and 24,872, cohos.

In Miles Lake, all fishing was by means of gill nets, a total of 3,250 fathoms being used. Fishing in the canyon was carried on by the use of dip nets, there being from 20 to 50 men employed as dip-net fishermen, the number varying with the fluctuations in the run of salmon. Fishing began both in lake and canyon on June 15 and continued until September 16. The following catch of salmon was made: Reds, 157,597; kings, 4,092; and cohos, 15,778; or a total of all species of 177,467. This entire catch was canned by F. H. Madden at the Abercrombie cannery, formerly operated by the Abercrombie Packing Co. The following number of cases of salmon was packed: Reds, 13,933 cases of 1-pound talls and 1,248 cases of ½-pound flats; kings, 1,383 cases; and cohos, 1,461 cases.

The total catch of salmon in Copper River waters was 1,307,401, of which number 1,253,687 were reds, 13,064, kings, and 40,650 cohos.

Early in the season Assistant Agent E. M. Ball of the Bureau's staff and Special Agent Joseph A. Bourke, whose services had been temporarily secured by detail through courtesy of Gov. Riggs, erected a number of notices on the Copper River delta, indicating the extent of the waters affected by departmental regulations. Soon thereafter Mr. Ball returned to Cordova and devoted his attention to fishery matters in the Prince William Sound region and to the westward. Mr. Bourke continued to act for the Bureau during the fishing season on the Copper River. Newt Casperson was employed in special capacity and stationed for a number of weeks in the vicinity of Miles Lake and Abercrombie Canyon.

The great importance of the Copper River fishery and the several unusual problems involved in connection therewith, especially in regard to the extent of the spawning areas, seemed to demand a special inquiry into conditions in order that as complete information as possible might be available for future guidance. Accordingly arrangements were made for an investigation under the leadership of Dr. Henry B. Ward, of the University of Illinois. Associated with Dr. Ward were Prof. W. A. Oldfather, also of the University of Illinois, and J. R. Russell, superintendent of the Bureau's fish-cultural stations in Washington. The party arrived at Cordova on July 17, 1919, and proceeded up the Copper River & Northwestern Railway, thence taking a local guide and suitable camping equipment. The investigation covered several hundred miles of territory and included visits to a number of the more important spawning grounds on the tributary streams and lakes of the Copper River system. The party returned to Cordova September 6, 1919. A complete report submitted by Dr. Ward is given on page 119.

YUKON RIVER FISHERY.

In 1919 the Yukon River salmon fisheries assumed a position of large interest due to the successful operation of a cannery on Kwiguk Pass or Slough near the upper end of Kwikluak Pass, the most southerly outlet of the Yukon. The commercial utilization of salmon dates back to 1918 only, as prior to that year all salmon taken from the Yukon were used locally. The canning of Yukon salmon was begun in 1918 by the Carlisle Packing Co., rather as development or experimental work. The company was entering virgin territory, where business prudence required that it make a practical test of the feasibility of commercial operations in a region whose fishery wealth was almost unknown. Operations were conceded to be of experimental nature to determine whether the size of the runs of salmon would warrant the permanent establishment of a cannery on the river. Until that time little was known regarding the number of salmon ascending the Yukon River and its tributaries, though it was generally understood that a considerable catch was made annually by the natives for domestic use. The number thus taken probably did not exceed a few hundred thousand salmon each season, or a comparatively small number for a river of such size. The canning company made a total catch in 1918 of 115,531 salmon, more than half of which were chums.

In 1918 strong objections were made in certain quarters to cannery operations on the Yukon. Toward the end of the season, these objections took form and culminated in protests by some of the natives and white settlers along the river against the continued operation of this cannery, or the establishment of any more, the basic contention being that the supply of salmon was not more than adequate for local requirements. In contradiction of these representations, the packing company insisted that the runs were of enormous proportions and that fishing as conducted in the lower reaches of the river had made no appreciable impression on the supply of salmon and that in all probability it never could.

In November, 1918, a public hearing was held at Seattle, Wash., to determine the need, if any, of limits upon commercial fishing in the Yukon River as a means of safeguarding the fishery, and to ascertain the facts in regard to conflicting opinions and expressions bearing upon the entire matter. The information presented at the hearing showed the existence of a situation which might become serious if reasonable protective regulations were not made effective. Bishop P. T. Rowe, in charge of Episcopal Church affairs in Alaska, expressed the opinion that it was not so much that one cannery might result disastrously, but that it might be the thin entering wedge of extensive commercial exploitation. At the same time W. T. Lopp, chief of the Alaska division of the Bureau of Education, entertained a similar view. He felt that some regulation was necessary, but that reasonable cannery operations could be permitted with safety.

The outcome of the hearing was the promulgation of regulations which included prohibiting the taking of salmon for export purposes from the Yukon and its tributaries above the junction of Clear River and the Yukon, and limiting the case pack and the number of barrels and tierces which might be pickled or mild cured. The pack of canned salmon was limited to 30,000 cases; pickled salmon, to 1,000 barrels; and mild-cured salmon, to 200 tierces.

In 1919 the total number of salmon taken from Yukon River waters for export was 469,949, divided as follows: Cohos, 37,070; chums, 327,898; kings, 104,822; and reds, 159. The pack was as follows: Cases, 57,085; barrels, 214; tierces, 47. Of the total number of salmon caught, it was reported that 29,256 cohos, 194,452 chums, 65,433 kings, and 159 reds, an aggregate of 289,300 were taken in waters outside the scope of the regulations referred to above. The catch within the river was 180,649 salmon. Thus it appears that approximately 62 per cent of the commercial catch of salmon in Yukon River waters was taken in areas beyond the jurisdiction of the Department of Commerce, while only 38 per cent were caught within such areas.

In addition to the cannery of the Carlisle Packing Co., there were four salteries operated on the lower Yukon River in 1919. The Delta Fish Co. was located about 2 miles above the entrance to Kwiguk Slough; J. J. Stokes, about 4 miles below Aproka Pass; William O'Connor, 4 miles above the entrance to Akularak Slough; and the Fuller Fish Co., at the mouth of Andreafski River. Operations of all these concerns were upon a small scale, the total pack being only 239 barrels of pickled salmon. The Delta Fish Co. was the only one that salted in tanks and afterwards transferred their pack to barrels for shipment. The pack of J. J. Stokes was disposed of locally, as was also the pack of William O'Connor. The Fuller Fish Co. intends to operate on a larger scale next year. Part of their pack this season was sent to the States and the balance sold locally. John Lamont has an outfit of barrels, salt, and fishing gear ready to begin operations another season.

During the fall and winter of 1919 concerted action of ecclesiastical inception was undertaken to end commercial fishing for salmon in Yukon River waters, it being alleged that a continuance of such activities meant the destruction of the salmon runs, without which the natives would be unable to survive as a self-supporting people. Undoubtedly the salmon of the Yukon are indispensable to the ordinary development of the country and economical maintenance of human life therein. Various industries of interior Alaska, such as mining and trapping, are more or less directly or indirectly dependent upon salmon. Fishing is not carried on by the resident whites to an extent that would constitute an industry. The natives, however, spend part of their summers in catching salmon and drying them for winter food for themselves and their dogs. Some of them prepare annually quan-

FIG. 1.—NATIVE SALMON FISHERY, YUKON RIVER.

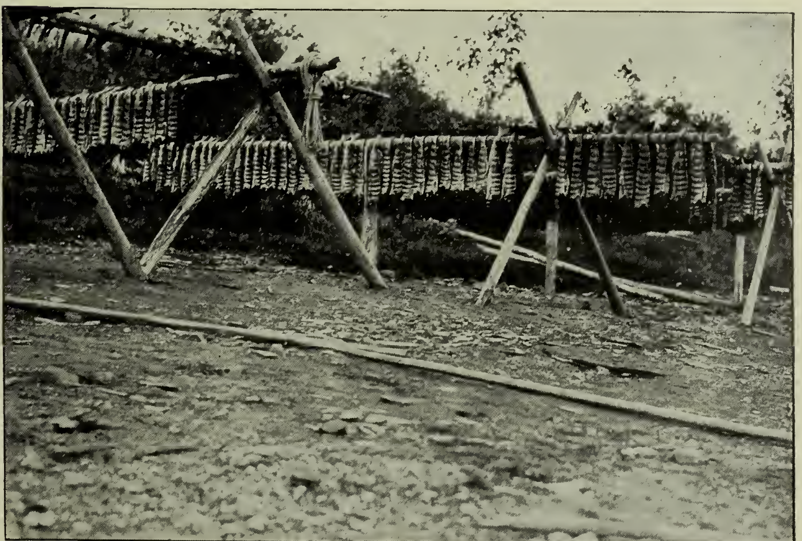

FIG. 2.—NATIVE METHOD OF CURING SALMON, YUKON RIVER.

tities of fish over and above their own needs and sell them to trappers, prospectors, military telegraph stations, and commercial companies at various places along the river.

In the propaganda circulated by Archdeacon Hudson Stuck late in 1919 it was asserted that the cannery near the mouth of the Yukon was operated under permission granted by the Bureau of Fisheries. No such permission was granted, nor was any asked; in fact the Department of Commerce has authority only to limit fishing operations but not to prohibit the establishment of canneries. Allegations were made at the same time as to the great privation caused to the natives and other residents of the Yukon and tributary waters because of the shortage of the salmon in 1919. Undoubtedly there was a light run of salmon in 1919 in the Yukon, as there was in practically all other waters of Alaska; it was an unfavorable season for salmon throughout Alaska. The light run in the Yukon has had its counterpart heretofore, as it is a matter of record that in earlier years the runs of salmon have been very light. There is authentic record of limited runs of salmon as far back as 1879, in which year the natives of the Yukon were forced to go to Norton Sound and elsewhere for salmon.

It seems appropriate to point out that in 1919 there was much high water in the Yukon, which interfered with the operation of native fishing gear; heavy quantities of driftwood also lessened the take of salmon by the natives. Over and above all, consideration must undoubtedly be given to the psychological effect of the establishment of the cannery on the natives; they heard that the cannery was in operation, hence at once assumed that there would be no salmon passing to upper waters. They, therefore, in many instances did not make proper effort to take salmon.

An extensive investigation of the Yukon was made by Inspector Townsend, of the Alaska service, who covered more than 4,000 miles of Yukon waters on the Bureau's vessel *Swan*. He interviewed many traders and other residents of the Yukon in order to ascertain the actual condition of the natives. In some instances it was found that the natives not only had enough fish for themselves, but were able to make sales of the surplus; elsewhere shortages were recorded. But as the season progressed there was no information from official sources received by the Bureau or by the governor of Alaska, which indicated that there had been undue privation suffered during the year by the natives because of any shortage of salmon.

In 1918 it was reported that 6,638 whites, 4,269 natives, and 6,183 dogs were dependent largely upon the salmon of the Yukon. It is computed that about 1,100,000 salmon would suffice amply for all such food requirements. Present requirements are materially smaller, as influenza has since taken heavy toll of the Yukon natives. It must not be overlooked that there are various other species of fish in the Yukon, such as whitefish, grayling, and trout, available for food purposes. The whitefish is a close relative of the famous whitefish of the Great Lakes. The natives also have an abundant supply of game to augment their larder.

It is not the province of the Department of Commerce in its legal relation to the fisheries of Alaska to consider as paramount the interests of any particular packing company or of any branch of the fishery industry, or any class of people, but under the law it is charged primarily with the protection of the salmon fisheries. Congress has given the Secretary of Commerce authority to do certain things when in his judgment the protection and preservation of the fisheries demand such action. The Department will therefore give unbiased consideration to all the information which comes before it touching upon the questions involved, but it is not required to accept as correct anything less than a fair, unprejudiced presentation of the facts.

The two main contradictory views involving the Yukon situation are, first, that of the commercial interests which contend that there are large runs of salmon in the Yukon and that the number taken for their purposes is but a small fraction of the total; and second, that of certain of the natives and others who maintain that the runs are small and that no salmon can be exported without a resulting local state of privation. The question of large interest, however, to the Department is not whether commercial fishing shall cease in order that noncommercial fishing may continue, but whether the runs of salmon in the Yukon are being or will be depleted under the present scale of operations. It is proper that cognizance be taken of any condition that threatens to destroy the fisheries, whether it be the result of operations by a packing company or by a resident population, or by both.

There is much to be learned regarding the salmon runs in the Yukon before the Department considers further limitations upon fishing in those waters. Competent investigators will, therefore, be sent to the Yukon in 1920 to study the salmon runs and to ascertain the actual conditions of the natives in their relation to the salmon fisheries. Further regulations of the Yukon salmon fisheries will depend very largely upon the results of their observations. It remains true that a just regard for the rights of humanity must inevitably weigh heavily in considering the final regulation of these fisheries, but it seems now that the Yukon can support at least a reasonable commercial fishery for salmon and at the same time insure an ample supply for local food purposes in perpetuity.

CENTRAL AND WESTERN ALASKA FISHERY.

In order that the Bureau might be in possession of accurate and trustworthy information regarding certain phases of the salmon fisheries of central and western Alaska, arrangements were made for a joint investigation by Dr. C. H. Gilbert, of Stanford University, engaged as special assistant, and Henry O'Malley, field assistant. Dr. Gilbert and Mr. O'Malley left Seattle on May 12 and returned early in September, 1919. While en route to western Alaska, a stop was made at Cordova, from which place local trips were made in connection with Copper River fishery conditions. Thereafter the journey to the Bristol Bay region was continued, the overland route from Iliamna being followed. A number of weeks were spent on Bristol Bay waters and tributaries, following which inquiries were made in the Port Moller and Ikatan regions. The conclusion of major field work was in the vicinity of Karluk. Much valuable information was secured as a result of the investigation. The report of Dr. Gilbert and Mr. O'Malley is given on page 143.

WOOD RIVER CENSUS.

A count of the salmon entering Lake Aleknagik, on Wood River, in western Alaska, was made in 1919 in accordance with the custom of past seasons. Warden Shirley A. Baker had general supervision of the work. The actual count was intrusted to Russell Noyes, fish-culturist at Afognak station, who was assigned to this special duty. He was assisted in the counting by three men in the employ of the Alaska Packers Association.

The rack, consisting of heavy cotton web attached to piling driven across the lower end of the lake just above the outlet, was made ready by June 24. It was installed by the Alaska Packers Association, some assistance in towing equipment to the lake and returning it to the cannery at Nushagak at the completion of the count being rendered by the Alaska-Portland Packers Association.

Salmon made their appearance at about the usual time and continued to run through July, as is ordinarily the case. Counting began June 25 and stopped July 31. Weather conditions in 1919 were normal, and no circumstances arose to differentiate the season from preceding ones except the heavy decline in the run of salmon. The largest counts were made on July 10 and 11, when 31,035 and 41,519 salmon entered the lake on those respective dates. Records of the enumeration are surprising in that only 3 days out of 37 show a count in excess of 10,000 salmon. As compared with 943,202 red salmon counted in 1918, the census gives a total of 145,114 red salmon as having entered Lake Aleknagik in 1919. Details of the count appear in the following table:

Wood River Salmon Census in 1919.

Date.	Number.	Date.	Number.	Date.	Number.
June 25	62	July 8	177	July 21	513
26	91	9	3,480	22	437
27	5	10	31,035	23	827
28	208	11	41,519	24	513
29	203	12	7,610	25	327
30	219	13	2,116	26	172
July 1	379	14	1,530	27	252
2	799	15	6,734	28	59
3	830	16	4,795	29	128
4	5,111	17	1,988	30	179
5	23,108	18	925	31	156
6	6,831	19	336		
7	1,055	20	405	Total	145,114

Upon the recommendation of Dr. C. H. Gilbert, of Stanford University, who, with Field Assistant Henry O'Malley of the Bureau, made extensive investigations for the Government in Alaska in 1919, it has been decided to discontinue the Wood River census. As soon as funds are available it is planned, as recommended by Dr. Gilbert, to undertake similar work at Chignik Lake and probably also at Karluk.

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In view of the discontinuance of the Wood River census, it seems advisable to present herewith the following tabulation pertaining to the work from the time of its inception in 1908 through 1919:

Wood River Census and Red Salmon Run in Nushagak Bay and Tributaries, 1908–1919.

Year.	Nushagak Bay catch.	Wood River tally.	Total.	Per cent of escape.
1908	6,140,031	2,603,655	8,740,686	30.0
1909	4,687,635	893,244	5,580,879	16.0
1910	4,384,755	670,104	5,054,859	13.2
1911	2,813,637	354,299	3,167,936	11.1
1912	3,866,950	325,264	4,192,214	7.7
1913	5,236,008	753,109	5,989,117	12.5
1914	6,174,097	(a)	....	....
1915	5,676,457	259,341	5,935,798	4.3
1916	3,592,574	551,959	4,144,533	13.3
1917	5,679,818	1,081,508	6,761,326	15.9
1918	6,078,965	943,202	7,022,167	13.4
1919	1,452,931	145,114	1,598,045	9.0

a Count not made.

SALMON HATCHERIES.

EXTENT OF OPERATIONS.

Four salmon hatcheries were operated in Alaska in 1919, two by the Government and two by packing companies, and in addition some fish-cultural work was carried on by the Territory. The four hatcheries referred to have a combined hatching capacity of 280,000,000 red-salmon eggs. The Territorial work was somewhat experimental in nature.

The total collection of red-salmon eggs in Alaska in 1918 was 142,001,000, from which there were hatched and liberated in the waters of Alaska 95,969,700 fry, or 5,579,500 more than in 1917–18. In 1919 the take of red-salmon eggs was 119,060,000, or 22,941,000 less than in 1918. This decrease was due to smaller runs of salmon at all the hatcheries except that of Afognak.

Operations of Alaska Hatcheries in 1919.

Station.	Red or sockeye salmon eggs taken in 1918.	Red or sockeye salmon liberated in 1918–19.	Red or sockeye salmon eggs taken in 1919.
McDonald Lake	a47,300,000	35,329,700	9,752,000
Afognak	b54,681,000	25,583,000	79,178,000
Fortmann	19,620,000	15,205,000	18,420,000
Quadra	20,400,000	19,852,000	11,710,000
Total	142,001,000	95,969,700	119,060,000

a 3,440,100 eyed eggs transferred to the State hatchery at Bonneville, Oreg., and 1,059,900 to Federal hatcheries in Oregon.
b 20,700,000 eyed eggs transferred to British Columbia, and 5,000,000 to Quinault, Wash.

HATCHERY REBATES.

The act of June 26, 1906, provides, among other things, that the catch and pack of salmon by the owners of private hatcheries in Alaska shall be exempt from all license fees and taxation of every nature at the rate of 10 cases of canned salmon for every 1,000 red or king-salmon fry liberated upon certain conditions, which are (1) the approval of the character of their hatchery operations by the Secretary of Commerce, notice thereof to be filed in the office of the clerk or deputy clerk of the United States district court of the division of Alaska wherein such hatchery is located and the owners accordingly so notified; and (2) the filing of proof by the hatchery operators with the clerk of the court of the number of salmon fry liberated during the fiscal year for which report is made. Duplicates of such statements must also be filed with the Secretary of Commerce. The clerk of the court then issues to the owner whose hatchery operations have been approved nontransferable certificates in such denominations as he desires covering in the aggregate the number of fry so liberated. These certificates are accepted by the Government in lieu of money in payment of all license fees or taxes against the pack of canned salmon as above stated. The following table gives the rebates due to private operators for the fiscal year ending June 30, 1919.

REBATES CREDITED TO PRIVATE SALMON HATCHERIES DURING FISCAL YEAR ENDED JUNE 30, 1919.

Owner.	Location.	Red-salmon fry liberated.	Rebate due.
Alaska Packers Association	Naha Stream	15,205,000	$6,082.00
Northwestern Fisheries Co	Hugh Smith (Quadra) Lake.	19,852,000	7,940.80
Total		35,057,000	14,022.80

HATCHERY OPERATIONS.

M'DONALD LAKE.

Out of the collection of 47,300,000 red-salmon eggs taken at the McDonald Lake hatchery in 1918, a shipment of 3,440,100 eyed eggs was made to the State hatchery at Bonneville, Oreg.; one of 1,059,900 eyed eggs, to Bureau stations in Oregon; and 35,329,700 fry were liberated in waters tributary to Yes Bay, Alaska. The loss of eggs and fry aggregated 7,470,300, or approximately 16 per cent.

The collection of red-salmon eggs at the McDonald Lake station in the fall of 1919 was the smallest that has ever been made, only 9,752,000 being obtained. Operations were interrupted in the midst of the season by high water which damaged the retaining racks and permitted the escape of a large number of spawners. No humpback-salmon eggs were collected.

AFOGNAK.

The Afognak station experienced the most successful season in the history of its operations, the total take in 1919 being 79,178,000 red-salmon eggs. It was also reported that there were many salmon available for spawning still in the lake when the capacity of the hatchery had been reached. No effort was made to obtain humpback-salmon eggs.

From the collection of 54,681,000 red-salmon eggs taken in 1918, a consignment of 20,700,000 was shipped to the Fisheries Department of British Columbia for the restocking of the Fraser River, and a shipment of 5,000,000 was made to the Bureau's station at Quinault, Wash. Plants of fry and fingerlings in Litnik Lake aggregated 25,583,000. The loss of eggs and fry was 3,398,000, or 6.2 per cent.

FORTMANN.

The Fortmann salmon hatchery of the Alaska Packers Association is located at Heckman Lake on Revillagigedo Island, southeast Alaska.

In 1918, a collection of 19,620,000 red-salmon eggs was made, from which were hatched and liberated through nursery ponds into the Naha Stream system 15,205,000 fry. The loss of eggs and fry was 4,415,000, or 22½ per cent. Between September 8 and November 22, 1919, a total of 18,420,000 red-salmon eggs was taken.

The collection of humpback-salmon eggs in 1918 was 3,660,000, from which there were produced and planted 3,235,000 fry, the loss of eggs and fry being 425,000, or 11.6 per cent. The number of humpback-salmon eggs taken in 1919 was 600,000, a decrease of 83.6 per cent from the previous year.

QUADRA.

The Northwestern Fisheries Co. continued the operation of its Quadra hatchery, located on Hugh Smith Lake, previously known as Quadra Lake. Spawn taking in 1918 began August 8 and was discontinued September 24. It resulted in a collection of 20,400,000 red-salmon eggs from which there were hatched and planted 19,852,000 fry. The loss of eggs and fry was 548,000, or approximately 2.7 per cent.

In 1919, the collection of red-salmon eggs at Quadra began August 12 and ended November 14; the total take was 11,710,000.

GENERAL STATISTICS OF THE FISHERIES IN 1919.

The total investment in the Alaska fisheries in 1919 was $74,181,560, an increase of $430,771 over 1918. Of this amount approximately 92 per cent was invested in the salmon industry. The fishery industry gave employment to 28,534 persons, a decrease of 2,679 from the number employed in 1918. The total value of the products in 1919 was $50,282,067, a decrease of $8,872,792 from 1918, or approximately 15 per cent. This lessened production was due almost wholly to the heavy falling off in the pack of salmon.

Summary of Investments, Persons Engaged, and Products of Alaska Fisheries in 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENTS.								
Salmon canning		$33,741,891		$12,897,947		$19,855,333		$66,495,171
Salmon mild-curing		741,635						741,635
Salmon pickling				236,261		354,161		590,422
Salmon, fresh		104,336						104,336
Salmon dry-salting						103,862		103,862
Halibut fishery		1,979,457						1,979,457
Herring fishery		418,571		431,338		50,663		900,572
Cod fishery				938,699		347,376		1,286,075
Whale fishery		545,256				1,245,611		1,790,867

SUMMARY OF INVESTMENTS, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FISHERIES IN 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENTS—contd.								
Clam fishery				$147,167				$147,167
Crab fishery		$200						200
Shrimp fishery		41,796						41,796
Total		37,573,142		14,651,412		$21,957,006		74,181,560
PERSONS ENGAGED.								
Whites	7,027		3,435		5,864		16,326	
Natives	2,584		843		448		3,875	
Chinese	1,366		536		868		2,770	
Japanese	982		266		259		1,507	
Filipinos	919		280		379		1,578	
Mexicans	232		250		1,409		1,891	
Miscellaneous	246		59		282		587	
Total	13,356		5,669		9,509		28,534	
PRODUCTS.								
Salmon:								
Canned							a 4,583,688	43,265,349
Mild-cured							b 4,290,600	916,800
Pickled							b 1,622,000	195,447
Frozen							b 1,552,480	130,355
Fresh							b 5,208,327	356,688
Dry-salted							b 212,244	17,601
Dried and smoked							b 415,000	43,000
By-products, oil							c 966	966
By-products, fertilizer							b 724,000	18,680
Halibut:								
Fresh							b 7,783,179	880,433
Frozen							b 6,495,372	670,147
Canned							b 240	25
Herring:								
Canned (½-pound cans)							a 6,357	40,395
Canned (1-pound cans)							a 95,448	811,366
Dry-salted for food							b 510,000	20,150
Fresh, for bait							b 1,254,926	11,210
Frozen for bait							b 2,444,655	24,246
Pickled, for bait							b 40,000	800
Pickled, Scotch cure							b 7,718,985	451,240
Pickled, spiced							b 11,715	1,676
Pickled, Norwegian cure							b 2,216,120	147,634
Fertilizer							b 1,712,000	56,653
Oil							c 169,374	110,800
Cod:								
Dry-salted							b 9,829,343	773,297
Pickled							b 956,098	46,014
Frozen							b 86,971	4,209
Stockfish							b 2,900	700
Tongues							b 18,000	1,770
Whales:								
Oil							c 875,374	656,510
Sperm oil							c 377,032	276,344
Fertilizer, meat							b 2,060,000	76,420
Fertilizer, bone							b 538,000	13,472
Bone							b 13,647	2,729
Ivory							b 746	225
Meat, frozen							b 50,000	1,500
Clams							a 33,765	184,363
Trout:								
Fresh							b 80,977	9,086
Frozen							b 2,780	408
Pickled							b 2,200	165
Canned							a 371	3,496
Sable fish, fresh and frozen							b 509,369	35,485
Red rockfish							b 69,048	1,414
Crabs							d 80	160
Shrimps							b 60,000	21,000
Miscellaneous fresh fish							b 52,123	1,639
Total								50,282,067

a Cases. b Pounds. c Gallons. d Dozens.

SALMON INDUSTRY.

The situation in southeast Alaska is serious. It is certain that under present conditions, a repetition of the astounding production of 1918 could not reasonably be expected, nor could it be assumed that there would be a progressive increase in pack with the passing seasons. Fluctuations in runs, which in themselves should not be regarded as absolute indicators of conditions, will occur, but a lessened catch is not to be dismissed as an unimportant development in the situation. A diminished catch, together with an inadequate escapement of salmon to the spawning grounds, presents what may be a serious condition of the fisheries, one which should receive the careful and thoughtful attention of both the Government and the packers. It is a recognized fact that in the southeast district salmon fishery operations are becoming more intensified each season, seines and traps alike being employed in greater numbers than before, and other movable appliances being operated more assiduously as the years go by. In view of these things, it is a logical conclusion that the industry can not hold its present position, much less grow, unless some provision is made for the replenishment of the fisheries.

Central Alaska, which is of much greater extent than either of the other districts, embraces some localities that showed a greatly reduced production of salmon in 1919, while other regions yielded approximately as many fish as in 1918, but for the district as a whole there was a heavy falling off sufficient to attract more than passing notice. A comparison of the packs in 1918 and 1919 shows that the shrinkage was largely in the catch of humpback and chum salmon and that the localities most seriously affected were Prince William Sound, Cook Inlet, and Kodiak Island waters. Though the decline was felt in all sections of the district, there is less cause for concern over the situation here than elsewhere in Alaska.

The season of 1919 was markedly a failure in western Alaska. The shrinkage in production was approximately 67 per cent, and it affected both canning and pickling operations. The pack of canned salmon was the smallest that has been made since 1900 and was 62 per cent less than in 1918. On the basis that the salmon of 1919 were four-year fish, a comparison with the pack in 1915 shows a drop of 48 per cent; if they were five-year fish, a comparison with the pack in 1914 shows a decline of 58 per cent. These percentages would have been higher were it not that the pack in 1919 included 57,085 cases of Yukon River salmon, whereas the packs of 1914 and 1915 did not include any Yukon salmon.

The cause of this sudden and serious falling off in the salmon runs of western Alaska, and especially Bristol Bay, is not known, but in the absence of a better reason it may be attributed to overfishing in recent years. Apparently it was not a question of delayed runs, but seems to have been due to a real scarcity of salmon. Some persons have held that the exhaustion of the salmon fisheries is practically impossible, but to those taking a broad view of the situation this breakdown of the run of red salmon is acceptable evidence of the fallacy of any theory that the runs are impregnable.

The records of the Bristol Bay district for the last 20 years afford a basis for serious study. At first glance they show that the drain on the red-salmon run has been steadily increasing, larger numbers of salmon being taken, with few exceptions, in the successive seasons. The pack increased from 600,000 cases in 1900 to 1,666,000 in 1918. It then dropped to 589,464 cases in 1919, a decrease of about 65 per cent. Attention has been directed in the past to these constantly increasing catches and the encroachments they meant upon the number of salmon necessary for the maintenance of the runs and the corresponding reduction of the safety quota. It may be that the packers, who seemed to be devoting all their energies to increasing production, viewed the situation too optimistically during the plenteous years and that facts of vital importance were overlooked until the sudden break in 1919 from superficially satisfactory conditions. While there may be many speculations as to the cause of the let-down in 1919, the best explanation is that it was due to overfishing. This was in substance concurred in by various salmon packers, who agreed to the necessity of further limitation by departmental regulations upon fishing at a hearing on the matter held at Seattle in November, 1919.

Operations on the Yukon River were greater than in 1918, as a pack of approximately 57,000 cases of king and chum salmon was made by the one company there established. In addition a few hundred barrels of salmon were pickled. Approximately 500,000 salmon were used in the preparation of these products. All commercial fishing was carried on below the junction of the Clear River and the Yukon, and according to the reports of operators about two-thirds of the catch of salmon was made in Bering Sea off the mouth of the Yukon.

SALMON CATCH AND FORMS OF GEAR.

The greater part of the salmon catch of Alaska is made by three kinds of apparatus, namely, seines, gill nets, and pound nets. Statistics show that a total of 800 seines were operated in 1919, aggregating in length 137,284 fathoms. This is a decrease of 38 seines from the number used in 1918, but an increase of 6,157 fathoms in the amount of seine web. There was an increase of 28 in the number of seines in southeast Alaska, and a decrease of 39 and 27 in central and western Alaska, respectively. The total number of gill nets used in the salmon industry in 1919 was 4,120, the combined length of which was 459,937 fathoms, a decrease of 19,175 fathoms in the amount of gill-net web operated in Alaska as a whole. Each district shows a decline in the use of this form of gear. In southeast Alaska there were 3,172 fathoms less than in 1918; in central Alaska, 4,552 fathoms less; and in western Alaska, 11,451 fathoms less. These decreases were due in large part to the collapse of the pickling industry.

There were operated in connection with the salmon industry 630 pound nets, of which 484 were driven and 146 were floating, or an increase of 78 over the number used in 1918. Southeast Alaska is credited with 301 driven and 143 floating traps, gains of 11 and 64, respectively; central Alaska had 172 driven traps, an increase of 6 over 1918, and 3 floating traps, the first to be used in the district; western Alaska had 11 driven traps, as against 17 in 1918, a decrease of 6.

Taking Alaska as a whole, there was an increase in the number of fathoms of seines of 4½ per cent over 1918; there was a decrease in the number of fathoms of gill nets of 4 per cent, and an increase of 14 per cent in the number of pound nets. In 1919 seines took 36 per cent of the total catch of salmon in Alaska; pound nets 42 per cent; gill nets 19 per cent; and lines, wheels, and dip nets the remaining 3 per cent. The catch, by apparatus, in 1918 was as follows: Seines, 30 per cent; pound nets, 41 per cent; gill nets, 28 per cent; and other appliances, 1 per cent. There was an increase in the 1919 catch by seines of 6 per cent, by pound nets of 1 per cent, and a falling off in the catch by gill nets of 9 per cent. The following table shows the proportionate catch by districts according to the principal kinds of apparatus:

PERCENTAGE OF SALMON CAUGHT IN EACH ALASKA DISTRICT BY PRINCIPAL FORMS OF APPARATUS.

Apparatus.	Southeast Alaska.		Central Alaska.		Western Alaska.	
	1918	1919	1918	1919	1918	1919
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Seines	38	46	39	31	4	3
Pound nets	58	49	48	50	4	4
Gill nets	2	2	11	18	90	92

Alaska produced 58,172,665 salmon of all species in 1919 as compared with 101,454,688 in 1918, a falling off of 42½ per cent. The decrease in southeast Alaska was 12,095,965, or approximately 23½ per cent; in central Alaska, 12,681,153, or 56 per cent; and in western Alaska, 18,504,905, or 67 per cent. This is the largest shrinkage from a previous season in the yield of salmon ever reported for Alaska. In 1919, the decrease by species was 481,835 cohos, 1,981,698 chums, 22,421,386 humpbacks, and 18,637,334 reds. Kings increased 240,230.

SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Seines:				
Coho, or silver	414,341	91,317	800	506,458
Chum, or keta	6,061,747	696,139	98,499	6,856,385
Humpback, or pink	10,459,348	736,662	13,343	11,209,353
King, or spring	9,516	2,076	4,826	16,418
Red, or sockeye	1,087,611	1,491,915	130,793	2,710,319
Total	18,032,563	3,018,109	248,261	21,298,933
Gill nets:				
Coho, or silver	335,739	61,869	103,419	501,027
Chum, or keta	249,133	87,432	586,190	922,755
Humpback, or pink	93,692	58,049	29,611	181,352
King, or spring	19,053	17,646	234,782	271,481
Red, or sockeye	401,561	1,580,602	7,232,274	9,214,437
Total	1,099,178	1,805,598	8,186,276	11,091,052
Pound nets:				
Coho, or silver	794,053	338,929	325	1,133,307
Chum, or keta	3,083,663	1,180,484	49,962	4,314,109
Humpback, or pink	13,760,123	645,287	2,681	14,408,091
King, or spring	43,963	34,863	26,944	105,770
Red, or sockeye	1,725,587	2,604,659	349,074	4,679,320
Total	19,407,389	4,804,222	428,986	24,640,597

SALMON TAKEN IN 1919, BY APPARATUS AND SPECIES, FOR EACH GEOGRAPHIC SECTION OF ALASKA—Continued.

Apparatus and species.	Southeast Alaska.	Central Alaska.	Western Alaska.	Total.
Lines:				
Coho, or silver	278,692			278,692
Chum, or keta	63,372			63,372
Humpback, or pink	96,180			96,180
King, or spring	564,606			564,606
Red, or sockeye	880			880
Total	1,003,730			1,003,730
Dip nets:				
Coho, or silver		10,362		10,362
King, or spring		3,554		3,554
Red, or sockeye		95,775		95,775
Total		109,691		109,691
Wheels:				
Chum, or keta			22,499	22,499
King, or spring			6,163	6,163
Total			28,662	28,662
Total:				
Coho, or silver	1,822,825	502,477	104.544	2,429,846
Chum, or keta	9,457,915	1,964,055	757,150	12,179,120
Humpback, or pink	24,409,343	1,439,998	45,635	25,894,976
King, or spring	637,138	58,139	272,715	967,992
Red, or sockeye	3,215,639	5,772,951	7,712,141	16,700,731
Grand total	39,542,860	9,737,620	8,892,185	58,172,665

SALMON CANNING.

CHANGES IN CANNERIES.

Several changes in the ownership of canneries were reported in 1919. In southeast Alaska, the Mountain Point Packing Co. acquired the plant of the Alaska Clam Canning Co., which ceased to operate in Alaska; the Southern Alaska Canning Co. took over the cannery of the Alaska Pacific Herring Co., at Big Port Walter, which latter concern was dissolved; the Doyhof Fish Products Co. sold its plant at Scow Bay to the G. W. Hume Co. and withdrew from Alaska. In central Alaska, the plant of the Lighthouse Canning Co., at Cordova, was sold to the Hillery-Scott Co.; the Eyak River Packing Co., operating a plant on Eyak River, was formerly the Clark-Graham Co.; and the Abercrombie Packing Co. was superseded by F. H. Madden. No change in the ownership of the latter cannery is understood to have taken place. In western Alaska, the interests of the Everett Packing Co., Phoenix Packing Co., and the Fidalgo Island Packing Co., all at Herendeen Bay, were consolidated. Their canning operations were carried on at the plant of the Fidalgo Island Packing Co. The Yukon cannery of the Carlisle Packing Co. was moved from Andreafski down to Kwiguk Slough, about 12 miles from the mouth.

NEW CANNERIES.[a]

There were 13 new salmon canneries in Alaska in 1919, 9 of which were opened and operated in southeast Alaska.

[a] New canneries are indicated by asterisks (*) in the table on page 42.

In the central district two canneries, which before 1919 were engaged in canning other sea food, began the canning of salmon, and one new plant was opened.

In western Alaska one new cannery was put in operation. The Alaska Packers Association built a cannery on the Ugashik River, but owing to the small run of salmon it was not opened, and therefore is not included in the list in 1919.

CANNERIES NOT OPERATED.

Fourteen canneries in Alaska were not operated in 1919, 9 of which were in southeast, 2 in central, and 3 in western Alaska. They were owned and located as follows:

Alaska Fisheries Co	Washington Bay.
Lane & Williams	Moira Sound.
T. E. P. Keegan	Douglas.
H. Van Vlack & Co	Thomas Bay.
Columbia Salmon Co	Craig.
Anacortes Fisheries Co	Shakan.
Northwestern Fisheries Co	Santa Ana. Hunter Bay. Roe Point. Orca. Seldovia.
Everett Packing Co	Herendeen Bay.
Phoenix Packing Co	Do.
Midnight Sun Packing Co	Kotzebue Sound.

The first 4 named above were permanently closed; the other 10 are reported as being idle rather than permanently closed.

TOTAL CANNERIES OPERATED.

In all, there were 134 salmon canneries operated in Alaska in 1919, of which number southeast Alaska had 76, central Alaska 30, and western Alaska 28. There was no change in the number credited to the southeast district; the central district gained 1; and the western district lost 2.

COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919.

[New canneries indicated by *.]

Company.	Canneries.		Pound nets.
	Number.	Location.	
Southeast Alaska:			
Alaska Fish Co	1	Waterfall	
Alaska Herring & Sardine Co	1	Port Walter	a 20
Alaska Pacific Fisheries	3	Chilkoot	b 11
		Chomly	c 8
		Yes Bay	d 13
Alaska Packers Association	2	Loring	e 11
		Wrangell	e 6
Alaska Packing & Navigation Co	1	Pavlof Harbor	
Alaska Salmon & Herring Packers (Inc.)	1	Tyee *	
Alaska Sanitary Packing Co	2	Cape Fanshaw *	
		Wrangell	5
American Packing Co	1	Juneau	b 2
Anacortes Fisheries Co	1	Kasaan	8
Annette Island Packing Co	1	Metlakatla	7

a 17 floating. b 1 floating. c 4 floating. d 9 floating. e 5 floating.

COMPANIES CANNING SALMON IN ALASKA, NUMBER AND LOCATION OF CANNERIES OPERATED, AND NUMBER OF POUND NETS OWNED BY EACH, 1919—Continued.

Company.	Canneries. Number.	Canneries. Location.	Pound nets.
Southeast Alaska—Continued.			
Astoria & Puget Sound Canning Co	1	Excursion Inlet	a 13
Auk Bay Salmon Canning Co	1	Auk Bay	6
Baranof Packing Co	1	Red Bluff Bay	....
Barnes, F. C., Co	1	Lake Bay	2
Beauclaire Packing Co	1	Port Beauclerc *	1
Beegle Packing Co	1	Ketchikan	a 5
Burnett Inlet Packing Co	1	Burnett Inlet	b 5
Cape Fanshaw Fish & Packing Co. (Inc.)	1	Cape Fanshaw *	....
Carlson, John L., & Co	1	Auk Harbor *	b 3
Cole, R. L	1	Deweyville	1
Columbia Salmon Co	1	Tenakee	....
Deep Sea Salmon Co	2	Ford Arm Port Althorp	b 9 b 20
Douglas Island Packing Co	1	Douglas Island *	....
Fidalgo Island Packing Co	2	Ketchikan Pillar Bay	c 9 7
George Inlet Packing Co	1	George Inlet	2
Haines Packing Co	1	Letinkof Cove	....
Harris, P. E., & Co	1	Hawk Inlet	....
Hidden Inlet Canning Co	2	Hidden Inlet Hood Bay	d 5 5
Hood Bay Packing Co	1	Hood Bay*	....
Hoonah Packing Co	2	Gambier Bay Hoonah	a 13 e 17
Hume, G. W., Co	2	Nakat Harbor Scow Bay	7 4
Karheen Packing Co	1	Karheen	5
Ketchikan Packing Co	1	Ketchikan	....
Libby, McNeill & Libby	2	Taku Harbor Yakutat	16 ....
Marathon Fishing & Packing Co	1	Cape Fanshaw	b 3
Mountain Point Packing Co	1	Wrangell Narrows	....
Myers, Geo. T., & Co	1	Chatham	10
Northern Packing Co. (Inc.)	1	Juneau	....
North Pacific Trading & Packing Co	1	Klawak	....
Northwestern Fisheries Co	2	Dundas Bay Quadra	d 10 d 11
Noyes Island Packing Co	1	Steamboat Bay	....
Olympic Fisheries Co	1	(Floating)*	....
Pacific American Fisheries	1	Excursion Inlet	d 16
Petersburg Packing Corporation	2	Petersburg Washington Bay*	a 10 a 6
Point Warde Packing Co	1	Point Warde	....
Pure Food Fish Co	1	Ketchikan	c 4
Pybus Bay Fish & Packing Co	1	Pybus Bay	....
Pyramid Packing Co	1	Sitka	2
Sanborn-Cutting Co	1	Kake	b 8
Sitka Packing Co	1	Sitka	....
Smiley, J. L., & Co	1	Ketchikan	5
Southern Alaska Canning Co	3	Big Port Walter Quadra Bay Rose Inlet	b 5 a 5 4
Starr-Collinson Packing Co	1	Moira Sound	b 2
Straits Packing Co	1	Skowl Arm	....
Sunny Point Packing Co	1	Ketchikan	7
Swift-Arthur-Crosby Co	1	Heceta Island	c 6
Tee Harbor Packing Co	1	Tee Harbor	a 9
Tenakee Fisheries Co	1	Tenakee Inlet	c 7
Thlinket Packing Co	1	Funter	f 21
Todd Packing Co	1	Peril Strait	c 6
Union Bay Fisheries Co	1	Union Bay	4
Ward's Cove Packing Co	1	Ward Cove	....
Central Alaska:			
Alaska Packers' Association	4	Alitak Chignik Kasilof Larsen Bay	5 4 16 ....
Alaska Sea Food Co	1	Cordova	c 2
Alitak Packing Co	1	Lazy Bay	2
Canoe Pass Packing Co	1	Shepard Point	a 4
Carlisle Packing Co	1	Cordova	10
Columbia River Packers' Association	1	Chignik	6
Copper River Packing Co	1	Port Nellie Juan	5
Eyak River Packing Co	1	Eyak River	....

a 2 floating. c 1 floating. e 5 floating.
b All floating. d 3 floating. f 4 floating.

Companies Canning Salmon in Alaska, Number and Location of Canneries Operated, and Number of Pound Nets Owned by Each, 1919—Continued.

Company.	Canneries.		Pound nets.
	Number.	Location.	
Central Alaska—Continued.			
F. H. Madden	1	Abercrombie	....
Fidalgo Island Packing Co	1	Port Graham	4
Franklin Packing Co	1	Sawmill Bay *	7
Hillery-Scott Co	1	Cordova	2
Hoonah Packing Co	1	Katalla	1
Kadiak Fisheries Co	1	Kodiak	1
Kenai Packing Co	1	Drier Bay	3
Libby, McNeill & Libby	1	Kenai	18
Moore Packing Co	1	Orca Inlet	2
Northwestern Fisheries Co	3	Chignik	4
		Kenai	16
		Uyak	....
Pacific American Fisheries	2	Ikatan	18
		King Cove	18
Pioneer Packing Co	1	Cordova *	4
San Juan Fishing & Packing Co	1	Seward	2
Sockeye Salmon Co	1	Morzhovoi Bay	4
Surf Packing Co	1	Tuxedni Harbor *	1
Valdez Packing Co	1	Valdez	4
Western Alaska:			
Alaska Packers' Association	8	Kvichak River (2)	....
		Naknek River (3)	....
		Nushagak Bay (2)	4
		Ugaguk River	....
Alaska-Portland Packers' Association	2	Naknek *	....
		Nushagak Bay	3
Alaska Salmon Co	1	Wood River	....
Bristol Bay Packing Co	1	Kvichak River	....
Carlisle Packing Co	1	Kwiguk Slough	1
Columbia River Packers' Association	1	Nushagak Bay	....
Herendeen Bay Consolidated Canneries	1	Herendeen Bay	....
Libby, McNeill & Libby	6	Ekuk	....
		Kvichak Bay (Koggiung)	....
		Libbyville	....
		Lockanok	....
		Nushagak	....
		Ugaguk River	....
Naknek Packing Co	1	Naknek River	....
Nelson Lagoon Packing Co	1	Nelson Lagoon	....
Northwestern Fisheries Co	2	Naknek River	....
		Nushagak	....
Pacific American Fisheries	1	Port Moller	....
Red Salmon Canning Co	2	Naknek River	....
		Ugashik River	....

STATISTICS.

The number of salmon canneries in operation in Alaska in 1919 was 134, one less than in 1918. The investment in the salmon-canning industry was $66,495,171, an increase of $2,593,774. The southeast district shows an increase of $4,770,765; the central district, an increase of $937,266; and the western district, a decrease of $3,114,257.

In 1919, the canning industry gave employment to 25,499 persons, or 1,003 less than the number employed in 1918. Whites increased 74, Chinese 36, Filipinos 239, and Mexicans 157. Natives decreased 1,124, Japanese 34, and miscellaneous 351.

A total of 4,583,688 cases of salmon, valued at $43,265,349, was packed in Alaska in 1919, a decrease in pack of 2,022,147 cases and in value of $7,776,600 from the production of 1918. This is a drop of 30½ per cent in output and 15 per cent in value from the high records of 1918. Perhaps for the first time in the history of salmon canning in Alaska each district shows a smaller pack than was made in the preceding year. Comparing the 1918 pack with that of 1919, southeast Alaska dropped from 3,375,445 cases to 3,119,260, a decrease of 256,185 cases; central Alaska, from 1,391,951 to 771, 907 a decrease of 620,044 cases; and western Alaska, from 1,838,439 to 692,521, a decrease of 1,145,918 cases. Comparing the pack by species for 1918 and 1919, it is found that cohos increased from 218,958 to 232,870 cases, a gain of 13,912 cases; chums increased from 1,364,960 to 1,365,563 cases, a gain of 603 cases; humpbacks dropped from 2,438,954 to 1,611,608 cases, a decrease of 827,346 cases; kings increased from 49,226 to 95,986 cases, an increase of 46,760 cases; and reds dropped from 2,533,737 to 1,277,661 cases, a decrease of 1,256,076 cases.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-CANNING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
INVESTMENT.								
	No.		No.		No.		No.	
Canneries operated	76	$6,860,381	30	$2,606,786	29	$5,101,559	135	$14,568,726
Working capital		13,445,847		4,570,887		6,674,595		24,691,329
Wages paid		7,012,062		2,511,223		3,991,311		13,514,596
Vessels:								
Power vessels over 5 tons	358	2,374,186	100	1,009,051	77	1,145,325	535	4,528,562
Net tonnage	6,635		2,711		7,015		16,361	
Launches under 5 tons	147	157,114	149	152,458	43	201,847	339	511,419
Sailing	2	54,000	8	323,500	33	1,118,010	43	1,495,510
Net tonnage	2,954		12,389		45,982		61,325	
Barges	3	35,086					3	35,086
Net tonnage	3,295						3,295	
Rowboats and skiffs	1,242	104,093	821	124,413	1,458	629,438	3,521	857,944
Lighters, scows, and houseboats	392	332,193	246	257,133	185	369,176	823	958,502
Pile drivers	61	390,184	43	188,604	24	64,605	128	643,393
Apparatus:								
Haul seines	188	92,024	113	39,161			301	131,185
Fathoms	22,510		16,265				38,775	
Purse seines	396	331,368	72	32,991	22	39,200	490	403,559
Fathoms	75,140		17,069		5,700		97,909	
Gill nets	270	52,283	1,071	119,255	2,633	482,317	3,974	653,855
Fathoms	45,875		77,211		328,098		451,184	
Pound nets driven	292	2,161,187	172	953,348	11	37,000	475	3,151,535
Pound nets, floating	142	339,241	3	8,700			145	347,941
Dip nets			35	437			35	437
Fish wheels	1	642			6	950	7	1,592
Total		33,741,891		12,897,947		19,855,333		66,495,171
PERSONS ENGAGED.								
Fishermen:								
Whites	1,781		1,135		3,028		5,944	
Natives	1,376		282		61		1,719	
Filipinos	41						41	
Mexicans	28						28	
Miscellaneous [a]	56						56	
Total	3,282		1,417		3,089		7,788	
Shoresmen:								
Whites	3,258		1,151		2,064		6,473	
Natives	1,173		493		213		1,879	
Chinese	1,366		536		868		2,770	
Japanese	928		266		237		1,431	
Filipinos	878		279		379		1,536	
Mexicans	204		250		1,384		1,838	
Miscellaneous [a]	151		37		275		463	
Total	7,958		3,012		5,420		16,390	

[a] Koreans, Porto Ricans, Kanakas, Negroes, etc.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON CANNING INDUSTRY IN 1919—Continued.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
PERSONS ENGAGED—continued.								
Transporters:	*No.*		*No.*		*No.*		*No.*	
Whites	774	....	251	....	226	....	1,251	....
Natives	14	....	19	....	3	....	36	....
Miscellaneous [a]	23	....	6	....	5	....	34	....
Total	811	....	276	....	234	....	1,321	....
Grand total:								
Whites	5,813	....	2,537	....	5,318	....	13,668	....
Natives	2,563	....	794	....	277	....	3,634	....
Chinese	1,366	....	536	....	868	....	2,770	....
Japanese	928	....	266	....	237	....	1,431	....
Filipinos	919	....	279	....	379	....	1,577	....
Mexicans	232	....	250	....	1,384	....	1,866	....
Miscellaneous [a]	230	....	43	....	280	....	553	....
Total	12,051	....	4,705	....	8,743	....	25,499	....
PRODUCTS.[b]								
Coho, or silver:	*Cases.*		*Cases.*		*Cases.*		*Cases.*	
½-pound flat	8,597	$130,524	910	$10,926	212	$3,400	9,719	$144,850
1-pound flat	10,359	128,680	....	....	79	995	10,438	129,675
1-pound tall	150,558	1,661,074	54,831	601,210	7,324	88,017	212,713	2,350,301
Total	169,514	1,920,278	55,741	612,136	7,615	92,412	232,870	2,624,826
Chum, or keta:								
½-pound flat	3,981	33,209	....	....	....	....	3,981	33,209
1-pound tall	1,141,744	7,706,656	160,222	1,084,132	59,616	496,459	1,361,582	9,287,247
Total	1,145,725	7,739,865	160,222	1,084,132	59,616	496,459	1,365,563	9,320,456
Humpback, or pink:								
½-pound flat	27,990	286,607	195	1,835	....	....	28,185	288,442
1-pound flat	7,553	58,700	....	....	....	....	7,553	58,700
1-pound tall	1,488,979	12,420,147	86,449	698,213	442	3,544	1,575,870	13,121,904
Total	1,524,522	12,765,454	86,644	700,048	442	3,544	1,611,608	13,469,046
King, or spring:								
½-pound flat	2,670	45,459	2,378	44,791	2,536	46,797	7,584	137,047
1-pound flat	2,002	27,981	640	8,052	8,890	132,803	11,532	168,836
1-pound tall	25,609	295,042	9,325	108,113	41,936	552,019	76,870	955,174
Total	30,281	368,482	12,343	160,956	53,362	731,619	95,986	1,261,057
Red, or sockeye:								
½-pound flat	53,620	902,247	44,639	755,947	23,977	379,430	122,236	2,037,624
1-pound flat	43,960	589,979	43,487	511,117	23,044	294,405	110,491	1,395,501
1-pound tall	151,638	1,936,763	368,831	4,522,995	524,465	6,697,081	1,044,934	13,156,839
Total	249,218	3,428,989	456,957	5,790,059	571,486	7,370,916	1,277,661	16,589,964
Grand total	3,119,260	26,223,068	771,907	8,347,331	692,521	8,694,950	4,583,688	43,265,349

[a] Koreans, Porto Ricans, Kanakas, Negroes, etc.
[b] Cases containing ½-pound cans have been reduced one-half in number, and thus, for the purpose of affording fair comparison, all are put upon the basis of 48 1-pound cans per case.

OUTPUT OF CANNED SALMON IN ALASKA, 1913 TO 1919.[a]

Product.	1913	1914	1915	1916	1917	1918	1919	Total.
Coho, or silver:	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*	*Cases.*
½-pound flat	3,587	4,579	2,050	13,145	30,412	26,238	9,719	89,730
1-pound flat	266	285	2,338	8,191	362	12,786	10,438	34,666
1-pound tall	71,926	152,199	119,880	240,573	162,457	179,934	212,713	1,139,682
Total	75,779	157,063	124,268	261,909	193,231	218,958	232,870	1,264,078
Chum, or keta:								
½-pound flat	985	373	....	1,423	26,760	3,559	3,981	37,081
1-pound flat	2,619	5,568	317	....	2,530	2,996	....	14,030
1-pound tall	287,314	657,918	479,629	722,692	877,457	1,358,405	1,361,582	5,744,997
Total	290,918	663,859	479,946	724,115	906,747	1,364,960	1,365,563	5,796,108
Humpback, or pink:								
½-pound flat	20,822	2,103	4,325	41,491	91,403	63,557	28,185	251,886
1-pound flat	3,258	9,286	3,508	14,796	6,014	20,215	7,553	64,630
1-pound tall	1,348,801	974,660	1,867,683	1,681,506	2,199,559	2,355,182	1,575,870	12,003,261
Total	1,372,881	986,049	1,875,516	1,737,793	2,296,976	2,438,954	1,611,608	12,329,777
King, or spring:								
½-pound flat	1,585	3,143	2,404	2,617	12,973	6,000	7,584	36,306
1-pound flat	....	4,804	3,755	3,804	5,133	5,267	11,532	34,295
1-pound tall	32,785	40,092	82,092	59,452	43,845	37,959	76,870	373,095
Total	34,370	48,039	88,251	65,873	61,951	49,226	95,986	443,696
Red, or sockeye:								
½-pound flat	29,041	53,825	52,033	81,565	124,309	137,008	122,236	600,017
1-pound flat	11,735	64,671	112,847	86,395	89,612	151,864	110,491	627,615
1-pound tall	1,924,461	2,083,147	1,765,139	1,936,971	2,274,460	2,244,865	1,044,934	13,273,977
1½-pound nominals	....	....	2,293	....	....	....	....	2,293
2-pound nominals	....	....	....	6,006	....	....	....	6,006
Total	1,965,237	2,201,643	1,932,312	2,110,937	2,488,381	2,533,737	1,277,661	14,509,908
Grand total	3,739,185	4,056,653	4,500,293	4,900,627	5,947,286	6,605,835	4,583,688	34,333,567

[a] The number of cases shown has been put upon the common basis of 48 1-pound cans per case.

AVERAGE ANNUAL PRICE PER CASE OF 48 1-POUND CANS OF SALMON, 1909 TO 1919.

Product.	1909	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919
Coho, or silver	$4.07	$4.89	$5.67	$4.44	$3.45	$4.39	$4.31	$5.34	$8.76	$9.15	$11.27
Chum, or keta	2.28	3.04	3.72	2.37	2.21	3.37	2.59	3.34	6.14	6.27	6.82
Humpback, or pink	2.40	3.15	3.94	2.55	2.58	3.50	2.78	3.64	6.44	6.58	8.35
King, or spring	4.32	5.34	6.48	5.37	4.04	5.01	4.63	5.36	10.40	9.85	13.13
Red, or sockeye	4.53	5.30	6.33	5.45	4.54	5.58	5.82	6.04	9.48	9.44	12.98

LOSSES AND DISASTERS IN SALMON-CANNING INDUSTRY.

The heaviest losses of property in the salmon-canning industry occurred in southeast Alaska, the largest single item being the cannery of the Alaska Pacific Fisheries, at Chilkoot, which, with its contents, was destroyed by fire on June 8, 1919. The buildings were valued at $20,502 and the contents, composed largely of gear and supplies for the season's operations, at $33,445, thus making a total loss of $53,947. Further losses in the same district were small buildings valued at $6,822, boats and floating equipment at $19,123, and gear at $12,448. The total of all reported property losses in southeast Alaska was $92,340.

In central Alaska a fire at the cannery of the Carlisle Packing Co., at Cordova, destroyed a web house and contents, the combined value of which was $30,144. Additional losses in that district consisted of miscellaneous small buildings valued at $2,000, scows and boats at $5,657, and gear at $7,550. In all, property valued at $45,351 was lost in central Alaska.

Losses in western Alaska aggregated $11,770, of which amount $4,450 represented the value of floating property, including the schooner *Premier* (292 tons net), which belonged to the Alaska Packers' Association, and was wrecked off the southern coast of the Alaska Peninsula while making the voyage from San Francisco to Bristol Bay. Small buildings and wharfs valued at $2,200 and gear valued at $5,120 constitute the other losses of property in western Alaska.

The value of all property lost in Alaska in connection with salmon canning in 1919 was $149,461.

Thirteen lives were lost in this industry. In southeast Alaska one fisherman was drowned and three shoresmen were killed; in central Alaska one fisherman and one shoresman were killed; and in western Alaska two fishermen were killed and three fishermen, one shoresman, and one transporter were drowned.

MILD CURING OF SALMON.

The mild-cure salmon industry shows a marked advance in 1919 over that reported in 1918. It was centered almost exclusively in southeast Alaska, the investment being credited wholly to that district. A total of 5,376 tierces of salmon was mild cured in Alaska in 1919, an increase of 1,428 tierces over the production in 1918. Of this number, 5,194 tierces were packed in southeast Alaska, 7 in central and 175 in the western district. There were more than 30 packers of mild-cured salmon, chief among which were the following concerns:

Goemaere Fish Co. (Inc.)	Washington Bay.
Pacific Mild Cure Co	Tyee. Port Conclusion. Port Alexander. Waterfall. Ketchikan. Cape Fanshaw. 3 floating plants.
Columbia & Northern Fishing & Packing Co	Wrangell.
Vendsyssel Packing Co	Tyee.
H. R. Thompson	Ketchikan.
Columbia Salmon Co	Tenakee.
M. B. Dahl & Co	Floating plant.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON MILD-CURING INDUSTRY IN 1919.

Item.	Tierces.	Number.	Value.
INVESTMENT.[a]			
Plants		11	$89,388
Operating capital			547,006
Vessels:			
Power vessels over 5 tons		23	86,888
Net tonnage		407	
Barges		1	3,000
Net tonnage		176	
Launches under 5 tons		9	5,124
Rowboats and skiffs		10	347
Lighters and scows		4	9,850
Apparatus:			
Lines		4	32
Total			741,635
PERSONS ENGAGED.[a]			
Fishermen:			
Whites		2	
Shoresmen:			
Whites		101	
Natives		8	
Japanese		1	
Total		110	
PERSONS ENGAGED—continued			
Transporters:			
Whites		21	
Grand total		133	
PRODUCTS.			
Southeast Alaska:		*Pounds.*	
Coho salmon	28	22,600	$4,656
Chum salmon	2	1,600	140
King salmon	5,164	4,130,800	874,879
Total	5,194	4,155,000	879,675
Central Alaska:			
King salmon	7	5,600	950
Western Alaska:			
King salmon	175	140,000	36,175
Grand total	5,376	4,290,600	916,800

[a] Southeast Alaska only.

SALMON PICKLING.

The salmon-pickling industry of Alaska in 1919 shows a general shrinkage in all directions from the high figures of 1918 and in such proportions as to be little less than a collapse of the industry. In comparing the records of 1918 with those of 1919, some interesting facts are disclosed. Southeast Alaska had 7 plants in 1918 as against none in 1919, and an investment of $278,306 in 1918, as against none in 1919; central Alaska had 2 salteries in 1919 as against 9 in 1918, and investments of $236,261 in 1919 as compared with $492,160 in 1918; western Alaska had 9 salteries in 1919 as against 11 in 1918, and investments of $354,161, as compared with $592,491 in 1918. There was a total decrease of 16 salteries and a smaller investment by $772,535.

The reported pack of pickled salmon was 8,110 barrels, valued at $195,447, as compared with 56,890 barrels in 1918, valued at $1,079,881. All pickling operations in southeast Alaska in 1919 were incidental to more important undertakings, while a considerable part of the pack in central and western Alaska was prepared by concerns engaged chiefly in other fishery activities, particularly salmon canning. The most important packers in the respective districts were as follows: Southeast Alaska, Pacific Mildcure Co. and Columbia & Northern Fishing & Packing Co.; central Alaska, Shumagin Packing Co. and Universal By-Products Co.; western Alaska, Alaska Packers Association, Bering Sea Salmon Packing Co., Golden Gate Salmon Co., Libby McNeill & Libby, Peter M. Nelson, and Alaska Salmon Co.

One noteworthy change in the ownership of salteries occurred in western Alaska when the plant of Olson Bros., at Koggiung, was sold to the Bering Sea Salmon Packing Co., of San Francisco.

Losses in the salmon-pickling industry were small, consisting wholly of miscellaneous gear, valued at $3,550.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA SALMON-PICKLING INDUSTRY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
INVESTMENT.								
	No.		*No.*		*No.*		*No.*	
Salteries	...	...	2	$36,955	9	$102,750	11	$139,705
Operating capital	...	...	...	129,736	...	131,346	...	261,082
Vessels:								
Power vessels over 5 tons	...	...	2	11,000	3	23,000	5	34,000
Net tonnage	...	...	16	...	57	...	73	...
Sailing	...	...	...	...	3	49,725	3	49,725
Net tonnage	...	...	...	...	991	...	991	...
Launches under 5 tons	...	...	...	...	9	16,800	9	16,800
Rowboats and skiffs	...	...	32	1,920	47	10,015	79	11,935
Lighters and scows	...	...	...	...	5	6,800	5	6,800
Pile driver	...	...	...	...	1	2,000	1	2,000
Apparatus:								
Haul seines	...	...	...	...	7	800	7	800
Fathoms	...	...	...	...	300	...	300	...
Purse seines	...	...	1	2,800	...	...	1	2,800
Fathoms	...	...	200	...	...	...	200	...
Gill nets	...	...	14	3,850	110	10,225	124	14,075
Fathoms	...	...	1,050	...	6,438	...	7,488	...
Pound nets, driven	...	...	5	50,000	...	...	5	50,000
Wheels	...	...	...	...	2	700	2	700
Total	...	...	...	236,261	...	354,161	...	590,422
PERSONS ENGAGED.								
Fishermen:								
Whites	...	...	38	...	66	...	104	...
Natives	...	...	1	...	22	...	23	...
Total	...	...	39	...	88	...	127	...
Shoresmen:								
Whites	...	...	18	...	59	...	77	...
Natives	...	...	6	...	1	...	7	...
Mexicans	...	...	...	...	25	...	25	...
Total	...	...	24	...	85	...	109	...
Transporters:								
Whites	...	...	21	...	8	...	29	...
Natives	...	...	...	...	2	...	2	...
Total	...	...	21	...	10	...	31	...
Grand total	...	...	84	...	183	...	267	...
PRODUCTS.[a]								
	Barrels.		*Barrels.*		*Barrels.*		*Barrels.*	
Coho, or silver	706	$13,206	204	3,024	292	5,918	1,202	22,148
Chum, or keta	70	2,080	27	135	41	555	138	2,770
Humpback, or pink	26	260	50	700	45	548	121	1,508
King, or spring	241	4,542	8	232	618	16,267	867	21,041
Red, or sockeye	12	355	587	12,380	5,183	135,245	5,782	147,980
Total	1,055	20,443	876	16,471	6,179	158,533	8,110	195,447

[a] Each barrel holds 200 pounds of fish.

SALMON FREEZING.

The output of frozen salmon from Alaska in 1919 was prepared by six companies in southeastern Alaska engaged primarily in the freezing of halibut and the canning of salmon. For that reason, no investment is credited to this business and no persons are shown as employed therein. The companies referred to were as follows: Booth Fisheries Co., Goemaere Fish Co. (Inc.), Juneau Cold Storage Co., Libby, McNeill & Libby, National Independent Fisheries Co., New England Fish Co.

There was produced in Alaska in 1919 a total of 1,552,480 pounds of frozen salmon, valued at $130,355, a decrease from 1918 of 325,442 pounds in production and of $40,509 in value.

QUANTITY AND VALUE OF SALMON FROZEN IN ALASKA IN 1919, BY SPECIES.

Species.	Pounds.	Value.
Coho, or silver	254,784	$27,022
Chum, or keta	437,878	28,651
Humpback, or pink	356,680	17,834
King, or spring	396,213	46,156
Red, or sockeye	106,925	10,692
Total	1,552,480	130,355

FRESH-SALMON TRADE.

The fresh-salmon trade of Alaska in 1919 was confined wholly to the southeast district. Nearly all of this business was incidental to the canning and mild-curing industry, there being only three firms whose chief trade was dealing in fresh salmon. They were Knutsen Bros., at West Point, and H. Bergman and the Fresh Fish Co., both at Ketchikan. The quantity of salmon sold fresh in Alaska in 1919 was reported as 5,208,327 pounds, valued at $356,688. This is an increase in production of 947,412 pounds, and in value of $20,112.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA FRESH-SALMON TRADE IN 1919.[a]

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.	*Number.*		PERSONS ENGAGED.		
Operating capital		$27,685	Fishermen: Whites	16	
Wages paid		27,581	Shoresmen: Whites	8	
Launches	2	2,800	Transporters: Whites	10	
Rowboats	11	470	Total	34	
Seines, haul (100 fathoms)	1	150			
Gill nets (105 fathoms)	2	150	PRODUCTS.	*Pounds.*	
Pound nets, driven	4	43,000	Coho, or silver	1,306,698	$71,694
Pound nets, floating	1	2,500	Chum, or keta	420,722	15,334
Total		104,336	Humpback, or pink	450,429	9,703
			King, or spring	2,695,854	242,756
			Red, or sockeye	334,624	17,201
			Total	5,208,327	356,688

[a] Confined wholly to southeast Alaska in 1919.

DRY SALTING OF SALMON.

The dry salting of salmon in Alaska in 1919 was represented by the activities of a single packer, the Kuskokwim Fishing & Transportation Co., at Apokak. The investment was increased from $58,345 in 1918 to $103,862 in 1919, the increase being accounted for entirely by the inclusion of the value of certain vessels not reported in 1918.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA DRY SALTING OF SALMON IN 1919.[a]

Item.	Quantity.	Value.
INVESTMENT.		
	Number.	
Plants	1	$10,000
Operating capital		29,162
Power vessels over 5 tons	4	63,000
Net tonnage	423	
Launches	1	200
Seine and rowboats	16	900
Gill nets, 1,160 fathoms	20	600
Total		103,862
PERSONS ENGAGED.		
Fishermen:		
Whites	10	
PERSONS ENGAGED—cont.		
	Number.	
Shoresmen:		
Whites	3	
Natives	25	
Transporters:		
Whites	1	
Total	39	
PRODUCTS.		
	Pounds.	
Coho, or silver	71,670	$7,167
Chum, or keta	15,104	1,359
King, or spring	110,820	7,757
Red, or sockeye	14,650	1,318
Total	212,244	17,601

[a] Confined wholly to western Alaska.

DRYING AND SMOKING OF SALMON.

The drying and smoking of salmon in Alaska is not an essential branch of the salmon industry, though a considerable quantity of salmon is doubtless so prepared and used locally, chiefly by the Indians. Statistics of the number of salmon used in this way are unavailable, but a conservative estimate would place the quantity at 400,000 pounds, having a value of at least $40,000. In addition to this, the Juneau Cold Storage Co. kippered 15,000 pounds of salmon, valued at $3,000.

SALMON BY-PRODUCTS.

The most notable change in the salmon by-products industry was the withdrawal from Alaska of the Fish Canners By-Products Co., at Ward Cove. This company met with misfortune in 1918 by the loss in transit of new machinery intended for installation in its oil and fertilizer factory, and as a result it decided not to operate. The plant was then offered for sale and remained idle in 1919.

The Pacific American Fisheries was the only concern in Alaska in 1919 utilizing the offal and other fishery waste at its canneries in the production of by-products. It operated plants in connection with the canneries at Excursion Inlet in southeast Alaska, and at Ikatan in central Alaska. As these reduction plants were incidental to the canning of salmon, no investment in the by-products industry is shown for 1919. The products were 362 tons of fertilizer, valued at $18,680, and 966 gallons of oil, valued at $966.

HALIBUT FISHERY.

The large halibut banks of the North Pacific Ocean are located largely in extraterritorial waters. They are fished by vessels from Seattle, Prince Rupert, and Alaskan ports, to which places fares are delivered. There are also large banks off the coast of British Columbia, Washington, and Oregon, which are visited by these same vessels. The impracticability of making the necessary segregation of catches, in order to show how much of the total production of halibut from the Pacific Ocean should be credited to the respective regions, is at once obvious. The statistics appearing herein include all catches delivered at ports in Alaska and at Seattle by American vessels fishing on Yakutat, Portlock, Albatross, and the banks adjacent to the coast of southeast Alaska. A total of 14,278,791 pounds is thus accounted for. American vessels also delivered at Prince Rupert and Vancouver a total of 11,761,750 pounds of halibut which in all probability came largely from the Alaskan banks.

STATISTICAL SUMMARY.

The investment in the halibut industry in 1919 was $1,979,457, as against $2,594,292 in 1918, a falling off of $614,835. The industry gave employment to 867 persons as compared with 1,186 in 1918, a decrease of 319. Production increased from 13,869,706 pounds in 1918 to 14,278,791 pounds in 1919, a total of 409,085 pounds. Values dropped from $1,667,686 to $1,550,605, a decline of $117,081.

The principal handlers of halibut were Libby, McNeill & Libby, at Taku; New England Fish Co., at Ketchikan; Alaska Fish & Cold Storage Co., successor to the Glacier Fish Co., at Scow Bay; Booth Fisheries Co., at Sitka; Juneau Cold Storage Co., at Juneau; National Independent Fisheries Co., at Juneau; Ripley Fish Co., at Ketchikan, Wrangell, and Petersburg; and the San Juan Fishing & Packing Co., at Seward.

One fisherman was drowned while engaged in halibut fishing. Minor property losses aggregating in value $10,000 were also reported.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HALIBUT FISHERY IN 1919.

Item.	Quantity.	Value.	Item.	Quantity.	Value.
INVESTMENT.			PERSONS ENGAGED.		
				Number.	
Fishing vessels:	*Number.*		Whites	863	
Steam and gas	94	$1,140,900	Natives	3	
Net tonnage	1,957		Japanese	1	
Outfit		560,000	Total	867	
Launches	5	11,451			
Dories and scows	192	10,200	PRODUCTS.		
Fishing apparatus		51,550		*Pounds.*	
Shore property		205,356	Fresh (including local)	7,783,179	$880,433
Total		1,979,457	Frozen	6,495,372	670,147
			Canned	240	25
			Total	14,278,791	1,550,605

HERRING FISHERY.

The herring industry of Alaska suffered a decided setback in 1919, due to a weaker demand for Alaska pickled herring. Packers experienced great delay in marketing their products, the explanation being that the importation of European herring had closed the large eastern markets to the Scotch-cured herring from Alaska, and that the Norwegian-cured herring from Alaska were virtually unsalable. A further reason may be given for this unsatisfactory condition, namely, faulty packing and poor selection, both of which are matters wholly within the control of the packers. Any difficulty they encountered in the disposal of herring so packed may be easily understood. If the industry is to survive and expand, it is imperative that goods of high standard be produced regardless of method of cure.

A review of operations in 1919 would indicate that packers recognized the fact that Scotch-cured herring are preferred in American markets to those of any other cure. This is evidenced by the statistics for that year, which show that the bulk of the pack was prepared according to the Scotch formula, though the total production was considerably less than in 1918.

STATISTICAL SUMMARY.

The investment in the herring industry in 1919 was $900,572, a decrease of more than 50 per cent from the amount reported in 1918. This was partly due to a change in classification of some operators, but a further cause was the failure of a number of packers to resume operations in 1919. The number of persons employed was 427, or approximately 50 per cent less than in 1918, when 884 were reported. The herring products in 1919 were valued at $1,676,170, as compared with $1,819,538 in 1918, a decrease of $143,368. Canned herring was the leading product, representing in value more than 50 per cent of the total output. Scotch-cured herring took second place, although there was a decline in production of 20 per cent and a shrinkage in value of approximately 40 per cent from 1918. The production of Norwegian-cured herring dropped to 11,080 barrels, or a falling off in output of 73 per cent as compared with the pack in 1918.

Losses in the herring industry aggregated $7,360, of which amount $2,600 represented the value of apparatus and other equipment, and $4,760 the value of 281 barrels of pickled herring.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA HERRING FISHERY IN 1919.

Item.	Southeast Alaska.		Central Alaska.		Western Alaska.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
INVESTMENT.								
Plants operated	4	$98,192	6	$92,491	1	$12,000	11	$202,683
Operating capital		224,866		257,550		24,283		506,699
Vessels:								
Power vessels over 5 tons	8	41,500	8	37,300	1	6,500	17	85,300
Net tonnage	195		134		11		340	
Launches under 5 tons	2	6,592	5	7,500	1	1,000	8	15,092
Boats, row and seine	22	1,860	26	1,375	11	1,000	59	4,235
Lighters and scows	8	12,500	8	9,700	2	350	18	22,550
Pile driver	1	1,500					1	1,500
Apparatus:								
Haul seines	6	10,500	10	13,077	2	530	18	24,107
Fathoms	560		1,685		200		2,445	
Purse seines	10	21,061	3	8,000	6	3,500	19	32,561
Fathoms	1,230		490		600		2,320	
Gill nets			14	1,860	100	1,500	114	3,360
Fathoms			700		1,700		2,400	
Dip nets			2	10			2	10
Pound nets			6	2,475			6	2,475
Total		418,571		431,338		50,663		900,572
PERSONS ENGAGED.								
Fishermen:								
Whites	67		38		5		110	
Natives	3		9		16		28	
Others	5		16				21	
Total	75		63		21		159	
Shoresmen:								
Whites	58		86		6		150	
Natives	7		24		71		102	
Others	11						11	
Total	76		110		77		263	
Transporters: Whites			5				5	
Grand total	151		178		98		427	
PRODUCTS.								
Canned (½-pound cans)							[a] 6,357	40,395
Canned (1-pound cans)							[a] 95,448	811,366
Dry salted for food							[b] 510,000	20,150
Fresh for bait							[b] 1,254,926	11,210
Frozen for bait							[b] 2,444,655	24,246
Pickled for bait							[b] 40,000	800
Pickled for food, Scotch cure							[b] 7,718,985	451,240
Pickled for food, spiced							[b] 11,715	1,676
Pickled for food, Norwegian cure							[b] 2,216,120	147,634
Fertilizer							[c] 856	56,653
Oil							[d] 169,374	110,800
Total								1,676,170

[a] Cases. [b] Pounds. [c] Tons. [d] Gallons.

COD FISHERY.

The outstanding facts in connection with the cod industry of Alaska in 1919 are a decrease in production of 23 per cent as compared with that of 1918 and a reduction in the number of operators from 32 to 19. The most conspicuous withdrawal from this field was that of the Northern Fisheries (Inc.), which in 1918 was likewise the most conspicuous accession to the list of operators. Other withdrawals were said to have been occasioned by the lack of transportation, a difficulty which could not be overcome successfully, since no regular steamer service was maintained in western Alaska. Other operators claimed that their business was injured by the importation of cod from Japan with which they were unable to compete.

Bering Sea retains its supremacy as the chief field of production, though very considerable catches were made on the banks of the Pacific Ocean south of the Alaska Peninsula. Winter fishing in the vicinity of the Shumagin and Sannak Islands is carried on rather indifferently since the introduction of power dories, previous to the use of which it constituted a prosperous industry. The reason assigned for the decline of the winter fishing is that the fishermen are not able to handle the additional weight which the installation of power in the dories has meant when it becomes necessary to launch or haul out their boats. The common dory was easily handled on the beaches.

VESSEL FISHERY.

Two important changes occur in the list of companies and individuals carrying on the vessel cod fishery of Alaska in 1919; one is the omission of the Northern Fisheries (Inc.), which did not resume operations after 1918, and the other the addition of Lars Mikkelson who purchased and sent north to engage in cod fishing in the vicinity of the Aleutian Islands the steamer *Dora*, which by reason of its years of faithful service to the people of western Alaska, is now the most noted vessel in Territorial waters. The small gas schooner *Alice*, used by the Northern Fisheries (Inc.), in connection with its shore station at Kodiak, is now shown under the name of the W. J. Erskine Co., while the schooners *Charles Brown* and *Azalea* and the gas schooner *Valdez* are dropped from the list. The *Allen A*, belonging to the Alaska Codfish Co., was reported a total loss by being blown ashore on Unga Island early in the year, but subsequently it was hauled off and towed to Seattle for repairs, and finally sold. The *Fanny Dutard*, owned by J. A. Matheson, was withdrawn from foreign trade in which it was engaged in 1918 and reentered the Bering Sea cod fleet in 1919. No other changes were noted in the vessels operated.

ALASKA COD FLEET IN 1919.

Name.	Rig.	Net tonnage.	Operators.
City of Papeete	Schooner	370	Alaska Codfish Co., San Francisco, Calif.
Glendale	do	281	Do.
Maweema	do	392	Do.
Alasco	Power schooner	23	Do.
Alasco II	do	5	Do.
Alasco III	do	8	Do.
Trio	do	9	Alaska Ocean Food Co., Seattle, Wash.
Fanny Dutard	Schooner	252	J. A. Matheson, Anacortes, Wash.
Dora	Steamer	217	Lars Mikkelsen, Seattle, Wash.
John A	Schooner	235	Pacific Coast Codfish Co., Seattle, Wash.
Chas. R. Wilson	do	328	Do.
Maid of Orleans	do	171	Do.
Alice	do	220	Robinson Fisheries Co., Anacortes, Wash.
Wawona	do	413	Do.
Sequoia	do	324	Union Fish Co., San Francisco, Calif.
Galilee	do	328	Do.
Beulah	do	339	Do.
Louise	do	328	Do.
Martha	do	14	Do.
Golden State	Power schooner	223	Do.
Pirate	do	30	Do.
Union Flag	do	10	Do.
Alice	do	15	W. J. Erskine Co., Kodiak, Alaska.
Flossie	do	10	Do.
Edith	do	7	Do.

SHORE STATIONS.

Only two concerns in southeast Alaska reported having handled any cod. They were Libby, McNeill & Libby and the New England Fish Co., both of which froze a few tons of cod incidentally in the freezing of halibut. The more important operators in central Alaska were the Alaska Ocean Food Co., at Port Chatham; W. J. Erskine Co. and O. Kraft & Son, at Kodiak; Shumagin Packing Co., at Squaw Harbor; Pacific American Fisheries, at Ikatan; and the Union Fish Co. and the Alaska Codfish Co., at several stations in the Shumagin and Sannak Islands.

STATISTICAL SUMMARY.

The investment in the Alaska codfish industry in 1919 was $1,286,075, which is an increase of $14,957 over that of 1918. A total of 702 persons were employed as compared with 697 in 1918.

A total of 10,893,312 pounds of cod was produced, having a value of $825,990. This is a decrease of 3,169,648 pounds in production, and $131,194 in value.

Investment, Persons Engaged, and Products of Alaska Cod Fishery in 1919.

Item.	Quantity.	Value.
INVESTMENT.	*Number.*	
Value of shore stations		$139,070
Cost of operations		196,590
Wages paid		546,063
Vessels:		
Power vessels over 5 tons	10	114,644
Net tonnage	547	
Launches under 5 tons	50	26,915
Sailing vessels	14	239,070
Net tonnage	3,753	
Dories	292	14,590
Pile drivers	2	250
Apparatus:		
Seines (75 fathoms)	1	250
Gill nets (75 fathoms)	1	195
Hooks	3,024	53
Lines	1,246	8,385
Total		1,286,075
PERSONS ENGAGED.		
Fishermen:		
Whites	494	
Natives	8	
Negroes	2	
Total	504	
Shoresmen:		
White	25	
PERSONS ENGAGED—contd.		
Transporters:	*Number.*	
White	173	
Grand total	702	
PRODUCTS.		
Vessel catch:	*Pounds.*	
Dry salted cod	8,015,668	$638,880
Pickled cod	416,398	20,837
Frozen cod	86,971	4,209
Tongues	17,400	1,740
Total	8,536,437	665,666
Shore-station catch:		
Dry-salted cod	1,813,675	134,417
Pickled cod	539,700	25,177
Stockfish	2,900	700
Tongues	600	30
Total	2,356,875	160,324
Total:		
Dry-salted cod	9,829,343	773,297
Pickled cod	956,098	46,014
Frozen cod	86,971	4,209
Stockfish	2,900	700
Tongues	18,000	1,770
Total	10,893,312	825,990

WHALE FISHERY.

SHORE STATIONS.

Three companies were reported as having engaged in whaling operations in Alaska in 1919. They were the United States Whaling Co., at Port Armstrong; North Pacific Sea Products Co., at Akutan; and the Pioneer Mining & Ditch Co., at Nome, the latter concern taking only the beluga or white whale.

The United States Whaling Co. operated three steamers in whale killing, *Star I* (133 tons), *Star II*, and *Star III* (97 tons each). The North Pacific Sea Products Co. employed a fleet of four steam whalers, the *Kodiak* and *Unimak* (99 tons each), the *Paterson* (77 tons), and the *Tanginak* (71 tons). The steamer *Elihu Thompson* (448 tons) and the barge *Fresno* (1,149 tons) were used as transporting and refrigerating vessels. No losses were reported in this industry. The results of the season were exceptionally gratifying, a large number of whales being captured.

STATISTICAL SUMMARY.

The investment in the whaling industry in Alaska in 1919 was $1,790,867, an increase of $439,896 over 1918. Employment was given to 311 men, or 14 less than in 1918. The value of the whale products was $1,027,200 as compared with $834,127 in 1918. Whales to the number of 580 were taken, exceeding the number taken in 1918 by 132.

Investment, Persons Engaged, and Products of Alaska Shore Whaling Operations in 1919.

Item.	Number.	Value.
INVESTMENT.		
Vessels:		
Steam and gas	8	$415,000
Net tonnage	1,121	
Barge	1	30,000
Net tonnage	1,149	
Launches under 5 tons	2	1,400
Rowboats	2	60
Scows	2	400
Pile driver	1	150
Value of plants		427,339
Cash capital		633,139
Wages paid		283,379
Total		1,790,867
PERSONS ENGAGED.		
Whites	226	
Natives	26	
Japanese	59	
Total	311	

Item.	Number.	Value.
PRODUCTS.		
Whales:		
Finback	242	
Humpback	132	
Sulphur-bottom	68	
Sperm	95	
Sei	2	
Beluga	41	
Total	580	
Whale oil	[a] 875,374	$656,510
Sperm oil	[a] 377,032	276,344
Fertilizer, meat	[b] 2,060,000	76,420
Fertilizer, bone	[b] 538,000	13,472
Whalebone	[b] 13,647	2,729
Ivory, sperm	[b] 746	225
Meat, frozen	[b] 50,000	1,500
Total		1,027,200

[a] Gallons. [b] Pounds.

CLAM CANNING.

The only reported clam canning in Alaska in 1919 was carried on by three companies in the central district. Two of these, the Pioneer Packing Co., at Cordova, and the Pinnacle Rock Packing Co., at Boswell Bay, Hinchinbrook Island, continued operations in accordance with the custom of preceding seasons, obtaining their raw product from the beds between Hinchinbrook Island and the mainland from Cordova to Katalla. The Surf Packing Co., a new concern, opened a cannery at Tuxedni Harbor, on the west shore of Cook Inlet, and made a small pack. It operated in virgin territory where clams were said to be fairly abundant, but on this point there is no trustworthy information at hand and nothing is known of the size of areas occupied by the clams. As that company was also engaged in the canning of salmon, it is shown in that category and not listed as a clam cannery. It is also indicated elsewhere in this report that the Pioneer Packing Co. entered the salmon-canning business for which reason its classification was changed from the clam to the salmon industry, and the investments entered accordingly. This leaves the Pinnacle Rock Packing Co. as the only concern engaged exclusively in the canning of clams. The Lighthouse Canning Co., the pioneer clam-packing concern of central Alaska, sold its cannery at Cordova and ceased to operate. The Hillery-Scott Co., its successor, did not pack clams. Aside from the changes in the character of operations as noted above, the smaller pack in 1919 in comparison with that of the two seasons immediately preceding would presage a diminution in the supply of clams.

The investment in this industry in 1919 was $147,167. Employment was given to 237 persons, an increase of 55 over 1918. The total pack was 33,765 cases as against 43,575 in 1918. The products were valued at $184,363, as compared with $214,504 in 1918, a decrease of $30,141.

INVESTMENT, PERSONS ENGAGED, AND PRODUCTS OF ALASKA CLAM-CANNING INDUSTRY IN 1919.

Item.	Number.	Value.
INVESTMENT.		
Canneries operated	1	$22,000
Working capital		49,990
Wages paid		69,377
Vessels:		
Power dories	10	3,000
Rowboats and skiffs	36	1,800
Scows	1	1,000
Total		147,167
PERSONS ENGAGED.		
Diggers:		
Whites	185	
Natives	6	
Filipinos	1	
Total	192	
PERSONS ENGAGED—contd.		
Shoresmen:		
Whites	42	
Natives	3	
Total	45	
Grand total	237	
PRODUCTS.		
½-pound cans [a]	[b] 13,874	$55,496
No. 1 eastern oyster cans [a]	[b] 19,891	128,867
Total	33,765	184,363

[a] 48 per case.

[b] Cases.

MINOR FISHERIES.

TROUT.

The most notable change in respect to the trout fisheries of Alaska in 1919 was the failure to operate of the Midnight Sun Packing Co., at Kotzebue, where 2,587 cases of Dolly Vardens were canned in 1918—the largest single product of the trout fisheries. The canning and pickling of trout almost ceased in 1919; only 371 cases, valued at $3,496, were packed, largely by four salmon-canning companies in central Alaska, and 11 barrels were salted in western Alaska. There was an increase in the quantity of fresh trout handled in southeast Alaska, the entire production being credited to the Ripley Fish Co. The gross value of all trout products in 1919 was $13,155, a decrease of $20,529 as compared with the output in 1919.

Products of Alaska Trout Fishery in 1919.

Section and species.	Fresh.		Frozen.		Pickled.		Canned.	
	Pounds.	*Value.*	*Pounds.*	*Value.*	*Barrels.*	*Value.*	*Cases.*	*Value.*
Southeast Alaska:								
Dolly Varden	68,584	$8,282					3	$27
Steelhead	12,383	804	2,780	$408				
Total	80,967	9,086	2,780	408			3	27
Central Alaska:								
Dolly Varden							265	2,761
Steelhead							12	108
Total							277	2,869
Western Alaska:								
Dolly Varden					11	$165	91	600
Grand total	80,967	9,086	2,780	408	11	165	371	3,496

SABLEFISH.

None of the minor fisheries of Alaska shows a greater shrinkage in production than the sablefish. Whether it be due to a smaller catch or to the failure to save the entire catch can not be stated. As sablefish are taken in fishing for halibut and yield but a small return to the fishermen, it seems probable that a considerable quantity may have been wasted rather than that there was an actual shortage in the supply. The catch is made chiefly on the halibut banks off the coast of Alaska. The total production of sablefish was 509,369 pounds, valued at $35,485, a decrease of 826,670 pounds in quantity and $31,866 in value; 289,158 pounds, valued at $22,682, were shipped fresh, and 220,211 pounds, valued at $12,803, were shipped frozen.

RED ROCKFISH.

The red rockfish, like the sablefish and other deep-water fishes, are taken largely on the halibut banks in connection with that fishery. The demand for rockfish is somewhat limited, a fact which doubtless curtails deliveries to buyers. The total reported production in 1919 was 69,048 pounds, valued at $1,414, as compared with 338,669 pounds in 1918, valued at $67,351.

CRABS.

John Murphy, at Tenakee, was the only operator in Alaska reporting a catch of crabs in 1919. He marketed 80 dozen, valued at $160. His investment in the crab fishery was $200.

Inquiries made in 1919 regarding the methods of canning crabs indicate a desire on the part of some salmon packers to engage in the canning of crabs if the process is not too difficult and costly. This is a matter which merits investigation, as under proper encouragement a new industry may be developed in Alaska.

SHRIMPS.

Shrimp fishing in Alaska in 1919 was carried on by one operator, the Alaskan Glacier Sea Food Co., at Petersburg. Employment was given to 2 white fishermen and 15 Japanese shoresmen. The investment in plant, boat, gear, and wages paid was $41,796. The total production was 60,000 pounds of shrimp, valued at $21,000. Market conditions were unsatisfactory to the company operating in Alaska, as the competition originating in southern waters could not be met without serious loss.

MISCELLANEOUS FISHERY PRODUCTS.

Under this head are classed all flatfish, smelt, "lingcod", etc., which are taken in small quantities in connection with more important fishery operations. The total output was 52,123 pounds, valued at $1,639.

MINOR FUR-BEARING ANIMAL WORK.

GENERAL WORK.

The major functions of the Bureau in Alaska have been devoted primarily to affairs pertaining to the fur seals of the Pribilof Islands and the general fisheries operations in the coastal regions. To the extent that facilities and funds have permitted, attention has been devoted to the minor fur-bearing animals. In his annual report for the fiscal year ended June 30, 1919, the Commissioner of Fisheries again recommended that the Bureau be relieved of the incongruous duty of administering the minor fur-bearing animals of the Territory. Favorable action by Congress is anticipated in the near future, it being probable that jurisdiction will be transferred to the Bureau of Biological Survey of the Department of Agriculture.[a]

The arrangement made in 1918 with the governor of Alaska whereby employees of the Bureau have been named as ex officio game wardens and the Territorial game wardens and special employees for the suppression of the liquor traffic among the Indians have been designated as special wardens in the Bureau's Alaska service, without additional compensation, was continued in effect during the year 1919. Some changes in the force of wardens have occurred. The employees under direction of the governor's office identified with this work in 1919 were as follows:

Game wardens: Patrick Hamilton, Ketchikan; J. C. Lund, Juneau; P. S. Ericksen, McCarthy; J. A. Baughman, Seward; Stephen Foster, Nenana; R. E. Steel, Eagle; and M. O. Colberg, Nome.

Special employees: J. F. McDonald, Juneau; J. A. Bourke, Valdez; Thomas P. Killeen, Nome; and John A. Moe, Ruby.

P. S. Ericksen, of McCarthy, was succeeded by E. A. Young at Chitina.

In January, 1920, the services of Stephen Foster were discontinued.

The Bureau has continued the employment of Game Warden F. A. Martin at Anchorage as special fur warden at a nominal salary. The cooperative arrangement with the governor's office has been of value in that a number of violations of the fur-bearing animal law and regulations, which otherwise would probably have gone unnoticed, have received attention.

Reports have been received that more than the usual number of blue foxes have been taken along the Bering Sea coast between Cape Avinof and the Yukon delta. The death of so many natives in the Bristol Bay region as a result of the influenza epidemic has greatly reduced the number of persons trapping and will probably mean increased takes by the white trappers, though possibly not so large an output from the district as a whole.

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[a] The act of Congress approved May 31, 1920, transferred jurisdiction over the minor fur-bearing animals of Alaska to the Bureau of Biological Survey, Department of Agriculture.

REGULATIONS.

There was no change in the minor fur-bearing animal regulations in 1919, but under date of January 9, 1920, the following regulation was issued by the Secretary of Commerce, extending the prohibition on the killing of sea otters in Alaska:

> By virtue of the authority vested in me by section 4 of "An Act to protect the seal fisheries of Alaska, and for other purposes," approved April 21, 1910, it is hereby ordered that the killing of any sea otter within the limits of Alaska Territory or in the waters thereof is prohibited until November 1, 1925.

Years ago sea-otter hunting was a lucrative industry in North Pacific waters, and, as not infrequently happens, it was conducted so assiduously that the practical extinction of sea otters resulted. Protective legislation has undoubtedly had a beneficial effect, but the reestablishment of sea otters upon a commercial basis can not be expected for years to come. It is urgently necessary that every precaution be taken to protect fully this highly valuable marine fur-bearing animal. By the terms of the North Pacific Sealing Convention of July 7, 1911, the taking of sea otters in waters covered by it outside the 3-mile limit is prohibited. In administering the fur-bearing animal laws and regulations within the Territorial waters of Alaska, it is the policy of the Bureau to support and parallel the provisions of the international treaty in respect to sea otters.

The Bureau has from time to time received advices of a desire in certain parts of Alaska for the removal of the prohibitions upon the killing of beaver and marten. The Bureau feels, however, that the time is not yet ripe for making an open season for these valuable fur-bearing animals, as there is no authentic evidence available to show that their numbers have been replenished to an extent justifying such action. Undoubtedly both beavers and martens are more numerous in some sections of Alaska than a few years ago, but this is the best evidence that the regulations were needed and have been producing beneficial results. A continuance of the same policy for some time to come is considered advisable.

VIOLATIONS OF REGULATIONS AND SEIZURES OF SKINS.

On January 22, 1919, Assistant Agent Christoffers cooperated with the collector of customs at Seattle in the seizure from an express company of 10 trunks containing skins consigned from Seward, Alaska, to San Francisco. The trunks were the property of J. H. Smith, of Anchorage, and contained 717 beaver skins, 20 swan skins, and one can of beaver castors. No claim was made for possession of the furs, and the shipper was not apprehended for prosecution.

On February 1, 1919, Special Warden Martin seized 44 marten skins from John E. Carlson at Anchorage. Carlson was fined $100 and costs, amounting in all to $118.15.

Game Warden Stephen Foster seized two marten skins, one on February 17, 1919, from Charles P. Christiansen and one on March 4, 1919, from Tom Cook, both in the Kantishna River region.

United States Commissioner Charles J. Koen, of St. Michael, forwarded to the Seattle office three beaver skins which were seized from two natives, one of whom pleaded guilty and was sentenced to 20 days in jail, while the other stood trial, was convicted, and sentenced to 60 days in jail. Commissioner Koen also reported that in April and May he sentenced five other natives to terms in jail ranging from 10 to 30 days for the killing of beaver. The skins were not secured. All of these cases originated on the Galsovia River.

In May, 1919, Game Warden Lucy seized a beaver skin from a native named Jim Johnny Mie in the vicinity of Petersburg. Mie was prosecuted for having the skin in his possession, pleaded guilty, and served five days in jail at Ketchikan.

In June, 1919, Warden Larson seized a beaver skin from an Indian near Ketchumstock.

One June 22, 1919, Frank O'Farrell shipped 13 marten skins from Tanana, which were seized by Deputy Collector of Customs Hillard at Eagle and turned over to Game Warden R. E. Steel. Twelve more marten skins were seized by Warden O'Connor at Skagway on July 7 when a parcel-post package addressed from Tanana to O'Farrell at Seattle was examined under search warrant. All the skins were forwarded to the Seattle office of the Bureau. O'Farrell afterward presented a certificate, dated June 26, 1919, that 25 marten skins were of Canadian origin. The Bureau, upon the recommendation of the deputy collector of customs at Eagle, refused to accept it as covering the seized skins, and they were confiscated.

Examination of mail shipments were made at Skagway under search warrants by Warden Philip R. Hough on July 16 and 17 and resulted in the seizure of 20 marten shipped by R. L. Smith from Ruby, 25 beaver shipped by D. R. Stern from Nulato, and 1 beaver by John B. Steppe from the Kantishna region. The skins were retained by the marshal at Skagway until released to the Bureau by a court order in March, 1920, and were then forwarded to Seattle.

In July, 1919, certain seizures of illegally taken furs were made in Alaska by the United States marshal, these furs having been placed in the mail by Peter Vachon of Tolovana. The shipments were located by means of search warrants executed with the permission of the Post Office Department at the post office at Tolovana and on board a vessel near Eagle. The seizures comprised 714 marten skins and 699 beaver skins, which at the end of the year were still in the possession of the United States marshal at Fairbanks for use in the prosecution of the shipper.

On August 9 customs officials at Seattle seized seven beaver skins from James P. Browner, chief engineer of the schooner *Ozmo*. Browner stated that the skins had been given to him by J. W. Felder in the Kuskokwim district, and that he did not know that their possession was unlawful. No prosecution was instituted; the skins were turned over to Assistant Agent Christoffers.

On September 5 the deputy collector of customs at St. Michael seized from a man named Miller 88 beaver skins turned over to him by Chris Betsch, a trader, to deliver to a bank at Nome. Other prosecutions were made as follows: Joe Knox, 7 beaver skins seized, sentenced to 30 days in jail; Sam Tajari, 24 beaver skins seized, fined \$200 and costs; Chris Betsch, 170 beaver skins seized, fined \$200 and costs. The case against Miller, in whose possession the 88 skins were found, was dismissed as it had been shown that the skins were turned over to him by Betsch for delivery to the Merchants and Miners Bank of Nome. The 289 skins were forwarded to the Bureau's Seattle office in June, 1920, by the United States marshal for sale for the account of the Government.

On October 17, 1919, Assistant Agent Christoffers, assisted by five deputy customs officers, searched the schooner *Ozmo*, arriving from the Kuskokwim River region, and seized 41 beaver and 4 swan skins.

On November 26, 1919, Warden O'Conner seized two marten skins from a native named Peter Brown. Prosecution was instituted in the United States commissioner's court at Haines against Brown for having illegally taken skins in his possession. He was tried on December 29 and was fined $25 and costs.

On November 30, 1919, Warden O'Connor seized 69 muskrat skins at Haines from Harry Lindberg, a fur buyer. Lindberg was arraigned before the United States commissioner for having unprime skins in his possession, but the case against him was dismissed with the understanding that he would testify in behalf of the Government against Tom Lahey from whom he had purchased the skins. Lahey was charged with trapping muskrats in the close season, but at the trial in the United States commissioner's court at Juneau on December 13, 1919, the jury returned a verdict of not guilty. The court returned the skins.

On December 21, 1919, N. A. T. Joe was convicted before the United States commissioner at St. Michael of killing a mink on October 4, 1919. He was sentenced to 60 days in jail.

During the year two fur-seal skins, which had not been properly authenticated, were received by Funsten Bros. & Co. Both had apparently been taken by fishermen, one being sent in by John Michelson of Sointula, British Columbia, and the other by Charles Landberg of Neah Bay, Wash. They were accordingly confiscated by the Government and will be sold by the company at public auction.

SALES OF SEIZED SKINS.

During the calendar year 1919, the following seized skins were sold at public auction: In St. Louis, 8 fur-seal skins; and in Seattle, 753 beaver, 92 marten, 54 mink, 7 weasel, 3 lynx, 32 muskrat, 1 cross-fox, 20 swan skins, and 42 pounds of beaver castors. The gross amount received was $16,236.27. Commission and other expenses amounted to $866.75, leaving a balance of $15,369.52 turned into the United States Treasury. A few seized skins remained unsold at the end of the year.

FUR FARMING.

Fur farming in Alaska is largely concerned with the propagation of foxes, though occasionally attempts are made to raise in captivity minks and martens, but without success. Foxes lend themselves more easily to domestication, especially the blue variety, and are exceptionally prolific under favorable conditions. Their skins have a comparatively high value at this time, which fact, coupled with that of easy breeding, constitutes sufficient inducement to the venturesome to engage in the industry, notwithstanding that the business is attended with risks and discouraging vicissitudes.

As in other undertakings, some failures were caused by careless and indifferent attention to business; others were due to the selection of islands much too small for the purposes intended or too near other land, and to improper or inadequate feeding or none at all.

Fox farming follows two methods, impounding or corral breeding, and free-range or island breeding. Under the corral method, propagation has proved decidedly unsuccessful in most cases, not so much in actual breeding but in the rearing of young and the preservation of parent stock. Confinement in pens, necessarily of very limited dimensions, has two noticeable effects on foxes. Being accustomed to freedom in their movements, its denial either makes them vicious or morose. In the one case, they become fighters, destroying their young, their mates, and companions of the same sex; in the other, their time, night and day, is spent in a continual search for a way of escape, which if not found increases their misery and is often not ended until death supervenes.

Island breeding has been very successful when seriously undertaken. A prime requisite is area great enough to afford considerable range to the foxes and sufficiently distant from other land to prevent their escape. An ample supply of food is also necessary, for underfed foxes become cannibalistic, or puny and weak, if not diseased. If the natural food to be found on the island is not sufficiently abundant to properly sustain the animals, the deficiency must be supplied by the efforts of the fur farmer. His energy in this direction will probably determine the degree of success or failure which will attend his labors. Foxes at liberty on suitable islands will take care of themselves just as long as food is ample and they are not crowded. In the end intelligent management is indispensable to successful results.

From time to time the Bureau receives information from the fox farmers in Alaska regarding their experiences and success or failure, much of which may be of general interest and benefit to all fur farmers. Among those who operated in 1919 and filed reports are the following:

Sholin Bros. & Co., of Homer, report encouraging results in the rearing of silver-black foxes in corrals. At the beginning of 1919 they had 12 pairs of breeders, 9 of which produced young, the litters varying from 2 to 5 pups each. The total increase was 28, all of which were successfully raised. Fifteen pairs are being held for breeders in 1920. The foxes are fed fish, birds, porcupines, hair seals, and cereals, but chiefly fish which is mixed with a cereal and boiled to a porridge and fed at evening. The morning meal consists of bread made of shorts and a little seal oil. Occasionally meat is fed. These operators have found that the foxes do better in pens built 6 feet apart than in those connecting or immediately adjoining each other.

F. Berry, 12 miles northeast of Homer, is also breeding foxes in corrals. He started business in 1918 in partnership with Dr. E. F. German, of Anchorage, with one pair of silver-black foxes. A litter of pups was produced in 1919, but nothing was saved from it, as the parent male fox destroyed the young. Mr. Berry gives directions for the prevention of worms and internal parasites in foxes, as follows:

> Burn all your old bones, pound them—not too fine—and add equal quantities of clean charcoal (burnt in the kitchen stove) of some hardwood; now chop fresh meat—something they like very well—and roll it and rub it into the charcoal and pulverized bone until it loses all semblance to meat in the mixture, then feed. They will not mind the dirt, just so they get the meat. One feed a week like this and your animals will never know worms.

In the fall of 1918, Abraham Ericksson, at Kenai, purchased two pairs of silver foxes at a cost of $1,700 and placed them in pens. During the year both males killed their mates. In October he traded one male for a female, thus giving him a pair for breeding in 1920.

Joseph Falardeau, operating a fox farm at the head of Kachemak Bay, reports encouraging results in 1919. At the beginning of the year he had on hand five male and seven female silver foxes. Three pairs of these produced a total of nine pups, five being males and four females. This enabled him to increase his breeding stock to nine pairs. Mr. Falardeau regards it as important that each farmer endeavor to raise farm produce, also other products which may be required for fox food, to supplement the natural food resources of the region, such as fish, rabbits, and birds. Milk and eggs are especially desirable as food for young foxes.

Andrew Siewertson, who is using Perry Island as a fox farm, reports that out of a breeding stock of 12 blue foxes he lost 4 families by theft or desertion, raised 36 young, killed 2 for their skins, and sold 12 pairs.

J. D. Jefferson has stocked Bald Head Chris Island with blue foxes and the Dutch Group with cross foxes, having entered upon both in the spring of 1917. The increase of blues is not definitely known by Mr. Jefferson, but he estimates that there are now from 20 to 25 foxes on the island. One male and two female cross foxes, placed on the Dutch Group in 1917, have done nothing. They were taken off this year. The islands will be stocked with blue foxes under the ownership and management of C. L. Hoyt, who is fox farming on Axel Lind Island, a few miles from the Dutch Group.

Lee E. Dickinson operates a fox farm on Flemming Island in the western part of Prince William Sound, having stocked it in 1919 with dark-blue foxes. He reports that the foxes are fed fresh fish, chiefly cod and halibut, and that they thrive on that diet. This is in striking contrast with the statement of Mr. Jefferson, who reported that his foxes did not like cod and would not eat it ordinarily unless cooked and mixed with other things.

Passage Island, situated in the entrance of Port Graham, is used as a blue-fox farm by J. A. Herbert, of Seldovia. This farm was established several years ago and has been fairly successful. At the beginning of 1919 the stock consisted of 25 pairs. These produced about 100 pups, but heavy losses occurred, as approximately 80 per cent of the young were killed and carried away by eagles. Only 23 pups reached maturity. Twenty-seven foxes were sold for breeding purposes, 25 were killed for their pelts, and 10 pairs were held as stock for 1920. Salted fish heads were used as food for the animals. These are easily obtained at the cannery of the Fidalgo Island Packing Co. at Port Graham.

Hesketh and Yukon Islands, in Kachemak Bay, are used for fox-breeding purposes by U. S. Ritchie, who began this work more than 20 years ago. His foxes run at large, and can pass from one island to the other at low water. A few were killed for their skins, while 10 pairs were obtained elsewhere with which to restock, as the old stock was degenerating from inbreeding.

D. F. Dunagan, H. H. Waller, and J. L. Waller took over the fox corrals of N. P. Shular at Anchor Point and will continue operations under the name of the Anchor Point Silver Fox Farm. When owned by Mr. Shular, this farm was reputed to be the most successful one in Alaska handling black and silver foxes.

O. Kraft & Son discontinued their fox-raising business on two small islands in Kalsin Bay, Kodiak Island, and removed all animals therefrom in the winter of 1918–19. The islands were much too small and were surrounded by reefs, to which the foxes would go at low water and not return before the flood tide cut them off from the island. When forced to swim, some of them left for the mainland of Kodiak and thus escaped.

Alex Friedolin continued operations on Hog Island, which he had stocked with blue foxes. No young animals were seen in 1919, and Mr. Friedolin thinks that the introduction of two strange males disturbed the other foxes and possibly caused the young to be killed. But one pelt was taken. Three pairs of breeders have been retained.

In May, 1919, Lars Hansen placed four pairs of blue foxes on Chankliut Island, near the entrance to Chignik, where he had the year before planted mice to supply food for the foxes. One litter of young was born in 1919, but as the foxes run at large he does not know how many there were.

A. F. Piper, of Seldovia, reports that he has started a skunk farm with eight animals which were shipped from the States.

Peter Petrovsky continued operations on Amook Island. Part of his foxes are kept in corrals and others run at large on the island. No young foxes were raised in the corrals in 1919. In all, 16 foxes were killed for their pelts.

Rufus D. Blakely, of Ketchikan, reported further on his fur-farming operations on Bold Island. Beavers have been established in the lake in addition to the muskrats and appear to find a plentiful supply of food. Plans for stocking the island with foxes and marten are in abeyance.

Harry D. Colp reported that he has established a fur farm on Kupreanof Island near Petersburg. He has five pairs of silver foxes in corrals, one of which raised three pups in the spring of 1919. A varied diet is given the foxes, consisting of fish, several kinds of meats, rice, dog biscuits, and green stuff. Mr. Colp states that he does not expect to market any furs for some time as he wishes to increase his stock. He considers the possibilities of the business good.

C. E. Zimmerman is using the Brothers Islands in southeast Alaska for the propagation of raccoons and skunks. These islands were similarly used about six years ago, and it is Mr. Zimmerman's belief that some of the original stock still remains. He placed additional animals on the islands in the fall of 1919.

A. C. Smith, of Haines, reports that he has five silver-gray and one cross fox. No pups were born in 1919. One pair of silvers died as the result of fighting.

Aug. Wenzel continued operations on a ranch 32 miles below Fairbanks on the Tanana River. He reports having seven pairs of silvers and three pairs of crosses. But one pup was produced and raised this year. A total of three silver, four red, and four cross pelts were sold in the spring of 1919. Mr. Wenzel says that his foxes are tame and healthy. The food given is principally fish, cooked in summer and dried in winter. The rabbits are said to be coming back, and will thus furnish needed fresh meat.

W. H. Newton, of Healy River, reported that there was no increase in 1919 from his stock of four pairs of foxes; this possibly was due to disturbance incident to clearing off timber near their quarters. Four of the animals were killed to cover expenses and two pairs were retained for stock. He feeds fish and vegetables with the addition of fat scraps.

L. G. Michael reports excellent results at his ranch near Franklin. At the beginning of 1919 he had 7 pairs of breeders, 2 silver and 5 cross males, and 4 red and 3 cross females; 17 pups were born, of which all but 1 were raised. He is retaining a stock of nine pairs of breeders. Mr. Michael writes that he feeds the young foxes plenty of canned milk, diluted 1 part milk and 2 parts water, with a little sugar added, about a tablespoonful to a quart. The adult foxes are fed fresh meat almost entirely. Although the foxes are all large animals they are confined in corrals. Mr. Michael says that the future for fox farming has never looked better.

A number of fur farmers mention the great number of gulls and other sea birds, and object to the prohibition against killing such birds for food for their animals.

LEASING OF ISLANDS.

The Department of Commerce has jurisdiction over 12 islands in central Alaska which are leasable, or have been leased to the highest bidder. These islands and their locations are as follows:

Chirikof	Southwest of Kodiak Island.
Long	Near Kodiak Island.
Marmot	East of Afognak Island.
Little Koniuji	Shumagin Group.
Simeonof	Do.
Little Naked	One of Naked Islands, Prince William Sound.
Carlson (Crafton)	Prince William Sound.
Middleton	Gulf of Alaska.
Pearl	One of Chugach Islands.
Elizabeth	Do.
Aghiyuk	One of Semidi Islands.
Chowiet	Do.

Pearl Island was leased to I. D. Nordyke in 1917, but the annual rental has not been paid since that year. The lease has therefore been forfeited and the island is again available for lease to the highest bidder.

The islands named below were under lease on December 31, 1919:

Island.	Lessee.	Annual rental.
Chirikof	Karl Armstrong Kodiak, Alaska	$200
Long	Kodiak Fox farm, Kodiak, Alaska	200
Marmot	C. W. Pajoman and N. I. Greive, Afognak, Alaska	200
Little Koniuji	Andrew Grosvold, Sand Point, Alaska	205
Middleton	Joseph Ibach, Cordova, Alaska	200

Chirikof Island, southwest of Kodiak Island.—This island was leased on July 1, 1919, to Karl Armstrong, of Kodiak. It had previously been used by the Semidi Propagating Co., but was abandoned a few years ago. Mr. Armstrong reported that on taking possession of the island there were found signs of a number of foxes and for that reason he will put no new stock on the island until after the present trapping season, when he will be able to judge what is needed for the future.

Long Island, near Kodiak.—On July 1, 1919, a lease for this island was issued to the Kodiak Fox Farm. This concern had been using the island for several years under a misapprehension that it had a valid right thereto through purchase from a former occupant, who was found upon investigation to have had no title to the island and could, therefore, convey none. This farm is probably the most completely equipped of any in Alaska. Extensive extracts from a previous report were published in "Alaska Fisheries and Fur Industries in 1915," and it is thought that the following from the recent report of the company will be of interest:

As previously reported, we had a number of blue foxes in captivity. Subsequently these were all liberated, for after two seasons of effort not a single blue pup had been born in the pens. Although we tried many experiments, our efforts were unavailing and we gave up our attempt to raise blue foxes in captivity.

Since the blue foxes have been at large, however, the increase has been highly satisfactory and the quality of the fur has improved. We attribute this to the careful selection we have made during each trapping season and to the fact that our foxes have been bountifully fed.

We still continue to feed salmon heads, as this has proved the most satisfactory for blue foxes. During the salmon season only fresh heads are fed; but at the same time we pack about 400 barrels in salt (about 80,000 pounds) to be used for winter feeding. These are thoroughly freshened for about six days in running water before being given to the foxes.

The foxes have segregated themselves in colonies about the island, and in the vicinity of each colony a feeding box has been placed. Twenty-two of these are now used where food is distributed every other day.

Breeding records, as originally planned, can not, of course, be kept for the blue foxes at large on the island, but by careful selection during the trapping season of only the desirable animals to be left as stock the quality of the fur can no doubt be greatly improved. We trap only in box traps; the foxes are carefully examined, and if desirable for breeding stock they are marked by "bobbing" the tail and again liberated. It is our aim to liberate three females to two males of the best animals trapped.

During the trapping season of 1919, 33 blue-fox skins were taken, and it was estimated that 150 animals were left.

Our efforts in raising silver-gray foxes in captivity have not been successful. While we have raised a number of these, and have several now in the pens of the third and fourth generation, the percentage of increase has been so small that we have decided it would not pay us to continue, so we will kill off the remaining stock and devote our efforts to the blues. Furthermore, the wire netting of our pens is commencing to rust after five years, and unless this is renewed in a short time there will be danger of the silver grays getting loose on the island and killing off the blues. At present prices the cost of renewing this wire would be about $6,000 and we do not feel that our experience justifies such an expenditure.

During the winter of 1918–19 we killed 9 silver-gray foxes, leaving 21 silvers and 1 cross for breeding purposes. Shortly after this 11 of the silvers died, evidently from some epidemic among them, although we have been unable to determine the cause. Consequently, this season, we have not had a single pup from the silvers.

Two years previous we had a similar experience, having lost 10 of our breeders after the killing season from apparently the same disease. But this loss was more than replaced by 17 pups born and all successfully raised to maturity.

The 10 silvers and 1 cross will be killed this coming winter. We intend, also, to take about 50 blues, leaving about 100 on the island for stock.

Marmot Island, east of Afognak.—On July 1, 1919, a lease for this island was issued to Charles W. Pajoman and N. I. Greive, of Afognak. In October they placed thereon four cross and nine silver foxes. At the time of the lease the island was supposed to be barren.

Little Koniuji, Shumagin Group.—Andrew Grosvold continues as the lessee of this island. In November, 1919, the stock was increased by the addition of 19 pairs of blue foxes. In the year ending November 15, 1919, Mr. Grosvold took 30 skins. A year later he estimated that there were 30 pairs on the island.

Middleton Island, Gulf of Alaska.—This island is under lease to Joseph Ibach, of Cordova. The number of skins taken in 1919 has not been reported, but it is understood that results were satisfactory.

FOREST SERVICE PERMITS.

Every island in Prince William Sound at all suitable for a fox farm is now being used for that purpose. All of them, except Little Naked Island and Crafton (Carlson) Island, are under the control of the Forest Service by reason of their location within the bounds of a national forest. A number of islands in southeast Alaska within the Tongass National Forest are also occupied as fox farms. An annual rental is charged and each operator is required to make a report to the Forest Service as to the character and volume of business carried on during the year. Records in the offices of the Forest Service at Cordova and Ketchikan show information in respect to the use of the several islands as follows:

ISLANDS OCCUPIED FOR FUR FARMS UNDER FOREST SERVICE PERMITS.

Date of permit.	Island.	Occupant.
Aug. 1, 1913	Lone	F. A. Shumaker, Latouche, Alaska.
Jan. 1, 1919	Eleanor	Do.
Jan. 10, 1913	Perry	Andrew Siewertsen, Latouche, Alaska.
Aug. 5, 1915	Axel Lind	John Stainer, Ellamar, Alaska.
Applied for	Glacier	Otto Hermsdorf, Latouche, Alaska.
Aug. 3, 1919	Bettles	H. D. Bush, Granite, Alaska.
Aug. 11, 1919	Observation	Robert E. Towsley, Seattle, Wash.
June 16, 1919	Seal	John Agamalian, Latouche, Alaska.
Jan. 1, 1918	Fairmount	Beyer & Davis, Cordova, Alaska.
Jan. 1, 1919	Bligh and Busby	Cloudman estate, Tom Cloudman, Valdez, Alaska.
Mar. 20, 1916	Smith	G. W. Fleming, Latouche, Alaska.
Mar. 13, 1919	Flemming	Gordon & Harris, Cordova, Alaska.
Jan. 1, 1914	Green	T. A. Haxby, Latouche, Alaska.[a]
June 14, 1919	Kanak	Joseph L. Hill, Katalla, Alaska.
July 20, 1916	Bald Head Chris	J. D. Jefferson, Valdez, Alaska.
Dec. 26, 1916	Dutch Group	Do.
May 24, 1919	Elrington	Kulper & Baker, Latouche, Alaska.
Apr. 21, 1917	Goose	Arthur Laviosa, Ellamar, Alaska.
Jan. 1, 1912	Naked and Peak	J. A. McPherson, Ellamar, Alaska.
Oct. 9, 1917	Olson and 3 unnamed	Ross & Hoyt, Valdez, Alaska.
Oct. 23, 1919	Entrance	R. M. Allen, Petersburg, Alaska.
Oct. 14, 1919	Walter	Andy Anderson, Petersburg, Alaska.
July 1, 1919	Hound	Blue Bell Ranch.
May 31, 1916	Bold	Bold Island Fur Farm Co., Ketchikan, Alaska.
Nov. 21, 1917	Strait	Cleary Bros., Petersburg, Alaska.
Dec. 15, 1919	Benjamin	H. S. Graves.
Jan. 25, 1917	Sukoi	Hercules Fox Co., Petersburg, Alaska.
Sept. 9, 1919	Hoonah	Hoonah Fox Co., Hoonah, Alaska.
Aug. 28, 1919	Hill	L. B. McCoy, Chichagof, Alaska.
Dec. 11, 1919	Keku	V. A. Paine, Juneau, Alaska.
Nov. 26, 1917	Onslow	L. A. Stockley, 527 39th Ave., San Francisco, Calif.
Nov. 17, 1919	Liesnoi	Eric Todal, Petersburg, Alaska.
June 1, 1919	Sokolof	Wikan Bros. & Co.
June 29, 1914	Sumdum	James York, c/o E. Valentine, Juneau, Alaska.
Sept. 13, 1918	Brothers	C. E. Zimmerman, Petersburg, Alaska.

[a] Four Japanese have subleased this island from Dr. Haxby.

At the present time a number of fur farmers are occupying islands which are outside of the forest reserves, and serious complaint is made in regard to the difficulty of securing any valid claim on the land which they are using for their operations. Apparently the only way to secure protection through the General Land Office from trespassers is to homestead the land. Some provision for leasing these islands, or granting certain rights to bona fide occupants who are doing valuable development work, would seem to be desirable to assure the future of the business. Many islands along the coast of Alaska are suitable for fox farms. Those outside of forest reserves are open to occupancy in like manner as any other public land.

SHIPMENTS OF FURS FROM ALASKA.

As in previous seasons, shipments of furs from Alaska were reported on special blanks prepared by the Bureau. Supplies of blanks were furnished to all postmasters in Alaska and to commercial companies, express companies, and all persons known to be shippers of furs. Postmasters indorsed the reports of mail shipments after they were properly filled out and forwarded them to the Bureau.

Reported shipments in 1919 confirm the general belief that the fur-bearing animals in Alaska are decreasing in numbers. In spite of the continued high prices of furs, there was an increased catch of only a few species, the chief of which were ermine, mink, and muskrat. The most notable declines were in the catch of foxes and lynx. As in previous reports, the fur year is reckoned from November 16 of one year to November 15 of the following year.

The following table shows the detailed statistics as compiled from information furnished the Bureau in regard to furs shipped from Alaska in 1917, 1918, and 1919:

FURS SHIPPED FROM ALASKA IN 1917, 1918, AND 1919.

Species.	Year ended Nov. 15, 1917.			Year ended Nov. 15, 1918.			Year ended Nov. 15, 1919.		
	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.	Number of pelts.	Average value.	Total value.
Bear:									
Black	1,061	$14.00	$14,854.00	1,164	$15.00	$17,460.00	1,388	$16.00	$22,208.00
Brown	62	12.00	744.00	35	12.00	420.00	44	12.00	528.00
Glacier	8	20.00	160.00	35	30.00	1,050.00	20	30.00	600.00
Grizzly	13	17.00	221.00	42	20.00	840.00	76	20.00	1,520.00
Polar	[a] 144	40.00	5,760.00	......	......	......	......	......	......
Beaver	[b] 118	10.00	1,180.00	[c] 109	21.00	2,289.00	[c] 796	17.76	14,139.96
Ermine	4,639	.90	4,175.10	9,133	1.50	13,699.50	18,617	1.90	35,372.30
Fox:									
Black	10	160.00	1,600.00	6	150.00	900.00	13	150.00	1,950.00
Blue	887	58.00	51,446.00	740	85.00	62,900.00	566	130.00	73,580.00
Blue, Pribilof Islands	567	61.11	34,653.50	692	82.51	57,099.50	667	195.31	130,274.50
Cross	2,669	35.00	93,415.00	1,704	50.00	85,200.00	1,280	70.00	89,600.00
Red	10,485	24.00	251,640.00	12,232	28.00	342,496.00	7,723	35.00	270,305.00
Silver gray	443	120.00	53,160.00	440	140.00	61,600.00	315	170.00	53,550.00
White	3,682	28.00	103,096.00	4,531	40.00	181,240.00	4,575	46.00	210,450.00
White, Pribilof Islands	39	26.33	1,027.00	19	56.84	1,080.00	30	55.33	1,660.00
Hare, arctic	89	.40	35.60	38	.10	3.80	135	.20	27.00
Lynx	21,210	14.00	296,940.00	7,692	26.00	199,992.00	1,085	42.00	45,570.00
Marten	[d] 1,210	14.00	16,940.00	[d] 1,023	19.00	19,437.00	[e] 1,107	32.00	35,424.00
Mink	18,832	4.00	75,328.00	24,572	6.50	159,718.00	28,040	9.00	252,360.00
Muskrat	72,264	.45	32,518.80	86,624	1.20	103,948.80	113,652	1.90	215,938.80
Otter:									
Land	1,308	15.00	19,620.00	1,647	22.00	36,234.00	1,709	25.00	42,725.00
Sea	[f] 2	344.85	689.70	[g] 1	150.00	150.00	[g] 1	300.00	300.00
Seal, fur, Pribilof Islands [h]	9,140	30.00	274,200.00	30,819	30.00	924,570.00	30,198	50.00	1,509,900.00
Seal, fur	[i] 5	30.00	150.00	[j] 9	30.00	270.00	......	......	......
Squirrel	117	.05	5.85	153	.02	3.06	2,120	.03	63.60
Wolf	195	8.00	1,560.00	207	18.00	3,726.00	284	19.00	5,396.00
Wolverine	435	8.00	3,480.00	846	14.00	11,844.00	516	15.00	7,740.00
Total	......	......	1,338,599.55	......	......	2,288,170.66	......	......	3,021,182.16

[a] The killing of polar bears in Alaska is unlawful.
[b] A considerable number were seized skins. It is unlawful to kill beavers in Alaska.
[c] Seized skins. It is unlawful to kill beavers in Alaska.
[d] Checked against affidavits permitting shipments. It is unlawful to kill martens in Alaska.
[e] Includes 93 seized skins. It is unlawful to kill martens in Alaska.
[f] Unlawfully killed by natives.
[g] Found dead.
[h] Figures are for shipments during calendar year rather than killings.
[i] Taken by natives.
[j] Seized skins.

FUR-SEAL INDUSTRY.

PRIBILOF ISLANDS.

GENERAL ADMINISTRATIVE WORK.

Commercial sealing operations were continued in 1919 on a scale commensurate with the size of the seal herd and the facilities available. The policy, inaugurated this year, of improving the seal herd and at the same time adding to the Government's revenue by killing considerable numbers of the surplus large males taxed the working force to the utmost. Careful attention was given to the herds of blue foxes, and the value of the pelts secured is ample evidence that appropriate methods are being pursued. The welfare of the natives was given conscientious attention, and it is felt that they are now living under much better conditions as a whole than ever before. The by-products plant was operated for a limited period with results which warrant operations on a larger scale in 1920.

Aside from the major features of the Bureau's work on the Pribilofs, numerous other matters in connection therewith received attention. Among these may be mentioned the annual seal census, maintenance and upkeep of Government property, and a special investigation devoted to improving sealing methods, particularly the curing of pelts. Details are set forth in the following pages.

PERSONNEL.

A list of the Bureau's statutory employees for the Pribilofs is given in the introduction to this report. Details in regard to their activities are, for purposes of record, stated below. The work of a number of temporary employees is also recorded.

Agent and Caretaker H. C. Fassett tendered his resignation early in the year and left St. Paul Island on the *Saturn* May 21. Agent and Caretaker A. H. Proctor proceeded from St. George Island to St. Paul Island on the *Saturn* May 6 to assume charge of the Bureau's work at St. Paul. Storekeeper H. D. Aller was on St. George Island until July 11, when he went aboard the Coast Guard cutter *Unalga* for St. Paul Island. He arrived there July 12, and left for Seattle on the Coast Guard cutter *Bear* October 20. From May 6 until July 10 he was in charge of the Bureau's work on St. George. School-teacher C. E. Crompton then assumed charge and was appointed agent and caretaker, effective August 16.

Storekeeper Dr. G. Dallas Hanna arrived at the Pribilofs on the *Saturn* May 5 and left on the *Nanshan* October 13. While on the islands he had charge of the seal census work. Dr. Charles E. Johnson was in charge of the medical work on St. George Island until relieved by his successor, Dr. W. M. Murphy, who arrived on the *Nanshan* in September. Later Dr. Johnson proceeded to St. Paul Island on the *Nanshan*, for temporary duty, where he remained until after the arrival of Dr. J. J. Richstein. Dr. Johnson left St. Paul Island for

Unalaska on the *Eider* November 25. Subsequently he proceeded to Seattle on a commercial steamer. Dr. J. J. Richstein left Seattle October 26 on the *Eider* and arrived at St. Paul Island November 23. Dr. H. H. Stromberger was on St. Paul until October 13, when, having tendered his resignation, he took passage on the *Nanshan* for Seattle. Mrs. Agnes K. Stromberger, who had been employed as a nurse at St. Paul, left at the same time. Dr. Frank H. Gunn arrived at St. Paul Island on the *Nanshan* in September and left the following month on the *Nanshan*. Mrs. Cora Giles Haley, school-teacher, tendered her resignation and left St. Paul Island on the *Nanshan* in October. Mrs. Lois Lippet Proctor was employed as teacher in the junior school on St. George Island for a number of months in the first part of the year and, effective October 1, was appointed school-teacher for St. Paul Island in place of Mrs. Haley. Edward C. Johnston, who had held a number of positions in the Bureau, including that of naturalist on the *Albatross*, prior to military service, was appointed school-teacher, effective August 16, and arrived at St. George Island on the *Nanshan* September 6 to take up his work. Mrs. Ella J. Johnston was appointed special school-teacher for St. George Island, effective September 15.

Mr. Wm. P. Zschorna, employed temporarily for certain technical investigations, arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October. Mr. A. Christoffersen, by-products expert, also arrived at the Pribilofs on the *Saturn* in May and left on the *Nanshan* in October.

PURCHASE AND TRANSPORTATION OF SUPPLIES.

The regular supplies for the support of the natives and for the general operation of the Bureau's business at the Pribilofs were purchased through competitive bids, chiefly at Seattle, Wash. Following the practice of previous years, schedules covering the greater part of these supplies were printed and distributed in the spring to prospective bidders.

About 100 tons of salt and 15 tons of general supplies were forwarded from San Francisco April 16 on the U. S. S. *Saturn*, Naval radio vessel, which arrived at the Pribilofs (St. George Island) May 5. The bulk of the season's shipment was subsequently assembled at Seattle and forwarded on the U. S. S. *Nanshan*, a supply vessel made available by courtesy of the Navy Department. The *Nanshan* sailed from Seattle August 22 and arrived at the Pribilofs (St. George Island) September 6, 1920. The supplies forwarded consisted of approximately 1,300 tons of general freight and 45,000 feet of lumber for St. Paul and about 400 tons of general cargo and 15,000 feet of lumber for St. George.

About 300 tons of supplies and 26,000 feet of lumber, which could not be taken by the *Nanshan* from Seattle, were forwarded August 28, to Unalaska on the Pacific American Fisheries steamer *Catherine D*. The supplies delivered by the *Catherine D* were then transported to the Pribilofs by the *Nanshan*, which made a trip from the islands to Unalaska for the purpose. The *Nanshan* was unable to make delivery of about 155 tons of the coal aboard for St. Paul Island, and it was accordingly left at Unalaska for subsequent delivery by the Bureau's vessel *Eider*.

FIG. 1.—FISHERIES VESSEL "EIDER," TENDER FOR PRIBILOF ISLANDS.

FIG. 2.—TRACTOR HAULING SEALSKINS FROM KILLING FIELD TO SALT HOUSE, ST. PAUL ISLAND.

Emergency supplies of coal and salt were purchased at Unalaska and delivered at the Pribilofs by the Coast Guard cutter *Unalga* in July.

The *Eider* made a trip from Unalaska to the Pribilofs in November. Cargo consisted of about 28 tons of the coal left by the *Nanshan* and approximately 20 tons of general supplies, part of which had been purchased by natives and some by employees at the St. Paul radio station.

USE OF TRACTORS.

For use in hauling seal carcasses to the by-products plant and sealskins to the salt houses, as well as for uses in connection with the upkeep and improvement of the St. Paul Island station, four Gray tractors were sent to the island on the *Nanshan*, arriving in September. These tractors will supplement the use of mules and autotrucks. Eight trailers were purchased and shipped with the tractors.

The tractors were secured from the War Department from unused stock originally intended for military use overseas. After the transportation problem at St. Paul Island, especially in respect to the lack of roads and sandy character of the surface had been given due consideration, the War Department recommended the Gray tractor as the most suitable. This is a wide-drive drum type. Instead of the customary two wide rear driving wheels, there is a single drum or wheel the full width of the road. Some use of the tractors in the fall indicates that they will prove a helpful addition to the equipment at St. Paul Island. Operations on St. George Island are much more concentrated near the village, hence there is less use for tractors than on St. Paul.

STEAMER "ROOSEVELT."

The steamer *Roosevelt*, which had been used in 1917 and 1918 for transporting the major portion of the supplies required by the Bureau at the Pribilofs and for bringing back sealskins and other products, was found to be in need of extensive repairs. The vessel was placed in dry dock at the Puget Sound Navy Yard April 21, 1919, where it was estimated that the cost of repairs and improvements would be approximately $186,000. A decision was reached that the vessel did not warrant such a large expenditure, and steps were taken to dispose of it through sale. The *Roosevelt* was accordingly advertised for sale, and on July 15 was disposed of at public auction to Capt. M. E. Tallakson for $28,000. Final payment was made and the sale approved July 30.

SCHOONER "EIDER."

As stated in the corresponding report for 1918 plans were under way for acquiring by construction or through purchase a suitable vessel of convenient size for local use at the Pribilofs. Early in 1919 it was realized that the appropriation of $20,000 available was not adequate, and that it would be necessary to secure a supplemental appropriation from Congress. An additional appropriation of $7,500 was obtained in a deficiency act approved July 11, 1919. Thus a total of $27,500 became available.

Failing to secure satisfactory bids for the construction of a vessel, the Bureau finally purchased the power schooner *Idaho* from Lee & Brinton, of Seattle, for $26,500. The vessel was renamed *Eider*. Its registered dimensions are: Length over all, 88 feet; beam, 19.4 feet; depth, 9.2 feet; draft loaded, 9 feet. The registered tonnage is 76 gross and 52 net. The vessel is equipped with a 3-cylinder 110-horsepower Frisco Standard engine, together with appropriate auxiliary machinery. The *Eider* was built in 1913, and had been employed in the offshore halibut fishery. Certain alterations were made to the vessel, which provided two additional staterooms and a room for wireless equipment. The cost of these alterations were included in the purchase price. The vessel was equipped through the Navy Deparment with a one-half kilowatt wireless outfit and a 1-pound gun.

The *Eider* sailed from Seattle October 26 for Unalaska, arriving there November 17. Stops were made en route at Kodiak and King Cove. At Unalaska there were taken aboard about 28 tons of coal for St. Paul Island and about 20 tons of supplies for the radio station and natives at St. Paul. The vessel arrived at St. Paul November 23, and after discharging cargo left the 25th. It was necessary to keep aboard about 10 tons of coal for ballast. A stop was made at St. George, landing mail at Zapadni, and leaving for Unalaska November 26. Unalaska was reached the following day. Dr. Charles E. Johnson was a passenger from St. Paul to Unalaska.

SHIPMENT AND SALE OF OLD BONES.

One shipment of old bone was made from the Pribilofs in 1919. The material was transported from the islands by the U. S. S. *Saturn*, and was landed at San Francisco in June. The gross weight of the shipment, including sacks, was 106,131 pounds. In determining net weight a deduction of 5 pounds per sack for each of the 1,766 involved was made, and from the resulting remainder a deduction of 25 per cent was made for moisture. The net weight was 72,973 pounds, and on this basis the material was sold to the Pacific Bone, Coal & Fertilizer Co. at $31 per ton. From the proceeds, $1,131.08, there were deducted $25.71 for expenses connected with the sale and $527.55 for making payments to the natives for collecting the bone. The balance, $577.82, was turned into the United States Treasury.

The shipment, by gross weight, originated as follows: St. Paul Island, 9,052 pounds unground bone; St. George Island, 56,584 pounds unground, 40,495 pounds ground.

The following statements present in tabular form the results of bone-collecting operations on the Pribilofs in the calendar years 1916 to 1918, inclusive. In addition to that shipped, there were perhaps 50 tons of bone practically ready for shipment at the Pribilofs at the end of 1919.

EXPENDITURES AND RECEIPTS ACCOUNT COLLECTION AND SALE OF OLD BONES, PRIBILOF ISLANDS, CALENDAR YEARS 1916 TO 1919, INCLUSIVE.

Approximate date of arrival at Seattle.	Net weight in pounds.	Expense of sale.	Receipts, less expense of sale.	Payments to natives.	Amount covered into United States Treasury.
August, 1917	32,170	....	$321.70	$179.68	$142.02
January, 1918	161,400	$333.18	2,087.82	807.00	1,280.82
July, 1918	80,092	70.75	1,090.58	492.21	598.37
September, 1918	97,408	59.10	1,353.31	487.04	866.27
January, 1919	28,111	65.83	341.77	140.50	201.27
June, 1919	72,973	25.71	1,105.37	527.55	577.82
Total	472,154	554.57	6,300.55	2,633.98	3,666.57

BY-PRODUCTS PLANT.

It was planned to operate the by-products plant, erected on St. Paul Island in 1918 for the reduction of seal carcasses into fertilizer and oil, to its full capacity in the season of 1919. Owing to a number of unforeseen difficulties, however, principally an unavoidable shortage of coal, it was possible to carry on operations for brief periods only. The output, including small quantities prepared in an experimental way in 1918, was transported to Seattle on the U. S. S. *Nanshan* in the fall. It consisted of 3,000 gallons of oil and 20,568 pounds of fertilizer, known to the trade as "meal." The oil and fertilizer were sold separately, to the highest bidder in each case. Four hundred and fifty gallons No. 1A clear and 450 gallons No. 2A clear were sold at $1.50 per gallon, 850 gallons No. 2B crude and 250 gallons No. 3 crude at $1.20, 700 gallons No. 1B crude at $1, and 300 gallons foots at 90 cents. The total amount received for the 3,000 gallons was $3,640. The 20,568 pounds of fertilizer "meal," sold at $75 per ton, the amount received being $771.30.

A. Christoffersen, a by-products expert, was employed as special assistant for several months in connection with the work of the plant.

STUDY OF SEALING METHODS.

In order that the quality of the sealskins placed on the market by the Government might be improved if possible, the Bureau carried on in 1919 a special investigation. William P. Zschorna was specially employed a number of months for the work. He first made a study of the methods of handling sealskins at St. Louis through the various processes involved in their dressing, dyeing, and machining. Skins which had developed defects in the various processes were also noted. The work at St. Louis was then supplemented by field work at the Pribilofs. Attention was given to the methods employed in driving and killing seals and in the curing of the skins. Quite elaborate experiments were carried on as to the matter of curing skins, and the particular skins involved were later carefully followed in the course of regular processing at St. Louis.

The investigation resulted in a number of recommendations, four of which were deemed of sufficient practicability to warrant further study and some actual modification of previous methods for the season of 1920. They were: First, to make drives whenever possible the evening before the killing; second, to expend a greater amount of work in handling seals immediately before killing in order to keep them cool; third, to cool and clean skins before salting by immersing them in salt water for a number of hours; and fourth, to employ more elaborate methods in the salting and curing of skins. The work will be continued in 1920. The proposed plan of washing and cooling skins before salting will be tried out in an exhaustive way.

The investigation in 1919 also gave attention to the question of how much blubber should be left on sealskins of various sizes. As a result of the experiments of last season, it seems that skins do not cure as thoroughly in places where the blubber is unusually thick. The logical remedy appears to lie in removing part or much of the blubber. It is possible that it may not be feasible to fully remove the blubber on account of the danger of flaying or cutting the skins, especially in the case of the smaller ones. There is naturally less danger from this source in removing blubber from the heavy large pelts as the hide is much thicker. Instructions will be issued that 1,000 skins be blubbered at the islands in 1920 in order to work out the best practice along this line. After results have been observed at the dressing and dyeing plant, it will be possible to determine the most advantageous course of action.

NATIVES OF PRIBILOF ISLANDS.

HEALTH CONDITIONS.

The health of the natives on both St. Paul and St. George Islands throughout the year 1919 was generally fair. The native community on St. George Island numbers about 120 people. For the full census year from April 1, 1919, to March 31, 1920, not one death occurred. When the circumstances and conditions are taken into consideration this is a noteworthy fact.

Undoubtedly more suitable supplies of food and clothing are telling in their effect upon the general health of the natives of the Pribilofs. Much remains, however, to be done. A great deal depends upon the attitude and interest taken in the natives by the employees of the Bureau stationed on the islands, but present efforts are hampered and the best results will never be attained until better housing conditions are provided on both islands, as well as facilities for obtaining suitable supplies of water for domestic purposes. To rebuild the natives' houses and install a water-supply system will require an expenditure of funds which can not be allotted from the current appropriations for the Alaska service, and specific action, therefore, is necessary by Congress in the matter. Such action can not be taken too soon, for every year the work is postponed means so much added loss. The efficiency with which the Department's work at the islands is performed depends to a degree, which is not likely to be overestimated, upon the maintenance of a community of strong, healthy laborers.

The people on the Pribilof Islands were exceptionally fortunate in 1919 in that they were not subjected to the ravages of the influenza which worked such havoc among other native communities in the Bering Sea region. At Unalaska, the port through which practically all travel between the Pribilof Islands and the rest of the world passes, there were upwards of 40 deaths due to influenza, most if not all the victims being natives. When the conditions at Unalaska became known at the Pribilofs, steps were immediately taken by the physician at St. Paul, through the agent in charge, to prevent the arrival of any vessel at the Pribilofs coming from Unalaska. The necessary action was taken, and while it resulted in depriving the Bureau of some assistance in sealing operations, the islands were in all probability spared from a very serious epidemic. The results secured by the Bureau's physicians during the year were very satisfactory in all matters requiring their attention.

A not unexpected epidemic of colds and allied disorders occurred shortly after the arrival of the first vessel at the islands in the spring of 1919. This was repeated again, on St. Paul Island at least, upon the arrival of the *Nanshan* later in the season.

SCHOOLS.

Statutory provision is made for three school teachers for the Bureau's work at the Pribilof Islands. Since the native population is considerably larger on St. Paul Island than on St. George Island, it has been the custom for the Bureau to detail two of the teachers to the former island and one to the latter. To do justice to educational matters on St. George Island, two teachers are necessary, and to help out until other provision is made a temporary assistant is employed from time to time at a nominal salary to teach a number of the smaller children and to give instruction in household duties to some of the larger ones. An additional teacher to give full time to the work is urgently needed on St. George.

The Bureau is fortunate in being able to have the services of persons who are genuinely interested in their work, and in the last few years the results secured have been highly satisfactory. The Bureau has made special effort to provide suitable materials for carrying on the school work. The scope of this work includes not only instruction along the usual formal lines but in practical matters as well.

St. Paul Island.—For various reasons the school year 1918–19 was shorter than usual. The number of days in which formal instruction was given was 116, and the total number of pupils enrolled was 59. Percentage of punctuality was 97 and attendance 98.

Much attention was devoted to the teaching of English. The tenacity with which the natives of the Pribilofs cling to the use of the Aleut tongue is remarkable. The teachers on St. Paul, when taking up their work in the latter part of 1918, after having been absent on leave during the summer, noted how much the children had lost in their ability to use English in the preceding vacation. Since Aleut is not written on St. Paul Island, anything which tends to encourage composition upon the part of the children tends to stimulate the use of English.

The teachers state that the school library was well patronized by the pupils and that several of the young women of the village are regular applicants for books.

By way of indicating some other lines of instruction afforded by the St. Paul school, the following extracts are taken from the report for the year 1918–19 by Mr. and Mrs. Haley:

> Sewing has been kept up all the year. The sewing classes are always popular. This year there have been three classes: The senior girls, the junior girls, and a class of boys. The materials furnished directly by the Bureau have been greatly enjoyed. Each of the senior girls has made by hand a pair of bloomers and a hemstitched towel. The class of boys (the oldest boys of the junior school) has learned to use thimbles, to sew "over and over," and to hem. This class was started at the request of the boys themselves. The junior girls did all their work with one kind of stitch. The sewing lessons have alternated with darning lessons, but darning does not appeal to the girls as sewing does. The knitting class did not begin until after Russian Christmas. It was taught this year, as last year, by a native woman.
>
> The young women of the island were given an opportunity to come to the junior school building once a week after school hours for a reading class. They chose American history stories for the class work. The severity of the weather during the winter made this gathering rather irregular.

St. George Island.—The 1918–19 school year on St. George Island began October 7, 1918, and ended April 1, 1919. The initial enrollment consisted of 32 pupils—17 girls and 15 boys. Due to the departure of one boy from the island and the death of another, the enrollment was subsequently reduced to 30. The number of days in which the school was in session was 92½. On this island also the school year 1918–19 was unavoidably shorter than is desirable. The percentage of punctuality was 99.96; attendance, 97.6.

No important changes were made in the method of instruction followed the preceding year. Special methods devised by the teacher on St. George were instrumental in securing and holding the interest of the children. Special emphasis was given to encouraging the use of English.

The importance of cleanliness, fresh air, and exercise was made a matter of instruction. The book, Gulick's Good Health, was taken up in the reading work of the most advanced class. A very good brief history of the Pribilof Islands, going back to the early discoveries of the Russians in Alaska, was prepared by Mr. Crompton and was taken up as a regular subject in the school.

Books in the school library were in good demand, an average of 10 volumes being exchanged daily. The services of a native boy who returned from the Salem Indian Training School, Chemawa, Oreg., in 1917, were utilized to assist with the school work. While the help of a native is essential under the circumstances, such assistance can not possibly be considered as satisfying the requirement for an additional teacher for St. George.

A temporary assistant was employed to aid in school work on St. George. The services of this assistant were devoted to instructing a number of the smaller children who had not yet entered the regular school, and also to teaching sewing and giving instruction in other matters pertaining to domestic economy.

ATTENDANCE AT SALEM INDIAN TRAINING SCHOOL, CHEMAWA, OREG.

The Salem Indian Training School maintained by the Government at Chemawa, Oreg., affords an opportunity for the young people of the Pribilofs to receive training in addition to that which they obtain at the local schools maintained on the islands by the Bureau.

In 1919, one boy, Laurence Merculief, from St. George Island, entered the training school, and four St. Paul boys, John Emanoff, Alfey Melovidov, Daniel Shabalin, and Peter T. Kochergin, returned home. Agrifina Fratis and Martha Fratis, of St. Paul Island, left the school June 15, 1919, but did not return to St. Paul. In the spring of 1920 they were at Marshfield, Oreg.

PRIBILOF ISLANDS NATIVES AT SALEM INDIAN TRAINING SCHOOL, DEC. 31, 1919.

Fratis, Akalina [a]	Resident of St. Paul Island.
Fratis, Ouliana	Do.
Stepetin, Nicolai	Do.
Stepetin, Vasilii	Do.
Lekanof, George	Resident of St. George Island.
Merculief, Laurence	Do.

SAVINGS ACCOUNTS.

Certain of the Pribilof Islands natives have personal funds in the custody of the U. S. Commissioner of Fisheries as trustee. These

[a] Mother of Ouliana Fratis and employed at the school.

funds are still on deposit with the Washington Loan & Trust Co., Washington, D. C., and draw interest at 3 per cent per annum, calculated on monthly balances. During the year 1919 three new accounts were opened by natives of St. Paul Island.

On January 1, 1919, the balance was $3,174.65. Interest credited July 1, 1919, amounted to $47.61, and on December 31, 1919, $46.54, making a total of $94.15 for the entire year. Funds in the sum of $38.70 were deposited during the year. Withdrawals amounted to $213.93. The balance on December 31, 1919, of $3,093.57 is in accordance with the itemized statement which follows:

PRIBILOF ISLANDS NATIVES' SAVINGS ACCOUNTS IN CUSTODY OF U. S. COMMISSIONER OF FISHERIES, AS TRUSTEE, DEC. 31, 1919.

ST. PAUL ISLAND.	
Bourdukofsky, Apollon	$87.78
Bourdukofsky, Peter	58.91
Diakanof, Auxenia (Mrs. C. H. Hope)	24.98
Emanoff, Alexey [a]	286.94
Fratis, Agrifina [b]	90.17
Fratis, Akalina [b]	531.68
Fratis, Martha [b]	90.17
Fratis, Ouliana [b]	90.17
Gromoff, Iuliania	388.24
Hanson, John	4.78
Kozloff, Parascovia	85.40
Krukoff, Iuleta	8.64
Mandregan, Alexandra M	9.93
Melovidov, Alfey	41.87
Melovidov, Anton	3.60
Melovidov, Iosef	41.87
Merculieff, Dosofey	37.53
Merculieff, Makary	37.53
Merculieff, Mariamna	37.53
Merculieff, Paul	14.70
Merculieff, Terenty [a]	$37.53
Oustigoff, Peter	23.72
Pankoff, Agrippina	228.78
Pankoff, Maria M	41.87
Sedick, Feofania [c]	13.09
Sedick, Laventy [c]	13.09
Sedick, Leonty [c]	13.09
Sedick, Marina	.38
Tetoff, Vikenty M	41.86
ST. GEORGE ISLAND.	
Galanin, Mary	236.68
Lestenkof, Michael	114.64
Merculief, Agrifina	62.65
Merculief, Joseph	23.57
Merculief, Polyxenia	11.92
Philemonof, Mary [a]	115.14
Philemonof, Zoya [d]	113.91
Shane, Michael	28.78
Zacharof, Emanuel	.45
Total	3,093.57

LIBERTY BONDS.

The 43 Liberty bonds of the fourth issue, amounting to $2,150, were forwarded on July 22, 1919, to the St. George natives who subscribed to them, with the exception of one $50 bond which was disposed of by the owner at par value.

The 44 Liberty bonds of the third issue, amounting to $2,200, were forwarded, on July 22, 1919, and March 30, 1920, to the respective natives of St. George and St. Paul Islands, who subscribed to them, with the exception of one $50 bond which was disposed of by the owner at par value.

From time of purchase the Commissioner of Fisheries had held these bonds in a safe-deposit box at the Washington Loan & Trust Co., Washington, D. C. In view of the fact that all bonds have been forwarded to their owners, the box is no longer retained by the Bureau.

[a] Deceased, estate undivided.
[b] Not living on islands in 1919.
[c] New accounts opened in 1919.
[d] Married to Michael Borenien in 1918. Now deceased.

PAYMENTS FOR TAKING SEALSKINS.

In 1919 the general plan followed the previous year for making payments for the taking of sealskins at the Pribilofs was continued. By the terms of the contract with Funsten Bros. & Co., that firm provides funds for paying persons engaged in killing and skinning seals and salting and handling sealskins, or otherwise employed in connection therewith, and secures reimbursement from the proceeds of sales of skins. Payments in 1919 covered the salary of one general assistant, wages of two cooks and of a number of Aleutian Islands natives temporarily at the Pribilofs, and payments to Pribilof natives in accordance with numbers and sizes of seals killed. It was arranged that A. H. Proctor, the Bureau's agent at St. Paul Island, should make the necessary disbursements for both St. Paul and St. George Islands. He was bonded in the amount of $15,000 by the United States Fidelity & Guaranty Co.

In July, 1919, the sum of $21,000 was deposited by Funsten Bros. & Co. in the Seaboard National Bank, Seattle, Wash., to Mr. Proctor's credit. An additional deposit of $2,850 was made by Funsten Bros. & Co., on January 22, 1920, to provide for payment of liabilities until the beginning of active work in 1920, a total deposit of $23,850. Through December 31, 1919, expenses incurred amounted to $22,318, leaving a balance of $1,532 to apply on 1920 operations.

The items of expenditure for the calendar year 1919 paid from funds advanced by Funsten Bros. & Co. were as follows:

Salary of general assistant, April to December	$1,350.00
Wages of 2 cooks	750.00
Wages of Aleutian Islands natives at St. Paul	4,055.00
Amount earned by St. Paul Island natives	14,093.00
Amount earned by St. George Island natives	2,070.00
Total	22,318.00

The natives of the Pribilofs were paid 50 cents each for skins taken from seals up to and including those of the 6-year-old class and $1 per skin for those taken from seals of the 7-year-old class and upward, except that after August 10 payment for skins of the 6-year-old class was increased to $1 per skin. No payments were made for skins of seals under the 6-year-old class killed for food purposes after August 10.

In determining the respective amounts due individually for sealing operations, the Pribilof natives were divided into classes according to their ability. Inasmuch as the taking of skins is necessarily cooperative work, each person can not individually take a definite number of skins.

St. Paul Island.—In the calendar year 1919 there were taken on St. Paul Island 24,053 skins. For these, after deducting skins from seals killed for food, payments were made on the basis of 50 cents each for 18,342 skins and $1 each for 4,822 skins. The division was as follows:

Disbursements to St. Paul Natives for Sealing Operations, Calendar Year 1919.

Classification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	24	$367.50	$8,820.00	Second boys' class	4	$5.00	$20.00
Second class	11	294.00	3,234.00	Undivided credit [a]			645.00
Third class	3	239.00	717.00	Additional compensation [b]			100.00
Fourth class	2	183.50	367.00				
Fifth class	2	50.00	100.00				
Boys' class	9	10.00	90.00	Total	55		14,093.00

[a] For 645 seals 6 years and over taken Nov. 8 to Dec. 31. Fund later divided as follows: 22 first-class men, $18 each; 11 second class, $16 each; 3 third class, $13 each; 1 fourth class, $10; and 4 fifth class, $6 each.
[b] Allowed 2 native foremen.

St. George Island.—The number of skins taken on St. George Island in the calendar year 1919 was 3,768. No skins were taken on this island after August 10 except from seals killed for food purposes, and no payments were made for taking such skins. Of the 3,768 skins taken, payment for 2,768 was on the basis of 50 cents each and for 586 on the basis of $1 each. The natives participating in the operations were divided into six classes according to their ability and the amount of work performed. The division was made as follows:

Disbursements to St. George Natives for Sealing Operations, Calendar Year 1919.

Clasification.	Number of men.	Share of each.	Total.	Classification.	Number of men.	Share of each.	Total.
First class	15	$78.50	$1,177.50	Boys' class	1	$29.50	$29.50
Second class	6	63.00	378.00	Additional compensation [a]			100.00
Third class	2	52.00	104.00				
Fourth class	5	44.00	220.00				
Fifth class	2	30.50	61.00	Total	31		2,070.00

[a] Allowed 2 native foremen.

PAYMENTS FOR TAKING FOX SKINS.

As in previous seasons, the natives of the Pribilofs were paid $5 for each fox skin taken in the season of 1918–19. The 144 skins taken on St. Paul Island yielded the natives of that island an aggregate of $720, which was divided among 38 persons in amounts varying in accordance with their respective earnings. The aggregate of $2,765 due the St. George natives for the 553 skins taken was divided among 29 persons in accordance with their respective earnings. The payments were made from the proceeds of the sale of the skins

CENSUS.

As in previous years, formal record was made as of March 31 of certain important facts regarding the native inhabitants of the Pribilofs. On March 31, 1919, the number of native inhabitants on St. Paul Island was 188 and on St. George Island 122, a total of 310. The corresponding figures for March 31, 1918, were: St. Paul Island, 199; St. George Island, 123, a total of 322. These figures show a total decrease of 12 in the year ended March 31, 1919. When the natives away from the islands, prospectively only temporarily, were taken into consideration, the total number on March 31, 1918, was

335 and on March 31, 1919, 329. On the basis of these last figures there was a decrease of 6 in the year ended March 31, 1919.

RECAPITULATION OF CENSUS OF NATIVES, MAR. 31, 1919.

St. Paul Island:	
Resident population Mar. 31, 1918	199
Births in year ended Mar. 31, 1919	11
	210
Arrival in year (from Atka Island)	1
	211
Deaths in year	10
	201
Departures in year, permanent—	
To St. George Island	3
To Unalaska	3
	6
	195
Departures in year, temporary—To Unalaska	7
Total native resident population, Mar. 31, 1919	188
Natives at Salem Indian Training School, Chemawa, Oreg	10
Others temporarily residing elsewhere	8
Total natives accredited	206
St. George Island:	
Resident population Mar. 31, 1918	123
Births in year ended Mar. 31, 1919	4
	127
Arrivals in year (from St. Paul Island)	3
	130
Deaths in year	6
	124
Departures	2
Total native resident population Mar. 31, 1919	122
Native at Salem Indian Training School, Chemawa, Oreg	1
Total natives accredited	123

FUR-SEAL HERD.

QUOTA FOR KILLING.

On April 8, 1919, the Secretary of Commerce approved the Bureau's recommendation that the quota of seals to be killed at the Pribilof Islands in the calendar year 1919 be as follows:

QUOTA OF SEALS FOR KILLING IN 1919.

Age class.	St. Paul.	St. George.	Total.
3-year olds	13,000	2,000	15,000
4-year olds	1,700	300	2,000
5-year olds	800	200	1,000
6-year olds and over	14,500	2,500	17,000
Total	30,000	5,000	35,000

It will be noted that the quota provided for the killing of a large number of seals 6 years of age and upwards. The five years of restricted killing of seals, from August 25, 1912, to August 24, 1917, provided for by the act approved August 24, 1912, giving effect to the North Pacific Sealing Convention of July 7, 1911, had resulted in the accumulation of a large number of males far in excess of the number required to maintain the breeding strength of the herd at a maximum. Furthermore, it was felt that this surplus accumulation of males meant not only a loss of revenue to the Government through failure to market as many of the pelts as possible, but through damage to the herd itself on account of the increased fighting on the part of the male seals. It had always been believed that the pelts of older males taken after the development of the so-called wig were practically useless to furriers. Fortunately, experiments conducted at the new dressing and dyeing plant at St. Louis on a limited number of large skins taken at the Pribilofs had demonstrated that a skin from a large seal could be dressed and dyed in such a manner that it commanded almost as great a market value as skins from 3 and 4 year old seals. Under these conditions it was deemed highly desirable to include a considerable number of large seals in the quota for 1919.

In establishing the quota it was realized that the inclusion of 17,000 seals 6 years old or older would involve work possibly beyond the facilities of the Bureau to accomplish. The killing and skinning of a small seal and the curing of its skin is an easy task compared with similar operations in respect to a full-grown bull seal. It was also known that a further difficulty would be encountered by reason of the fact that surplus large males would be found on the hauling grounds in greatest abundance only in the early part of the season, being less and less in evidence there as the season proceeded. It was thought best, however, to fix the quota at the figures which the interests of the service demanded and to accomplish as much as possible under the circumstances.

Through the year 1919 there were killed 7,731 seals 6 years old and over. While the number taken was very much below the number planned, it is believed that much good has been accomplished in the way of reducing the number of surplus males and in affording the means for increasing largely the Government's revenue from the Pribilofs.

KILLINGS OF SEALS.

St. Paul Island.—During the calendar year 1919 there were killed on St. Paul Island 24,053 seals. Aside from a few seals killed for food and for scientific experimental purposes, they were obtained in 70 drives, the first on April 5 and the last on December 18.

St. George Island.—During the calendar year 1919 there were killed on St. George Island 3,768 seals. With the exception of a few, these were secured in 38 drives, the first on June 3 and the last on November 7.

The total number of seals killed on both islands in the calendar year 1919 was 27,821. The tables following show details in regard to the killings in 1919.

SEAL KILLINGS ON PRIBILOF ISLANDS IN 1919.

ST. PAUL ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.
Apr. 5	1	Sivutch (Sea Lion Rock)	49
May 10	2	do	64
May —		Northeast Point	[a] 1
May 28	3	Sivutch (Sea Lion Rock)	115
June 11	4	Tolstoi	84
June 15	5	Vostochni	556
June 16	6	Reef	113
June 17	7	Zapadni and Little Zapadni	462
June 19	8	Morjovi and Vostochni	1,288
June 20	9	Polovina	323
June 21	10	Tolstoi	99
June 23	11	Zapadni and Little Zapadni	347
June 24	12	Reef	597
June 26	13	Morjovi	813
June 27	14	Vostochni	613
June 28	15	Polovina	197
June 30	16	Tolstoi, Lukanin, and Kitovi	286
July 1	17	Zapadni and Little Zapadni	873
July 2	18	Gorbatch	1,042
July 3	19	Reef	369
July 6	20	Morjovi	624
July 7	21	Vostochni	1,241
July 9	22	Gorbatch	1,029
July 10	23	Zapadni and Little Zapadni	894
July 11	24	Tolstoi, Lukanin, and Kitovi	412
Do	25	Gorbatch and Reef	719
July 14	26	Morjovi	919
July 15	27	Vostochni	328
Do			[b] 8
July 16	28	Gorbatch and Reef	1,259
July 17	29	Zapadni and Little Zapadni	554
Do	30	Tolstoi	168
July 22	31	do	184
Do	32	Lukanin and Kitovi	25
July 23	33	Gorbatch and Reef	332
July 27	34	Morjovi	658
July 28	35	Vostochni	512
July 30	36	Gorbatch	736
July 31	37	Reef	468
Aug. 1	38	Tolstoi	182
Do	39	Lukanin and Kitovi	72
Aug. 2	40	Zapadni and Little Zapadni	232
Aug. 5	41	Morjovi	469
Aug. 6	42	Vostochni	198
Aug. 7	43	Gorbatch	531
Do	44	Reef	182
Aug. 8	45	Zapadni and Little Zapadni	189
Aug. 9	46	Gorbatch	171
Do	47	Reef	82
Do	48	Lukanin and Kitovi	39
Do	49	Tolstoi	50
Aug. 10	50	Morjovi	153
Do	51	Vostochni	116
Aug. 22	52	Reef and Gorbatch	199
Aug. 23	53	Tolstoi	48
Aug. 25	54	Zapadni and Little Zapadni	106
Aug. 27	55	Vostochni	176
Do	56	Morjovi	51
Aug. 30	57	Tolstoi	41
Oct. 22	58	Reef and Gorbatch	175
Nov. 3	59	Gorbatch	122
Nov. 7	60	Reef	151
Do	61	Tolstoi	59
Nov. 10	62	Polovina	225
Nov. 14	63	Morjovi	247
Nov. 15	64	Vostochni	146
Nov. 26	65	Reef	47
Nov. 28	66	Gorbatch	49
Nov. 29	67	Tolstoi	41
Dec. 3		Zapadni	[a] 4
Dec. 5	68	Morjovi	60
Dec. 12	69	Tolstoi	27
Dec. 18	70	Morjovi	52
		Total	24,053

ST. GEORGE ISLAND.

Date.	Serial No. of drive.	Hauling ground.	Skins secured.
June 3	1	North and Staraya Artil	16
June 6	2	East Cliffs	96
June 10	3	do	10
June 12	4	North and Staraya Artil	41
June 14	5	Zapadni	33
June 15	6	East Cliffs	5
June 17	7	North and Staraya Artil	65
June 19	8	East Reef and East Cliffs	127
June 21	9	North and Staraya Artil	161
June 23	10	East Reef	36
June 25	11	North and Staraya Artil	107
June 26	12	Zapadni	58
June 30	13	East Reef and East Cliffs	219
July 2	14	North and Staraya Artil	242
July 3	15	Zapadni	32
July 5	16	East Reef and East Cliffs	146
July 7	17	North and Staraya Artil	144
July 9	18	East Reef and East Cliffs	164
July 10	19	Zapadni	25
July 12	20	North and Staraya Artil	287
July 14	21	East Reef and East Cliffs	154
July 16	22	North and Staraya Artil	149
July 17	23	Zapadni	82
July 19	24	East Reef	176
July 21	25	North and Staraya Artil	175
July 23	26	East Reef	122
July 28	27	North	84
July 30	28	East Reef	65
Aug. 2	29	North and Staraya Artil	82
Aug. 4	30	East Reef	39
Aug. 5	31	Zapadni	43
Aug. 7	32	North and Staraya Artil	109
Aug. 9	33	East Reef and North	60
Aug. 20–21		Zapadni	[a] 2
Sept. 1–30			[c] 6
Oct. 6			[c] 1
Oct. 20	34	North	107
Do	35	East Cliffs	124
Oct. 24	36	do	89
Oct. 30	37	East Reef	65
Nov. 4			[a] 8
Nov. 5			[a] 1
Nov. 7	38	East Reef	11
		Total	3,768

[a] Seals killed for natives' food. [b] Seals killed for experimental work. [c] Seals killed for fox food.

BRANDED SEALS.

Following the practice of previous years, there were killed on both St. Paul and St. George Islands in 1919 a number of the fur seals which had been branded when pups in 1912. The data obtained from year to year have been invaluable and are, of course, made more complete with the records of each succeeding year. The great value of the data lies in the fact that they are obtained from seals of known ages. The animals bearing the brand placed on pups in 1912 are the only ones which it has been possible to follow in a scientific way from year to year.

The animals were, of course, 7 years old in 1919. On St. Paul Island 11 were killed, on St. George Island 15. The following table gives certain information derived from them:

Records of Branded 7-Year-Old Male Fur Seals Killed on Pribilof Islands, Calendar Year 1919.

Serial No. of skins.	Date of killing.	Island.	Carcass weight.[a]	Carcass length.	Green-skin weight.		Trade classification.
			Pounds.	Inches.	Pounds.	Ounces.	
AP 6600	June 16, 1919	St. Paul	278.0	67.75	34	8	Wig.
AP 6601	June 24, 1919	do	337.0	73.00	29	8	Do.
AP 6603	June 24, 1919	do	323.0	65.50	31	8	Do.
AP 6604	do	do	481.0	74.25	48		Do.
AP 6605	do	do	370.0	72.75	34		Do.
AP 6606	do	do	206.0	61.50	15	8	Extra extra large.
AP 6701	Aug. 22, 1919	do	314.0	73.25	42		Wig.
AP 6702	do	do	330.5	73.25	37	8	Do.
AP 6703	do	do	274.0	74.50	36		Do.
AP 6827	Oct. 22, 1919	do	370.0	76.50	44	8	
G 6083	June 3, 1919	St. George	192.0	64.50	20		Wig.
G 6084	June 6, 1919	do	148.0	58.75	19		Do.
G 6089	do	do	226.0	72.50	31		
G 6092	June 11, 1919	do	413.0	72.00	40		Wig.
G 6093	June 17, 1919	do	191.0	66.50	23		Do.
G 6094	do	do	349.5	74.50	32		Do.
G 6095	do	do	360.0	72.75	40		Do.
G 6096	do	do	218.5	68.25	28		Do.
G 6097	June 19, 1919	do	215.5	63.75	23		Do.
G 6098	do	do	207.5	67.25	24		Do.
G 6099	do	do	212.0	66.50	28		Do.
G 6100	do	do	191.0	66.00	24		Do.
G 6101	do	do	486.5	78.00	64		Do.
G 6102	June 23, 1919	do	176.5	63.50	18		Do.
G 6126	July 2, 1919	do	323.0	68.25	32		Do.

[a] Seals were bled before being weighed.

Information in regard to the branded seals previous to 1919 may be obtained from preceding reports of the Alaska Fisheries and Fur Industries. It should be stated in this connection that an osteologic study of these branded seals is being made by Dr. G. Dallas Hanna.

AGE CLASSES OF SEALS.

Determination of the ages of seals killed is based on data derived from measurements of seals of known ages. The seals whose age was definitely known were those branded in 1912, of which a number have been killed from year to year. For practical purposes on the killing fields the length of the animal determines the age class into which it is placed, the length being the distance from the end of the nose to the root of the tail. The following table shows the figures used for determining the ages of male seals:

AGE STANDARDS OF BODY LENGTHS OF SEALS.

Age.	Lengths of summer seals.	Lengths of fall seals.	Age.	Lengths of summer seals.	Lengths of fall seals.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Yearlings	Up to 36.75	Up to 38.75	4-year olds	46 to 51.75	48 to 53.75
2-year olds	37 to 40.75	39 to 42.75	5-year olds	52 to 57.75	54 to 59.75
3-year olds	41 to 45.75	43 to 47.75	6-year olds	58 to 63.75	60 to 65.75

AGES OF SEALS KILLED ON PRIBILOF ISLANDS, CALENDAR YEAR 1919.

Age.	Summer (Jan. 1–Aug. 10), 1919.			Fall (Aug. 11–Dec. 31), 1919.			Grand total.
	St. Paul.	St. George.	Total.	St. Paul.	St. George.	Total.	
Yearlings	4	....	4	7	....	7	11
2-year olds	123	71	194	60	154	214	408
3-year olds	12,983	2,059	15,042	594	226	820	15,862
4-year olds	2,020	370	2,390	38	28	66	2,456
5-year olds	1,118	141	1,259	35	2	37	1,296
6-year olds	2,089	124	2,213	300	....	300	2,513
7-year olds and over	3,652	586	4,238	980	....	980	5,218
Cows [a]	38	3	41	12	4	16	57
Total	22,027	3,354	25,381	2,026	414	2,440	27,821

[a] The few cows reported above, about one-fifth of 1 per cent of the total take, shown in the table, were accidentally and unavoidably killed. Every possible effort is made to avoid the killing of cows, but persons familiar with conditions at the islands will readily appreciate that once in a great while a cow is killed.

CENSUS.

Following the practice of previous years a census of the fur-seal herd was taken in the summer of 1919. The increase in size of the herd from year to year renders it increasingly difficult to enumerate the animals and each year resort must be had to approximations and estimates to a greater extent than before. The difficulties can be eliminated to some degree by the erection of observation stations and perhaps the construction of walkways through the rookeries. The Bureau will take steps to bring about improvements of this character as soon as possible. Full information in regard to the census of 1919 is contained in the report, printed on pages 106 to 117, by Dr. G. Dallas Hanna, who was in immediate charge of the census work.

The following is a comparative statement of the numerical strength of the various elements of the herd in the years 1912 to 1919, inclusive:

GENERAL COMPARISON OF RECENT CENSUSES OF THE SEAL HERD.

Class of seals.	1912	1913	1914	1915	1916	1917	1918	1919
Harem bulls	1,358	1,403	1,559	2,151	3,500	4,850	5,344	5,158
Breeding cows	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Surplus bulls	....	....	....	....	....	8,977	17,110	9,619
Idle bulls	113	105	172	673	2,632	2,706	2,444	2,239
Young bulls (chiefly 5-year-olds)	199	259	1,658	....	....	....	....	....
6-year-old males	....	....	....	....	11,167	15,397	13,755	8,991
5-year-old males	....	....	....	11,271	15,494	14,813	11,941	5,282
4-year-old males	100	2,000	9,939	15,848	15,427	16,631	7,114	5,747
3-year-old males	2,000	10,000	13,880	18,282	19,402	19,507	9,117	13,596
2-year-old males	11,000	15,000	17,422	23,990	24,169	26,815	30,159	33,081
Yearling males	13,000	20,000	23,068	30,307	33,645	38,013	41,595	46,444
2-year-old cows	11,000	15,000	17,422	23,990	24,245	26,917	30,415	33,287
Yearling cows	13,000	20,000	23,067	30,306	33,646	38,018	41,608	46,447
Pups	81,984	92,269	93,250	103,527	116,977	128,024	142,915	157,172
Total	215,738	268,305	294,687	363,872	417,281	468,692	496,432	524,235

SPECIMENS FOR SCIENTIFIC PURPOSES.

In 1919 there were collected for the California Academy of Sciences, at San Francisco, a number of specimens of fur seals for its use in completing a fur-seal habitat group which is one of an elaborate series of groups installed at the academy's museum illustrative of natural history. The material included 3 adults from St. Paul Island and 3 adults and 13 pups from St. George Island. All the seals involved were animals found dead, with the exception of two accidentally killed on St. George Island. The appraised value of the collection was $43, which amount was paid by the academy and transmitted to the disbursing clerk of the Department for deposit in the United States Treasury.

FOXES.

The fox herds are a very important feature of the Bureau's operations on the Pribilof Islands. They produce considerable revenue for the Government each year, and the natives profit through payments made to them for taking the pelts. The revenue represents real production, for unless the herds were fostered by the Bureau's activities they would be reduced almost if not quite to the vanishing point. While the foxes would be able to subsist through the summer season on birds and other sources of food which they are able to secure unaided by man, few would survive the winter were seal meat not provided.

The fox herd is much larger on St. George Island than on St. Paul Island, at least the animals are apparent in larger numbers and the take of pelts each year is much greater. On St. George the feeding of foxes has been reduced to a system, on St. Paul it has not, but the matter is receiving very careful consideration. Natural and other factors on St. George have been much more favorable for controlling conditions than on St. Paul. In the matter of taking pelts, control of the food supply during the winter is almost as important as the supply itself. On St. George Island the beaches where foxes may resort for food are few and limited in extent. The seal-killing fields are limited to two, and both being small and close to the sea are easily cleaned of seal carcasses. The result is that the foxes are obliged to come to certain places for food put out for them. The food given them consists of seal carcasses saved from the killings of the preceding summer. The foxes accustomed to coming to certain places for food are easily induced to enter wire inclosures where the selection of those to be killed and of those to be released as breeders is a simple matter.

On St. Paul Island the open beaches are of considerable extent; the seal-killing fields are more numerous and some so situated that the removal of carcasses would be more difficult and has not been undertaken. It should be noted, that foxes will feed in the winter season on seal carcasses left on the killing fields since the preceding summer. The absence of control of food supply in the winter on St. Paul makes it necessary there to capture them in steel traps. A fox once caught in a steel trap must be killed, and the selection of animals for the future breeding stock is an impossibility. From the standpoint of selecting breeders, the beneficial results of being able to observe the herd practically as a whole and to handle the individuals is strikingly shown in one way by the almost entire elimination of white foxes from the St. George herd. On St. Paul Island the proportion of white foxes taken each year is very much larger. Furthermore, the releasing of animals as breeders insures that at least a minimum number has been reserved. When foxes are taken solely in traps, as on St. Paul, the maintenance of an adequate breeding stock must depend largely upon the judgment of the officer in charge. Whether it will be possible in time to follow profitably on St. Paul the methods employed on St. George is a problem for future solution.

TRAPPING SEASON OF 1919–20.

In the trapping season of 1919–20 there were taken on St. Paul Island 155 blue-fox pelts and 32 white-fox pelts, a total of 187; on St. George Island, 746 blue-fox pelts and 4 white-fox pelts, a total of 750 pelts. One additional white pelt was secured at St. Paul from a fox found dead in March, 1920. These figures show for both islands a take of 901 blue pelts, and 37 white pelts, or a total of 938 pelts. The aggregate take was considerably larger than that for the preceding season, when 144 were taken on St. Paul and 553 on St. George, a total of 697. The take on St. George in the season of 1919–20 was the largest in many years.

On St. Paul trapping operations were carried on for about one week. Traps were set out December 2 and taken up the night of December 9.

The following extract is from a report submitted by Agent Proctor:

> During the season of 1919–20 fox trapping was prosecuted under rather unusual w ather conditions. The temperature was well above the freezing point, the ground was entirely free from snow, and light rains fell at intervals. This weather had been preceded by lower temperatures that had continued since well back into November, and it was therefore believed that the skins would be in prime condition.
>
> In order that the fox runs would be well defined, the effort has heretofore been on this island to so time the trapping season as to get a period of clear weather, with the ground covered with a light layer of snow. Trips in the vicinity of the village made by the writer and reports from the more remote places by the natives showed that notwithstanding the absence of snow the fox runs were well defined in the soft ground and dead grass. Under the circumstances it was considered better to make a start under the conditions stated than to take a chance of encountering heavy winds with drifting snow at a later date.
>
> Following the practice that has always obtained on this island, foxes were trapped in ordinary steel traps placed in the various runways and at other favorable points. The traps were secured to the ground by means of a chain and an iron stake driven into the soil. The traps and chains were then covered with grass and other suitable material to conceal them.
>
> All the able-bodied workmen, with the exception of the native priest, were engaged in trapping, and each individual was supplied with as many traps as he was able to look after properly. In all, 42 men were engaged in trapping and an aggregate of 411 traps were employed by them.
>
> In determining the length of the trapping period, the length of the immediately preceding seasons and the size of the catch were taken into consideration, it being thought that if the catch during the first few days of the present season had been noticeably large the season could be prolonged safely. A large catch would have been accepted as an indication that a greater number of young foxes had been brought to maturity this year than during the past years. The catch this season, however, during the first few days did not give this assurance, and the season was therefore confined to the seven actual trapping days originally determined upon. The traps were placed out in the late evening of December 2 and were taken up during the night of December 9, allowing seven full days for trapping operations.
>
> The total number of skins secured during this period was 187 for a seven-day season, as against 144 skins secured in a five-day season in the preceding year. The average catch during the season of 1918 was 29 skins per day, with 39 men and 320 traps. The average number of skins taken daily during the present season by 42 men, with 411

traps, was 27 skins per day or 2 less per day than during the previous season. This would appear to indicate that the herd had made no such advances in numerical strength as to warrant a long period of trapping, with the attendant danger of over-trapping and an unwarranted reduction in fox life.

Under the conditions of fox life on this island it is difficult to see how any estimate of the actual number of foxes in existence can be secured. Unlike St. George Island, foxes here are rarely seen. During the summer and early fall the writer observed one family of two adults with three vigorous young in the cliffs near Zolotoi Sands, and several families were seen between Telegraph Hill and Halfway Point Lake and between Telegraph Hill and the vicinity of Little Zapadni rookery. A fox is rarely seen in the immediate vicinity of the village, though one did appear during the summer and loitered for a short time around our chicken house. Therefore, the only guide as to the number of foxes in existence is in the number taken from season to season. In earlier years this island supported a large fox herd, as indicated by the annual takes. The decrease in the herd, as indicated by the annual takes, appears to have followed the decrease in the number of seals taken and the gradual diminution in available food.

It would therefore appear that the problem of fox propagation here is, as on St. George Island, one of food. During the period from August, 1912, to August, 1917, the number of seals taken was limited to the number required for food for the native inhabitants. Little, if any, seal meat was available for the support of the foxes, and they had to subsist during that period almost entirely on the sea food of various kinds thrown up on the beaches. The increased takes of seals during the past two seasons have furnished abundant food, but the time has been too short to produce any marked effect upon the herd other than to show a satisfactory condition of nourishment, as indicated by the weights of the animals secured this season. The lightest fox taken this season was a blue female that weighed 4½ pounds, taken December 6, at Zapadni; the heaviest was a white male weighing 17½ pounds, taken at Tsammana on December 3. The average for the take was about 11 pounds. This may be accepted as a very satisfactory average weight for foxes of both sexes and all ages and indicates that the herd has found an abundance of food during the past year. Now that commercial sealing will proceed steadily there should be no shortage of food, and the physical condition of the herd should therefore show a steady improvement. With the animals in good physical condition and food abundant during all seasons of the year, we should expect larger litters to be brought to maturity and an early increase in the numerical strength of the herd. During the past sealing season killings were arranged, as far as practicable, with a view to leaving carcasses at various points on the island where foxes had been seen or where the ground formation was favorable for burrows, and this policy should be maintained.

As long as foxes are taken in steel traps nothing in the line of selective breeding can be considered, as every animal caught, regardless of its condition, must be killed. Neither can any effort be made to maintain approximately an equal number of animals of each sex. However, trapping by means of steel traps was not known to be detrimental to the herd in former years, when seals were killed in abundance and their carcasses permitted to lie on the ground in various places, and there is every reason to believe that with the continuation of commercial sealing the herd here can ultimately be brought to its former flourishing condition. How many years that will take can not at this time be foretold.

It has been suggested that the St. George method of fox trapping be tried on this island, but the writer is extremely doubtful as to the success of such an experiment. The St. George method of trapping foxes has been carried on only during the period of small seal killings and when the two killing fields used were kept free from carcasses during the winter season. The St. George killings are practically confined to the village killing field and to the killing field at Zapadni. During the period of the St. George method of trapping all of the seal carcasses on that island not required by the natives for food were placed in a silo and used for food at the village trap after the migration of the bird life. This method practically forced the foxes to resort to the village for food; that they come there solely for food during the winter season is shown by the promptness with which they abandon that feeding ground when the birds return to the island. To establish successfully the St. George method on St. Paul, traps would have to be built at several points and the killing fields would have to be kept free from food during the late fall and throughout the winter. This would place upon the working force an additional burden during sealing operations, and it is doubtful whether the results secured would warrant the necessary expenditure of money and labor at the present time.

The development of the by-products plant and extension of roads from the village to the various killing fields may materially change the conditions in the future, and should that be the case a change in the trapping methods here might then be seriously considered.

All the skins secured here were dried as slowly as conditions at the various stations would permit, and it is believed that the objectionable "papery" condition of the skin is less noticeable than before. Special attention was given to this phase of the work. All the skins have been cased fur side in, in accordance with the instructions received from the Bureau.

On St. George Island fox trapping for the season of 1919–20 was carried on in the months of November and December, 1919, and January, 1920. Seven hundred forty-six blue-fox pelts, including 1 from an animal found dead, and 4 white-fox pelts, a total of 750, were taken. Two hundred twenty-nine male foxes and 225 females were released to insure the maintenance of a suitable breeding stock. It appears that the take of skins was the largest in 27 years. It should be noted that the number of animals released represents the least possible number of animals available at the time as a breeding stock. It is a moral certainty that not all the foxes on the island enter the traps during the season, and the reserved breeding stock is augmented by just the number which does not enter. Foxes released for breeders are marked so that if retaken the same season they will not be killed or charged a second time to the breeding stock if released.

In August, 1919, a small wire cage fox trap was constructed at Zapadni on St. George Island. It was used in the season of 1919–20 and was a complete success. It, of course, only supplements the fox-trapping house at the village. In 1919 arrangements were made for burying in the future the carcasses of foxes killed at the village. The plan adopted will remove all possibility of foxes having access to the carcasses and feeding on them with possible injurious results.

In the summer season of 1919 a supply of seal meat was preserved on St. George for use for fox food in the coming winter season.

In connection with the taking of fox pelts on St. George Island in the season of 1919–20 the following report has been submitted by Agent Crompton:

Summary of season.—Cold weather during the latter part of November made it advisable to open the season during that month as the foxes were visiting the feeding place in great numbers. Accordingly, trapping was begun the night of November 24, when 183 animals were handled in five hours, of which number 151 were killed. More foxes might have been taken on the opening night had proper facilities for handling the skins been available.

It was a fortunate thing that work was begun on November 24, as the following day brought warm winds and rain and for three weeks thereafter the thermometer did not register below 35° F. This very unfavorable situation forced the recommendation that the release of the breeding reserve be postponed until at least three-fourths of the expected catch of skins had been secured. Upon adopting this policy very few animals were released until after a total of 450 skins had been obtained.

Warm weather, with the consequent necessity for securing the skins before unprimeness developed, brought about the practice of all-night trapping. On these occasions the trap was opened about 7 o'clock in the evening and kept in operation until 6 or 7 o'clock the following morning. The foxes which had been caught before 12 midnight were disposed of at that hour; the remainder were attended to in the morning. After the first few nights of such work a system of operation was worked out by means of which it could be conducted without interfering with the regular duties of the following day.

All-night trapping was a decided success and the practice will be made a regular feature in future operations. Its advantages are (1) that more foxes may be handled during a given period, (2) that fewer nights of trapping are required, and (3) the animals are thus given more nights for undisturbed feeding. The work has the single danger of being too zealously conducted, in which case the foxes would be deprived of food for too long a period, if not permanently frightened off. During the season just past it was the practice to trap three or four, and on rare occasions five, nights each week, no one being permitted to approach the fox house during the remaining nights. Except in emergencies it is felt that all-night trapping should be confined to not more than three nights in seven.

Observations.—The writer was present in the trapping room during several full nights and confirmed the well-known observation that low tides at night interfere with fox trapping. On one occasion, when the tide was extremely low during the midnight hours, 23 foxes were caught before 9.30 p. m., 3 foxes between that time and 3 a. m., and 38 were taken after 3 a. m. It was also repeatedly observed that the female fox is more nervous and timid than the male.

Garden Cove and Zapadni.—Trapping was conducted at two points other than the village, viz., Garden Cove and Zapadni. The work at Garden Cove, where a string trap was used, ended in a complete failure after 10 nights of trapping. It is not believed that a cage trap could be advantageously operated there.

The new cage trap at Zapadni was a great success. One hundred and thirty-four foxes were handled there during 20 nights, as against 38 animals in 18 nights of the preceding season. Of the foxes handled at Zapadni this season 77 were taken in four nights. The trapping work at Zapadni was placed in charge of only the most responsible of the native men and these were under definite orders as to the disposition to be made of the different classes of foxes caught. Telephone communication was continuous. Fox food has been periodically exposed at Zapadni since trapping ceased, and it is the intention to prepare a larger amount of food there next season.

Close of season.—Trapping was vigorously conducted along the lines indicated in the preceding paragraphs until, on January 30, the condition of the furs made it advisable to close the season. With a grand total of 1,204 foxes handled, this was the most successful season on this island since 1900–1901, when 1,335 animals were caught. With the single exception of the winter mentioned, it exceeds any season since 1890. In point of the number of pelts taken, it surpasses any season since 1892–93. These results speak high praise for the management of the foxes since the close of the last lease, when the herd was in an unsatisfactory condition.

Condition of furs.—Instructions were received to the effect that observations should be made to determine the relation of weather conditions to the primeness of the fox skins. Such observations as could be made on the pelts at this place showed that the relation is direct.

During a normal season the fur of the blue fox should certainly be prime between the dates December 1 and January 31, if not earlier and later than those dates. The skins taken on November 24, 1919, showed very dark on the flesh side, but the fur appeared to be in good condition. During the very warm and wet weather of early December the skins were fully furred but showed a tinge of reddish brown on the guard hairs. However, before the end of that month two unprime skins were noted on animals released for breeding, and it is not to be doubted that the unseasonable high temperatures of the fore part of the month had caused this condition. The statement is ventured that during a normal winter no unprime skins will be seen during the month of December.

During the greater part of January the weather was cold, with the result that the unprimeness threatened in the preceding month did not materialize until late in January. It is the writer's opinion that some of the finest pelts of the season were taken during early January.

Weights of foxes.—The following figures will be of interest and should be given special attention in the consideration of the recommendation which will be offered in connection therewith:

	Pounds.		Pounds.
Lightest male fox killed	7.00	Lightest male fox released	10.00
Heaviest male fox killed	22.00	Heaviest male fox released	21.00
Average male fox killed	13.09	Average male fox released	13.72
Lightest female fox killed	5.00	Lightest female fox released	8.00
Heaviest female fox killed	16.00	Heaviest female fox released	19.00
Average female fox killed	10.10	Average female fox released	11.00

Nearly all foxes handled were in good condition and carried heavy layers of fat. Except in rare cases, where a very vigorous young fox happened to weigh just within the minimum limit, all light-weight animals were killed. Only 9 such males and 11 females, weighing 10 and 8 pounds, respectively, were released as breeders; all others released were above those weights.

It is recommended that the minimum-weight limits for animals to be released for breeding be slightly increased; that the minimum for breeding males be set at 11 pounds and for breeding females at 8½ pounds, an increase of 1 pound on the former limit for each sex. Such a course will naturally cause more weights to approach the minimum limits but it is possible that the average may again draw upward in a few years as a result of the practice. If at any time the average weights are found to be too near the minimum it will be a simple matter to revert to the former rule and nothing can be lost by the experiment. When the average weight of all male foxes is more than 13 pounds and the average weight of all female foxes is over 10 pounds, the minimum limits of 11 and 8½ pounds are but proper.

Breeding reserve.—The recommendation that the breeding reserve be increased to 225 pairs was made in the belief that such a change was the most certain manner in which the number of foxes on the island could be positively increased and, in view of the large number of foxes handled, the change could be well afforded this year. The release of 225 pairs this season should be followed (as food and other factors allow) by further small increases each season.

As in previous years, the breeding animals were selected with great care. Weight and general vigor, age, condition of fur, and depth of color in the fur were the principal points upon which an animal's fitness was decided. No old or crippled animals were released even though the fur was of the best.

Prospect for coming season.—There is no reason known at this time why the catch of foxes during the winter 1920–21 should not exceed the number taken this season by at least 200 animals. Ideal conditions attending, a catch of 1,000 skins plus 500 breeding animals is more than a remote possibility.

Feeding of foxes.—Feeding of the foxes was begun on October 13, 1919, is being continued at this time, and will not be stopped until late April. The food was put out in the usual manner in the neighborhood of the trap, the amount being gauged by the appetite of the animals. It was always the intention to place more food on the feeding ground than the foxes could consume in a single night. The largest amount consumed in a single night was approximately 1,600 pounds.

Referring to the possibility of needing whale meat for fox food during the coming winter, it is no longer felt that such a step will be necessary. After the experience of the past winter it is believed that if all seal meat not used as natives' food is carefully preserved as fox food and the accumulation judiciously fed during the necessary period that no shortage will be encountered. There should be, however, vigorous trapping in the early winter for the purpose of reducing the number of feeding animals.

No efforts will be spared toward making the supply of fox food as large as will be possible with the number and sizes of seals which will be available for killing.

Lack of facilities.—There is great and urgent need of better facilities for caring for the fox skins. Owing to the lack of room in the crowded shop, it is very difficult to handle more than 125 skins at one time. This not only gives poorer results but is important when we consider that a catch of 200 skins on the opening night of the season may be expected in the near future.

The proposed new shop will do much to relieve the lack of space and will provide a place for the storage of the skins while they are awaiting shipment.

PARASITES.

Informal discussion of the value to fox-farming operations of more information in regard to parasitism among foxes led to a request from the Biological Survey in 1918 that a collection of viscera of foxes and of other material for examination be made at the Pribilofs. The making of the collection was begun on St. George Island in December, 1918, and continued into 1919. Material was secured from 18 foxes, and in addition specimens of fox food were preserved.

Dr. B. H. Ransom, Chief, Zoological Division, Bureau of Animal Industry, rendered a report in February, 1920, based on a study of the collection, as follows:

The intestines and other viscera from 18 blue foxes from St. George Island of the Pribilof Islands, killed or dying during the season of 1918–19, have been examined for parasites and the following findings noted:

Ten of the foxes had tapeworms in the small intestine, the tapeworms being a species of the genus Mesocestoides, and apparently a new species, although this material is still being studied. These tapeworms were present as a rule in large numbers. The life history of the worms is not known, but from the distribution of the parasite it is surmised that the intermediate hosts are fishes. One of the foxes had one tapeworm head, the worm apparently belonging to the genus Tænia, but having only a part of one circle of hooks remaining on the head; this worm has not been identified, and perhaps can not be identified on such a small amount of material in poor condition. Eight of the foxes were infested with ascarids, the large round worm of the small intestine, which is, at times, sufficiently numerous to cause serious damage. The damage due to ascarid worms is not only that which follows from their presence in the digestive tract but is also due, as recent investigations have shown, to injuries to the lungs occasioned by the passage of the larval ascarids from the blood stream to the air passages in the course of their migration through the body. One of the foxes had in the small intestine a number of dipterous larvæ which have not yet been identified. It is likely that these larvæ were not parasitic but were due to the fox having eaten some foodstuff, possibly meat, which had been flyblown.

In comment on the foregoing findings it may be said that a feature of considerable interest is the absence of any hookworms. Inasmuch as hookworm disease is one of the most serious pests to be met with in raising foxes or related carnivores, it appears that the island on which these foxes are being raised is a particularly favorable location from this standpoint. It would seem that conditions on the island are peculiarly unfavorable for maintaining a hookworm infection among foxes, or that the original stock placed on the island was fortunately free from hookworm. In any event it would appear to be worth while to take precautions to keep this island uninfested with hookworm either by not bringing in new stock which might be infected, or if new stock must be brought in by subjecting it first to careful fecal examination to ascertain the presence of hookworms, and the exclusion of infected animals until fecal examination following treatment had shown that the animals were free from infection.

Of the parasites already present in the foxes the ascarid is probably the most injurious, but this worm is readily removable by the use of oil of chenopodium accompanied by liberal doses of castor oil. The dose used for dogs is one-tenth of 1 mil of wormseed oil per kilo of weight of dog, or 1 mil of oil for a 22-pound dog followed immediately by an ounce of castor oil. The amount of damage due to the Mesocestoides is problematical. These tapeworms were present in very large numbers, in some instances forming a mass of worms which almost occlude the intestine. It is likely that these worms could be readily removed by treatment with oleoresin of male fern. The dose for dogs is 1 to 2 drams; for foxes it would be advisable to use smaller doses, perhaps 3 to 4 mils. Experiments indicate that contrary to what is sometimes said, the male fern may be followed immediately by an ounce of castor oil with good results.

An examination of the viscera other than the digestive tract does not disclose any parasites, nor was the seal meat, which was sent in as a sample of the food used by the foxes, found to be parasitized. The sea urchins were not examined, as we have no reason at present for believing that animals in this group need be suspected of being intermediate hosts or carriers of any sort for the parasites of foxes.

REINDEER.

The reindeer herds on St. Paul and St. George Islands maintained themselves in satisfactory condition during 1919. Limited use was made of them for furnishing food both for the natives and the Bureau's employees. The meat provides a welcome change of diet for all; it compares very favorably with beef.

A question having been raised as to the adequacy of the natural food supply on the islands for maintaining animals in larger numbers than already existed, the matter was looked into in some detail. It is now believed that no concern need be felt on this account for some years, even with the animals increasing considerably in numbers. For instance, it was found that there was an area of not less than 4 square miles on the eastern section of St. George Island covered with rich reindeer moss which had not been touched for months, if at all, during the season. Observations made on St. Paul Island indicate that the moss reproduces itself there much more rapidly than it does on the mainland of Alaska.

It is difficult to establish systematic methods of handling the reindeer on St. Paul and St. George Islands. The animals are wild and seldom approach within sight of the villages. To domesticate the reindeer to an extent which would permit of their being driven to corrals at will, where selections could be made of animals to be killed and of those to be reserved for breeders, would require supervision and experience beyond present facilities. The herds, however, in their present status are very valuable; they yield a not inconsiderable amount of food and cost the Government nothing.

Owing to the wildness of the reindeer and the considerable expanse of territory over which they roam, the task of making even an approximately accurate count of them demands the suspension of other work to an extent which can not often be afforded. It was estimated that the herd on St. Paul Island at the end of the year 1919 consisted of 35 males and 129 females, a total of 164. Fourteen reindeer were killed on St. Paul for food in 1919. A rough census of the St. George herd was taken in March, 1919, with the following results: Males, 1 year old and over, 5; males, less than 1 year old, 19; females, 1 year old and over, 60; females, less than 1 year old, 27; a total of 111 animals. At the end of the year the herd numbered approximately 123, of which 18 were males and 105 females. Twenty-two reindeer were killed for food on St. George in the year 1919.

The totals of 164 for St. Paul and 123 for St. George give an aggregate of 287 reindeer on both islands at the end of the year 1919, a net increase of 18 over the corresponding total a year previous. In 1918, 20 were killed for food, and in 1919, 36.

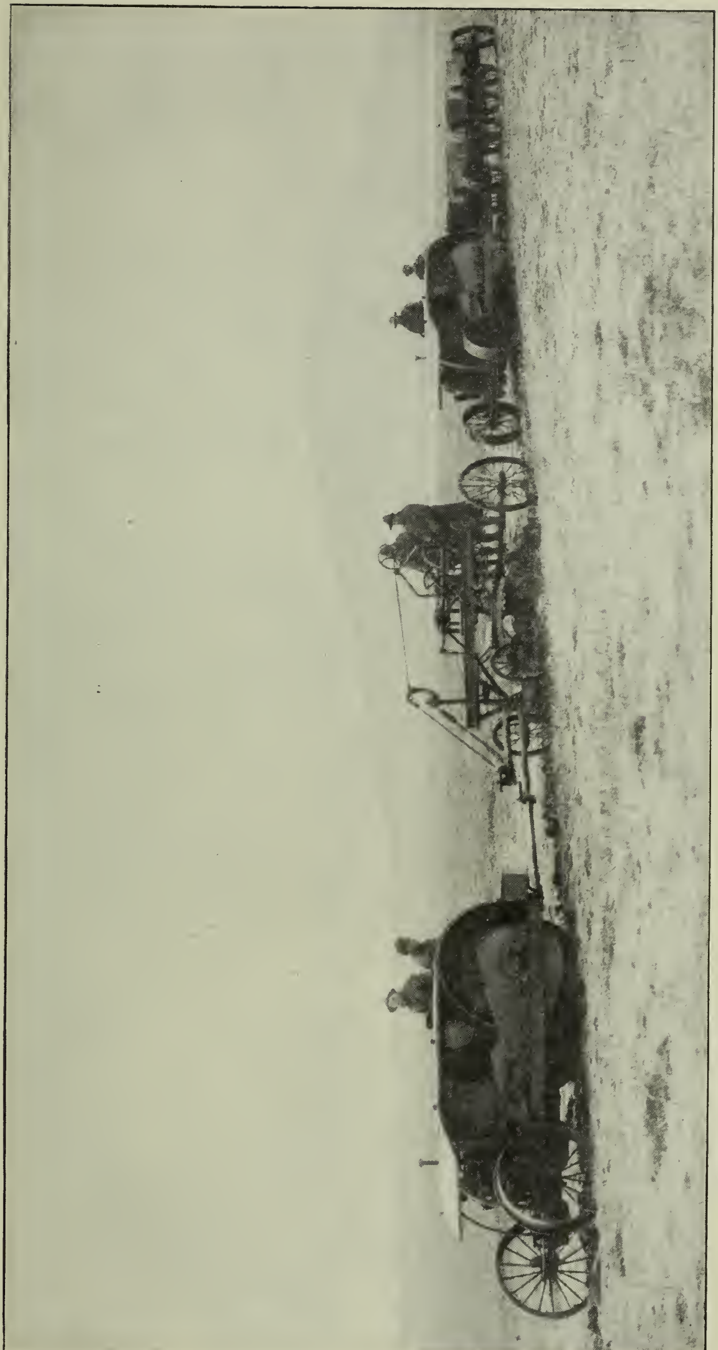
PATROL OF NORTH PACIFIC OCEAN AND BERING SEA.

The Coast Guard cutters *Unalga* and *Bear* were on duty in the North Pacific Ocean and Bering Sea in the season of 1919.

The *Unalga* left San Francisco for the season's cruise April 20 and returned to that port October 30. In addition to other multitudinous duties of various kinds in the interests of the public welfare, the vessel rendered valuable service to the Bureau. Freight and mail were transported between Unalaska and the Pribilofs; employees were transported between St. Paul and St. George Islands; at St. Paul Island a quantity of salt was taken from the village to Northeast Point and a quantity of sealskins transported from Northeast Point to the village.

The *Bear* left Seattle for the season's cruise on May 15 and returned there November 10. From Seattle there were aboard as passengers four men employed by Funsten Bros. & Co., who were en route for the Pribilofs to assist in sealing operations. The *Bear* after arriving at Unalaska joined in the work of caring for the victims of influenza. In line with the precautions taken to prevent the introduction of that disease at the Pribilofs, it was deemed best that the vessel should not stop there on its way northward from Unalaska. The four passengers for the Pribilofs were accordingly taken to Nome where they later secured passage to Seattle on the *Victoria*. Southbound on October 20, the *Bear* called at St. Paul Island and took aboard one passenger and mail and freight for Seattle.

While pelagic-sealing operations in connection with the North American fur-seal herd have ceased, the presence of patrol vessels is necessary as a precautionary measure against the recurrence of illicit activities.



TRACTORS, TRAILERS, AND ROAD GRADER, ST. PAUL ISLAND.

The Bureau is pleased to make acknowledgment of the numerous courtesies extended by the Coast Guard in connection with Alaskan operations, and to express its appreciation of the earnest spirit of cooperation constantly manifested by the personnel of that service.

SEALING PRIVILEGES ACCORDED ABORIGINES.

A considerable number of fur-seal skins were taken in 1919 by Indians in connection with operations in the waters off the coast of Washington. The taking of the seals was in accordance with the privilege granted by the North Pacific Sealing Convention of July 7, 1911, and the act of Congress approved August 24, 1912, giving effect to that convention. In the matter of authenticating these skins, the Bureau had the assistance of Mr. A. D. Dodge, superintendent, U. S. Indian School, Neah Bay, Wash., and of Dr. Otis O. Benson, superintendent, Taholah Indian Agency, Taholah, Wash. Five hundred fifty-four skins were authenticated by Messrs. Dodge and Benson, all of which with one or two exceptions were secured in 1919. Of these skins 251 were from male seals and 303 from females.

SHIPMENTS OF SKINS FROM PRIBILOF ISLANDS IN 1919.

Fur-seal skins.—There were two shipments of commercial fur-seal skins from the Pribilof Islands in 1919. The first was on the *Saturn* and consisted of 106 casks containing 3,624 skins from St. Paul Island and 14 casks containing 389 skins from St. George Island, a total of 4,013 skins. The St. Paul skins were placed aboard the *Saturn* on May 21 and the St. George skins on May 6. The *Saturn* left the islands May 22. The skins reached San Francisco June 5 and were shipped from there June 6 via Southern Pacific to Ogden, Union Pacific to Kansas City, and Wabash to St. Louis. They arrived at St. Louis June 18.

The second shipment was made on the *Nanshan* and consisted of 863 casks containing 22,829 skins from St. Paul Island and 131 casks containing 3,356 skins from St. George Island, a total of 26,185 skins. The St. George skins were placed aboard the *Nanshan* on September 30 and the St. Paul skins about the same time. The *Nanshan* left the islands October 13 and arrived at Seattle October 26. Thirty-seven barrels of skins were shipped from Seattle to St. Louis by express, this being done at the request of Funsten Bros. & Co. to insure more prompt delivery of raw material to keep the dressing and dyeing plant in operation without interruption. The company paid the difference in cost of shipment by express over that by freight. The remaining 957 barrels were shipped to St. Louis by freight in four cars via Northern Pacific to Minnesota Transfer and Chicago, Burlington & Quincy to St. Louis.

In addition to the commercial skins shipped from the Pribilofs in 1919, there were also shipped on the *Nanshan* 19 specimen skins for the California Academy of Sciences. Three of these were from St. Paul Island and 16 from St. George Island.

Fox skins.—The fox skins taken in the season of 1918–19 were shipped on the *Saturn* in May. The shipment consisted of 119 blue fox skins and 25 white fox skins from St. Paul Island, and 548 blue fox skins and 5 white fox skins from St. George Island, a total of 697 skins. The skins were shipped to St. Louis by express from San Francisco June 5.

SALES OF FUR-SEAL SKINS.

The fur-seal skins sold by the Department of Commerce in the calendar year 1919 were disposed of at St. Louis by public auction through the Department's agents, Funsten Bros. & Co. Two sales were held, April 28 and September 10, respectively. The total number of Pribilof Islands skins sold was 19,157 and the total price bid was $1,501,603.50. All had been dressed, dyed, and machined before being offered for sale.

At the sale on April 28 there were also sold eight other fur-seal skins which had been confiscated by the Bureau. These eight skins, dressed, dyed, and machined, sold for $75 each, or $600 for the lot. These skins are not included in the detailed statement in respect to the sale of April 28.

At the sale on April 28, there were sold 10,102 skins from the Pribilofs. The total price bid was $674,491. The maximum price was $85 per skin; the average price was $66.77 per skin, an advance of 29 per cent over the average of $51.72 received the last preceding sale, October 7, 1918, and an advance of 50 per cent over the average of $44.58 received at the sale on April 22, 1918.

At the sale on September 10, 1919, there were sold 9,055 skins from the Pribilof Islands. The total price bid was $827,112.50. The maximum price was $115 per skin; the average price was $91.34 per skin, an advance of 37 per cent over the average of $66.77 received at the last preceding sale, April 28, 1919, and an advance of 77 per cent over the average of $51.72 received at the sale on October 7, 1918. The following tables give details and summaries in regard to the sales:

SALES OF DRESSED, DYED, AND MACHINED PRIBILOF FUR-SEAL SKINS AT ST. LOUIS, 1919.

SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.	Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$81.00	$4,050.00	28	60	Extra extra large.	$75.00	$4,500.00
2	50	do	81.00	4,050.00	29	60	do	77.00	4,620.00
3	50	do	80.00	4,000.00	30	60	do	74.00	4,440.00
4	50	do	82.00	4,100.00	31	60	do	77.00	4,620.00
5	50	do	81.00	4,050.00	32	60	do	75.00	4,500.00
6	50	do	85.00	4,250.00	33	60	do	75.00	4,500.00
7	50	do	82.00	4,100.00	34	60	do	76.00	4,560.00
8	50	do	84.00	4,200.00	35	60	do	78.00	4,680.00
9	50	do	84.00	4,200.00	36	60	do	75.00	4,500.00
10	50	do	83.00	4,150.00	37	60	do	75.00	4,500.00
11	50	do	88.00	4,400.00	38	60	do	75.00	4,500.00
12	50	Wigs; cut, scarred, etc	60.00	3,000.00	39	60	do	74.00	4,440.00
13	50	do	60.00	3,000.00	40	60	do	79.00	4,740.00
14	50	do	62.00	3,100.00	41	60	Extra extra large; cut, scarred, etc.	59.00	3,540.00
15	60	Extra extra large	79.00	4,740.00	42	60	do	57.00	3,420.00
16	60	do	77.00	4,620.00	43	60	do	58.00	3,480.00
17	60	do	78.00	4,680.00	44	60	do	61.00	3,660.00
18	60	do	76.00	4,560.00	45	50	do	62.00	3,100.00
19	60	do	76.00	4,560.00	46	70	Extra large	73.00	5,110.00
20	60	do	76.00	4,560.00	47	70	do	74.00	5,180.00
21	60	do	78.00	4,680.00	48	70	do	76.00	5,320.00
22	60	do	79.00	4,740.00	49	70	do	74.00	5,180.00
23	60	do	77.50	4,650.00	50	70	do	74.50	5,215.00
24	60	do	76.50	4,590.00	51	70	do	75.00	5,250.00
25	60	do	80.00	4,800.00	52	70	do	76.00	5,320.00
26	60	do	76.00	4,560.00	53	70	do	79.00	5,530.00
27	60	do	77.50	4,650.00	54	70	do	77.00	5,390.00

Sale of Dressed, Dyed, and Machined Pribilof Fur-Seal Skins at St. Louis, 1919—Continued.

SALE OF 10,102 SKINS, ST. LOUIS, APR. 28, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
55	70	Extra large	$78.00	$5,460.00
56	70	do	75.00	5,250.00
57	70	do	77.00	5,390.00
58	70	do	78.00	5,460.00
59	70	do	77.00	5,390.00
60	70	do	78.00	5,460.00
61	50	do	77.00	3,850.00
62	45	do	77.00	3,465.00
63	70	Extra large; cut, scarred, etc	63.00	4,410.00
64	70	do	65.00	4,550.00
65	70	do	65.00	4,550.00
66	80	Large	74.00	5,920.00
67	80	do	74.00	5,920.00
68	80	do	80.00	6,400.00
69	80	do	77.00	6,160.00
70	80	do	77.00	6,160.00
71	80	do	77.00	6,160.00
72	80	do	77.50	6,200.00
73	80	do	78.50	6,280.00
74	80	do	79.50	6,360.00
75	80	do	78.00	6,240.00
76	80	do	80.00	6,400.00
77	80	do	83.00	6,640.00
78	80	do	81.00	6,480.00
79	50	do	79.00	3,950.00
80	80	Large; cut, scarred, etc	60.00	4,800.00
81	80	do	64.00	5,120.00
82	80	do	65.00	5,200.00
83	90	Mediums	69.00	6,210.00
84	90	do	70.50	6,345.00
85	90	do	70.00	6,300.00
86	90	do	75.00	6,750.00
87	90	do	73.00	6,570.00
88	90	do	73.00	6,570.00
89	90	Mediums; cut, scarred, etc	56.00	5,040.00
90	90	do	58.00	5,220.00
91	50	Small mediums	60.00	3,000.00
92	50	III wigs	51.00	2,550.00
93	55	III extra extra large	53.00	2,915.00
94	45	III extra large	48.00	2,160.00
95	65	III—47 large, 16 mediums, 2 small mediums	49.00	3,185.00
101	45	Wigs	79.00	3,555.00
102	45	do	77.00	3,465.00
103	45	do	78.00	3,510.00
104	45	do	77.00	3,465.00
105	45	Wigs; cut, scarred, etc	57.00	2,565.00
106	43	do	62.00	2,666.00
107	55	Extra extra large	70.00	3,850.00
108	55	do	69.00	3,795.00
109	55	do	68.00	3,740.00
110	55	do	69.00	3,795.00
111	55	do	70.50	3,877.50
112	40	Extra extra large	$70.50	$2,820.00
113	55	Extra extra large; cut, scarred, etc	69.50	3,822.50
114	48	do	63.00	3,024.00
115	70	Extra large	68.00	4,760.00
116	70	do	66.50	4,655.00
117	70	do	70.50	4,935.00
118	70	do	70.00	4,900.00
119	70	do	70.00	4,900.00
120	70	do	70.00	4,900.00
121	32	do	72.00	2,304.00
122	70	Extra large; cut, scarred, etc	55.50	3,885.00
123	70	do	55.50	3,885.00
124	24	do	55.50	1,332.00
125	80	Large	61.00	4,880.00
126	80	do	59.50	4,760.00
127	80	do	62.00	4,960.00
128	80	do	70.00	5,600.00
129	80	do	69.00	5,520.00
130	80	do	69.00	5,520.00
131	80	do	68.00	5,440.00
132	80	do	69.00	5,520.00
133	50	do	67.00	3,350.00
134	45	do	70.00	3,150.00
135	80	Large; cut, scarred, etc	55.00	4,400.00
136	80	do	50.00	4,000.00
137	80	do	50.50	4,040.00
138	90	Mediums	60.00	5,400.00
139	90	do	63.00	5,670.00
140	90	do	62.00	5,580.00
141	90	do	61.00	5,490.00
142	90	do	58.50	5,265.00
143	90	do	61.00	5,490.00
144	51	do	59.00	3,009.00
145	90	Mediums; cut, scarred, etc	40.00	3,600.00
146	90	do	37.00	3,330.00
147	90	do	39.00	3,510.00
148	66	do	40.00	2,640.00
149	94	Small mediums	50.00	4,700.00
150	74	Small mediums; cut, scarred, etc	28.00	2,072.00
151	57	III—43 wigs, 14 extra extra large	39.00	2,223.00
152	48	III extra large	40.00	1,920.00
153	79	III large	30.00	2,370.00
154	87	III mediums	27.50	2,392.50
155	85	do	27.50	2,337.50
156	71	III small mediums	23.00	1,633.00
157	26	IV—6 wigs, 2 extra extra large, 3 extra large, 15 large	18.00	468.00
158	57	IV—24 mediums, 33 small mediums	10.00	570.00
	10,102			674,491.00

SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
1	50	Wigs	$97.00	$4,850.00
2	50	do	101.00	5,050.00
3	50	do	100.00	5,000.00
4	50	do	101.00	5,050.00
5	50	do	103.00	5,150.00
6	50	do	105.00	5,250.00
7	50	do	102.00	5,100.00
8	50	do	104.00	5,200.00
9	50	do	106.00	5,300.00
10	50	do	105.00	5,250.00
11	50	do	115.00	5,750.00
12	35	do	107.50	3,762.50
13	50	Wigs; cut, scarred, etc	74.00	3,700.00
14	50	do	77.00	3,850.00
15	60	Extra extra large	$105.00	$6,300.00
16	60	do	104.00	6,240.00
17	60	do	105.00	6,300.00
18	60	do	107.50	6,450.00
19	60	do	104.00	6,240.00
20	60	do	110.00	6,600.00
21	60	do	109.00	6,540.00
22	60	do	107.00	6,420.00
23	60	do	107.00	6,420.00
24	60	do	106.00	6,360.00
25	60	do	109.00	6,540.00
26	60	do	106.00	6,360.00
27	60	do	110.00	6,600.00
28	60	do	108.00	6,480.00
29	60	do	111.00	6,660.00

SALE OF DRESSED, DYED, AND MACHINED PRIBILOF FUR-SEAL SKINS AT ST. LOUIS, 1919—Continued.

SALE OF 9,055 SKINS, ST. LOUIS, SEPT. 10, 1919—Continued.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
30	60	Extra extra large	$111.00	$6,660.00
31	60	do	112.00	6,720.00
32	60	do	111.00	6,660.00
33	60	do	110.00	6,600.00
34	60	do	112.00	6,720.00
35	60	do	115.00	6,900.00
36	60	Extra extra large; cut, scarred, etc.	97.00	5,820.00
37	60	do	95.00	5,700.00
38	60	do	95.00	5,700.00
39	70	Extra large	100.00	7,000.00
40	70	do	99.00	6,930.00
41	70	do	98.00	6,860.00
42	70	do	101.00	7,070.00
43	70	do	102.00	7,140.00
44	70	do	99.00	6,930.00
45	70	do	96.00	6,720.00
46	70	do	104.00	7,280.00
47	70	do	99.00	6,930.00
48	70	do	99.00	6,930.00
49	70	do	101.00	7,070.00
50	70	do	104.00	7,280.00
51	70	do	101.00	7,070.00
52	70	do	109.00	7,630.00
53	70	do	104.50	7,315.00
54	70	do	105.00	7,350.00
55	70	do	107.00	7,490.00
56	70	Extra large; cut, scarred, etc	95.00	6,650.00
57	70	do	87.00	6,090.00
58	50	do	95.00	4,750.00
59	80	Large	101.00	8,080.00
60	80	do	100.00	8,000.00
61	80	do	101.00	8,080.00
62	80	do	100.00	8,000.00
63	80	do	100.00	8,000.00
64	80	do	103.00	8,240.00
65	80	do	100.00	8,000.00
66	80	do	100.00	8,000.00
67	80	do	99.00	7,920.00
68	80	do	105.00	8,400.00
69	80	do	104.00	8,320.00
70	80	do	102.00	8,160.00
71	80	do	101.00	8,080.00
72	80	do	101.00	8,080.00
73	80	do	100.00	8,000.00
74	80	do	100.00	8,000.00
75	80	do	101.00	8,080.00
76	80	do	103.00	8,240.00
77	80	do	100.00	8,000.00
78	80	do	102.50	8,200.00
79	80	do	101.00	8,080.00
80	80	do	102.00	8,160.00
81	80	do	102.00	8,160.00
82	80	Large; cut, scarred, etc	79.00	6,320.00
83	80	do	81.00	6,480.00
84	80	Large; cut, scarred, etc	$80.00	$6,400.00
85	80	do	78.00	6,240.00
86	80	do	80.00	6,400.00
87	80	do	82.00	6,560.00
88	90	Mediums	90.00	8,100.00
89	90	do	85.00	7,650.00
90	90	do	85.00	7,650.00
91	90	do	82.00	7,380.00
92	90	do	82.50	7,425.00
93	90	do	82.00	7,380.00
94	90	do	82.00	7,380.00
95	90	do	83.00	7,470.00
96	90	do	83.00	7,470.00
97	90	do	83.00	7,470.00
98	90	do	83.50	7,515.00
99	90	do	83.00	7,470.00
100	90	do	87.00	7,830.00
101	90	do	85.00	7,650.00
102	90	do	83.00	7,470.00
103	90	do	83.00	7,470.00
104	90	do	86.00	7,740.00
105	90	do	84.00	7,560.00
106	90	do	82.00	7,380.00
107	90	do	85.00	7,650.00
108	80	do	83.00	6,640.00
109	80	do	86.00	6,880.00
110	90	Mediums; cut, scarred, etc	62.00	5,580.00
111	90	do	65.00	5,850.00
112	90	do	67.00	6,030.00
113	90	do	66.00	5,940.00
114	90	do	66.00	5,940.00
115	60	do	65.00	3,900.00
116	90	Small mediums	66.00	5,940.00
117	90	do	68.00	6,120.00
118	90	do	69.00	6,210.00
119	80	do	66.50	5,320.00
120	70	Small mediums; cut, scarred, etc.	50.00	3,500.00
121	65	do	50.00	3,250.00
122	50	III wigs	57.00	2,850.00
123	65	III—40 extra extra large, 25 extra large	61.00	3,965.00
124	55	III large	52.00	2,860.00
125	75	III—39 mediums, 36 small mediums	42.00	3,150.00
126	30	IV—8 wigs, 3 extra extra large, 4 extra large, 10 large, 4 mediums, 1 small medium	22.00	660.00
	9,055			$827,112.50

SUMMARY OF TRADE CLASSIFICATIONS, OF PERCENTAGES OF TOTAL IN EACH CLASS, AND OF AMOUNTS RECEIVED AT SALES OF FUR-SEAL SKINS, ST. LOUIS, 1919.

Trade classification.	Sale, Apr. 28, 1919.			Sale, Sept. 10, 1919.			Total.	
	Number.	*Per cent.*	*Amount.*	*Number.*	*Per cent.*	*Amount.*	*Number.*	*Amount.*
Wigs	1,067	10.56	$78,211.00	743	8.21	$71,288.50	1,810	$149,499.50
Extra extra large	2,339	23.16	168,911.00	1,483	16.38	156,496.00	3,822	325,407.00
Extra large	2,067	20.46	145,320.00	1,409	15.56	140,098.00	3,476	285,418.00
Large	2,446	24.21	166,473.00	2,385	26.34	227,760.00	4,831	394,233.00
Mediums	1,859	18.40	103,743.00	2,513	27.75	199,596.00	4,372	303,339.00
Small mediums	324	3.21	11,833.00	522	5.76	31,874.00	846	43,707.00
Total	10,102	100.00	674,491.00	9,055	100.00	827,112.50	19,157	1,501,603.50

GRADES AND COMPARATIVE VALUES OF SEALSKINS.

As was done in the 1918 Alaska report in respect to the sealskins sold in 1918, record is made of the comparative trade classifications and prices obtained for the various sizes of sealskins sold in 1919. The following table gives the number and grade of skins of each category and the high, low, and average prices received:

COMPARATIVE VALUES BY GRADES AND SIZES OF SEALSKINS SOLD IN 1919.

Classes and sales.	Grade.	Number.	High.	Low.	Average.	Total.	Total number.	Average.	Total price.
Wigs:									
Apr. 28	I and II.	730	$85.00	$77.00	$81.57	$59,545.00	1,067	$73.30	$78,211.00
	Cut, etc.	238	62.00	57.00	60.21	14,331.00			
	III	93	51.00	39.00	45.45	4,227.00			
	IV	6	18.00	18.00	18.00	108.00			
Sept. 10	I and II.	585	115.00	97.00	103.78	60,712.50	743	95.95	71,288.50
	Cut, etc.	100	77.00	74.00	75.50	7,550.00			
	III	50	57.00	57.00	57.00	2,850.00			
	IV	8	22.00	22.00	22.00	176.00			
Extra extra large:									
Apr. 28	I and II.	1,875	80.00	68.00	75.40	141,367.50	2,339	72.22	168,911.00
	Cut, etc.	393	69.50	57.00	61.19	24,046.50			
	III	69	53.00	39.00	50.16	3,461.00			
	IV	2	18.00	18.00	18.00	36.00			
Sept. 10	I and II.	1,260	115.00	104.00	108.55	136,770.00	1,483	105.53	156,496.00
	Cut, etc.	180	97.00	95.00	95.67	17,220.00			
	III	40	61.00	61.00	61.00	2,440.00			
	IV	3	22.00	22.00	22.00	66.00			
Extra large:									
Apr. 28	I and II.	1,597	79.00	66.50	74.25	118,574.00	2,067	70.30	145,320.00
	Cut, etc.	374	65.00	55.50	60.46	22,612.00			
	III	93	48.00	40.00	43.87	4,080.00			
	IV	3	18.00	18.00	18.00	54.00			
Sept. 10	I and II.	1,190	109.00	96.00	101.68	120,995.00	1,409	99.43	140,098.00
	Cut, etc.	190	95.00	87.00	92.05	17,490.00			
	III	25	61.00	61.00	61.00	1,525.00			
	IV	4	22.00	22.00	22.00	88.00			
Large:									
Apr. 28	I and II.	1,825	83.00	59.50	73.41	133,970.00	2,446	68.06	166,473.00
	Cut, etc.	480	65.00	50.00	57.42	27,560.00			
	III	126	49.00	30.00	37.09	4,673.00			
	IV	15	18.00	18.00	18.00	270.00			
Sept. 10	I and II.	1,840	105.00	99.00	101.24	186,280.00	2,385	95.50	227,760.00
	Cut, etc.	480	82.00	78.00	80.00	38,400.00			
	III	55	52.00	52.00	52.00	2,860.00			
	IV	10	22.00	22.00	22.00	220.00			
Mediums:									
Apr. 28	I and II.	1,131	75.00	58.50	66.00	74,649.00	1,859	55.81	103,743.00
	Cut, etc.	516	58.00	37.00	45.23	23,340.00			
	III	188	49.00	27.50	29.33	5,514.00			
	IV	24	10.00	10.00	10.00	240.00			
Sept. 10	I and II.	1,960	90.00	82.00	83.99	164,630.00	2,513	79.43	199,596.00
	Cut, etc.	510	67.00	62.00	65.18	33,240.00			
	III	39	42.00	42.00	42.00	1,638.00			
	IV	4	22.00	22.00	22.00	88.00			
Small mediums:									
Apr. 28	I and II.	144	60.00	50.00	53.47	7,700.00	324	36.52	11,833.00
	Cut, etc.	74	28.00	28.00	28.00	2,072.00			
	III	73	49.00	23.00	23.71	1,731.00			
	IV	33	10.00	10.00	10.00	330.00			
Sept. 10	I and II.	350	69.00	66.00	67.40	23,590.00	522	61.06	31,874.00
	Cut, etc.	135	50.00	50.00	50.00	6,750.00			
	III	36	42.00	42.00	42.00	1,512.00			
	IV	1	22.00	22.00	22.00	22.00			
Apr. 28							10,102	66.77	674,491.00
Sept. 10							9,055	91.34	827,112.50
Both sales							19,157	78.38	1,501,603.50

SUMMARY OF FUR-SEAL SKINS SHIPPED TO FUNSTEN BROS. & CO.

Beginning with the year 1913 all merchantable fur-seal skins shipped from the Pribilof Islands have been forwarded to Funsten Bros. & Co., St. Louis, Mo., for sale. The first sale, held in December, 1913, consisted of 1,896 salted skins. All subsequent sales have been of dressed, dyed, and machined skins. The table following records all shipments made to the firm in the years 1913 to 1919, inclusive, sales of skins, and balances remaining in the custody of the firm.

SUMMARY OF PRIBILOF ISLANDS FUR-SEAL SKINS RECEIVED AND SOLD BY FUNSTEN BROS. & CO., ST. LOUIS, MO., AND BALANCES IN FIRM'S CUSTODY, 1913 TO 1919.

Receipts					Sales.				Balances on hand.		
Approximate date of shipment from Pribilofs.	Approximate date of receipt by firm.	Number of skins.			Date of sale.	Number of skins.			Food skins.[a]	Commercial skins.[b]	Total.
		Food skins.[a]	Commercial skins.[b]	Total.		Food skins.[a]	Commercial skins.[b]	Total.			
Aug. 8, 1913	1913	2,296		2,296					2,296		2,296
					Dec. 16, 1913	1,896		1,896	400		400
Oct., 1914	1914	2,884		2,884					3,284		3,284
1914	1915	12		12					3,296		3,296
Sept., 1915	1915	3,000		3,000					6,296		6,296
					Sept. 20, 1916	1,900		1,900	4,396		4,396
Oct., 1916	Nov. 14, 1916	7,061		7,061					11,457		11,457
					Jan. 29, 1917	2,000		2,000	9,457		9,457
					Apr. 18, 1917	1,500		1,500	7,957		7,957
Aug. 1, 1917	Sept. 19, 1917	4,882		4,882					12,839		12,839
					Oct. 8, 1917	3,239		3,239	9,600		9,600
Dec. 17, 1917	Feb., 1918	2,427	1,831	4,258					12,027	1,831	13,858
					Apr. 22, 1918	6,100		6,100	5,927	1,831	,758
June 22, 1918	July 30, 1918		3,542	3,542					5,927	5,373	17,300
					Oct. 7, 1918	2,000		2,000	3,927	5,373	91,300
Sept. 14, 1918	Oct. 30, 1918		17,816	17,816					3,927	23,189	27,116
Oct. 6, 1918	Nov. 25, 1918		1,978	1,978					3,927	25,167	29,094
Dec. 12, 1918	Jan. 29, 1919		7,482	7,482					3,927	32,649	36,576
					Apr. 28, 1919	3,882	6,220	10,102	45	26,429	26,474
May 21, 1919	June 24, 1919		4,013	4,013					45	30,442	30,487
					Sept. 10, 1919		9,055	9,055	45	21,387	21,432
Oct. 13, 1919	Nov. 24, 1919		26,185	26,185					c 43	47,572	47,615

[a] Skins taken from seals killed for natives' food prior to the termination on Aug. 24, 1917, of the 5-year period of restricted killings provided by the act of Aug. 24, 1912.
[b] Skins taken subsequent to Aug. 24, 1917.
[c] Final count of food skins at St. Louis showed 2 less than the Bureau's former record. The St. Louis count was accepted by the Bureau in accordance with letter of Jan. 24, 1920, to Funsten Bros. & Co.

FUR-SEAL SKINS ON HAND DECEMBER 31, 1919.

In order to have available in concise form figures in regard to the number of fur-seal skins handled during the year and the number on hand both at the Pribilof Islands and at St. Louis at the end of the calendar year 1919, the following tabulations have been prepared:

St. Louis Record of Sealskins.[a]

On hand Jan. 1, 1919		29,080
Shipments received in 1919:		
January	7,482	
June	4,013	
July (from Washington)	12	
November	26,185	
		37,692
Total		66,772
Sales during 1919:		
April	10,102	
September	9,055	
		19,157
Balance on hand Dec. 31, 1919		47,615

Pribilof Record of Sealskins.[a]

On hand Jan. 1, 1919:		
St. Paul Island	3,796	
St. George Island	389	
En route (on board *Roosevelt*)	7,482	
		11,667
Skins taken in 1919:		
St. Paul Island	24,053	
St. George Island	3,768	
		27,821
Total		39,488
Shipments during 1919:		
St. Paul Island	29,352	
St. George Island	8,328	
		37,680
Balance on hand Dec. 31, 1919 (St. Paul, 1,405; St. George, 412)		[b]1,817
Grand total on hand Dec. 31, 1919		49,432

SALE OF FOX SKINS.

The fox skins taken on the Pribilof Islands in the season of 1918–19 numbered 667 blue pelts and 30 white pelts, which, with the exception of 2 blue pelts withheld for exhibition purposes at Washington, were sold at public auction at St. Louis on September 10, 1919. The 665 blues brought $130,274.50, an average of $195.90 each, and the 30 white skins $1,660, an average of $55.33 each. The following table shows details in regard to the sale:

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[a] When the shipment en route from the islands at the end of 1918 was checked out at St. Louis the number of skins was found to be 7,482 instead of 7,483, as stated on p. 114 of the corresponding report for 1918. It was also found when skins were packed on St. George Island in 1919 that 389 skins remained from the 1918 take, instead of 387, as stated on p. 109 of the printed report for 1918.

[b] A report from the agent and caretaker on St. Paul Island, dated Dec. 8, 1919, stated that counts of the skins on hand showed an excess of 9 over the number supposed to remain after all shipments. The shipment which reached the dressing and dyeing plant in November, 1919, had not been unpacked and checked at the end of the year, and part or all of this excess may be accounted for when final report is made on that shipment. In handling the large number of skins taken during the season, it seems practically impossible to avoid the occurrence of slight discrepancies in the counts.

Details of Sale of 665 Blue Fox Skins and 30 White Fox Skins From Pribilof Islands at St. Louis, Sept. 10, 1919.

Lot No.	Number of skins.	Trade classification.	Price per skin.	Total for lot.
Blue fox skins:				
300	4	Extra extra fine	$350.00	$1,400.00
301	4	do	310.00	1,240.00
302	4	Extra fine	315.00	1,260.00
303	4	do	320.00	1,280.00
304	4	do	275.00	1,100.00
305	6	do	370.00	2,220.00
306	6	do	325.00	1,950.00
307	5	Extra large fine	335.00	1,675.00
308	10	II extra large dark	220.00	2,200.00
309	6	I extra large dark	300.00	1,800.00
310	8	do	265.00	2,120.00
311	8	do	265.00	2,120.00
312	10	I dark	295.00	2,950.00
313	10	do	260.00	2,600.00
314	10	II extra large dark	225.00	2,250.00
315	10	do	210.00	2,100.00
316	12	II dark	190.00	2,280.00
317	12	do	190.00	2,280.00
318	10	II extra large dark low	145.00	1,450.00
319	8	do	125.00	1,000.00
320	16	II dark low	100.00	1,600.00
321	9	I extra large blue	190.00	1,710.00
322	10	I blue	205.00	2,050.00
323	10	II extra large blue	215.00	2,150.00
324	10	do	195.00	1,950.00
325	10	II blue	190.00	1,900.00
326	10	do	135.00	1,350.00
327	10	II extra large blue low	110.00	1,100.00
328	10	do	110.00	1,100.00
329	10	II blue low	85.00	850.00
330	8	Dark silvery	395.00	3,160.00
331	15	III dark	47.00	705.00
332	6	Extra large fine dark	380.00	2,280.00
333	4	Extra fine dark	325.00	1,300.00
334	4	do	320.00	1,280.00
335	8	II extra large fine dark	275.00	2,200.00
336	4	II large fine dark	215.00	860.00
337	6	I extra large fine dark	275.00	1,650.00
338	8	I fine dark	285.00	2,280.00
339	8	do	280.00	2,240.00
340	8	do	250.00	2,000.00
341	6	do	240.00	1,440.00
342	10	II fine dark	205.00	2,050.00
343	6	I extra large dark	220.00	1,320.00
344	5	do	215.00	1,075.00
345	8	II extra large dark	180.00	1,440.00
346	8	do	170.00	1,360.00
347	10	I dark	230.00	2,300.00
348	12	do	210.00	2,520.00
349	12	II dark	190.00	2,280.00
350	12	do	185.00	2,220.00
351	12	do	205.00	2,460.00
352	13	do	175.00	2,275.00
353	12	I blue	210.00	2,520.00
354	14	II extra large blue	160.00	2,240.00
355	10	II blue	160.00	1,600.00
356	10	do	155.00	1,550.00
357	7	do	130.00	910.00
358	12	II blue low	115.00	1,380.00
359	10	do	105.00	1,050.00
360	8	I extra large silvery	270.00	2,160.00
361	7	II silvery	205.00	1,435.00
362	11	I and II pale	175.00	1,925.00
363	17	III blue	60.00	1,020.00
364	21	IV	28.00	588.00
365	13	V	5.50	71.50
366	4	I fine dark	400.00	1,600.00
367	8	II fine dark	260.00	2,080.00
368	6	I dark	280.00	1,680.00
369	8	I blue	200.00	1,600.00
370	12	II blue	205.00	2,460.00
371	8	II blue low	160.00	1,280.00
372	11	I and II dark silvery	335.00	3,685.00
373	5	I silvery	230.00	1,150.00
373A	2	II extra large fine dark	280.00	560.00
White fox skins:				
374	16	I	67.00	1,072.00
375	14	II Pt. low	42.00	588.00
Total	695			131,934.50

JAPANESE SEALSKINS DELIVERED TO UNITED STATES.

The North Pacific Sealing Convention of July 7, 1911, provides that in respect to fur-seal skins taken annually upon Robben Island, or any other islands or shores of the waters covered by the convention subject to the jurisdiction of Japan, 10 per cent in number and value shall be delivered to the United States. In 1918 the Japanese take consisted of 555 skins. The same number were taken in 1919. The share of the United States for the two years was, accordingly, 111 skins. These skins were forwarded to the Bureau's agents, Funsten Bros. & Co., St. Louis, for sale. They arrived at St. Louis, March 15, 1920. Examination of the skins showed that they had been very carefully taken and cured. It is understood that the take of Japanese skins in 1918 and 1919 all came from Robben Island.

Information received informally from Mr. K. Ishino, of the Imperial Bureau of Fisheries of Japan, indicates that there were on Robben Island in 1919, between 11,000 and 12,000 seals, and that the seals on the Kuril Islands have gradually decreased in the past four or five years and have now almost disappeared. Mr. Ishino also stated that when at the Commander Islands in 1916 he determined that the Russian herd numbered about 50,000 animals. The Russian Government's report, however, claims only 30,000. In 1917 there were 800 seals killed on Copper Island, one of the Commander group. Mr. Ishino stated that sea otters are increasing among the Kuril Islands and that in 1919 he saw 300 and has reason to believe that there are at least 500 there. He advised also that sea otters are increasing about the Russian islands.

FUR-SEAL CENSUS, PRIBILOF ISLANDS, 1919.

By G. Dallas Hanna.

A census of the Alaska fur-seal herd was taken during the summer of 1919 by employing the methods which have been in practice for several previous years. These, together with the habits of the animals and the history of the herd have been fully described in the annual reports from 1914 to 1918, so that in order to avoid needless repetition these subjects will not be treated herein, except in so far as seems necessary to properly present the new data. Some new facts in regard to the natural history of the animals, learned in 1919, will be mentioned, however, in order to keep this phase of the subject up to date.

A complete count of bulls was made at the height of the breeding season. To facilitate the count, driftwood and paint markers were placed on some of the rookeries which are more difficult to count. While these were very helpful they only emphasized the need of permanent work of this character carried on with the erection of overhead observation positions.

After the breaking up of the harems, pups were counted on as many rookeries as possible in order to determine the average harem.

Preliminary harem counts (not tabulated herein) were made on St. George Island by C. E. Crompton and on St. Paul by the author. These proved helpful in the final counts and afforded a fair check on the work.

In the harem counts, H. D. Aller assisted on St. Paul and C. E. Crompton on St. George. The same men assisted in the pup counts on the same islands. Besides this Mr. Crompton made the pup count of Staraya Artil Rookery on St. George and Mr. Aller counted Polovina Cliffs Rookery on St. Paul.

DIFFICULTIES ENCOUNTERED.

As the seal herd grows a census taken by present means becomes less and less accurate. This is necessarily the case because of the large masses of animals dealt with, and unless an elaborate system of markers and elevated viewpoints be established it will not be many years until the count of harems will give no more accurate an enumeration than an estimation by the area method. The construction of the necessary apparatus, however, is believed to be feasible, and in view of the accurate knowledge which can be gained in regard to the state of the herd it would seem to be very profitable. Under present methods of calculation the harem count is fundamental. If it be far wrong the entire census becomes an estimate with figures which look mathematically exact. When the herd was small the harems could be counted exactly, but this is not true to-day. Therefore the readers of this report should bear in mind that although figures for the different classes are given exactly, only round numbers are intended. A complete census is an absolute impossibility. A close approximation to the truth is all that can be expected. The best census is a very careful estimate made by utilizing as many of the known factors in the biology of the species as possible.

The great difficulty in counting bulls is to find a point back of the large rookeries from which all the animals can be seen. In order to overcome the trouble we climb a high ladder which can be moved from place to place, and whenever the weather and sea will permit boats are utilized, because of the better view thus usually secured. But both of these methods are unsatisfactory and certain construction work has been outlined elsewhere. Possibly the work could be done with absolute accuracy from an airplane with the aid of photography, a means first suggested, it is thought, by Dr. Paul Bartsch, of the United States National Museum.

With the decrease in the number of bulls and the increase in the average harem in 1919 less difficulty was experienced in counting pups than in 1917 and 1918. The rookeries are so large on St. Paul now, however, that a complete pup count could hardly be attempted without a considerable force of men. And even then it is believed the loss which the herd would suffer from the count would not be warranted. If the persons intrusted with the census work can give the subject their undivided attention during the season the count of pups on a few of the smaller rookeries should suffice to establish the average harem, provided, of course, that the harem count be accurate.

SUGGESTIONS FOR FUTURE CENSUSES.

In connection with work on the fur-seal rookeries it is impossible to forecast even one year in advance the new problems which may be forthcoming and the difficulties which may arise to interfere with a satisfactory taking of the census. However, several years' experience have led to certain conclusions which may be worth recording for such use as future workers may care to make of them.

It is anticipated that the bull counts on St. George Island can be made with comparative ease at the height of the breeding season; no material increase in the idle and harem bull classes is expected for at least two or three years. Staraya Artil and North Rookeries are much more satisfactorily counted from a boat than from the land side if the weather is suitable for one to get out on the sea. Should it be necessary to count from the land however, the use of a long ladder is recommended in order to permit observation of the entire areas of the breeding masses. East Reef and East Cliffs Rookeries can be seen better from the water, but satisfactory counts can be obtained from the land. A considerable risk is run in the case of the latter rookery on account of the dense vegetation growing on a ragged slope. Should one slip here he would fall among the bulls and be in imminent danger of losing his life. However, should timidity be felt regarding the cliff, it seems entirely feasible for the person doing the counting to be supported from above with a rope. Zapadni Rookery can be counted by exercising the ordinary care one acquires in creeping upon the breeding rookeries; and the same is true in the case of South.

The much larger areas on St. Paul Island, however, can not be disposed of so easily. There is not likely to be any material diminution in the numbers of bulls, which are a constant menace to observers during the height of the season counts. While this is the most important of all census work it is becoming less and less satisfactory because of extraordinary difficulties encountered. The larger rookeries can not be seen from a point on the land side. Heretofore the precarious utilization of a long ladder supported by guys has been resorted to. These guys must be held by men and if a bull should charge one of these men a most uncomfortable fall to the rocks below would result.

Temporary marks of driftwood and paint have been placed on the difficult rookeries the past few years. Time and labor, however, have not permitted this to be done in any but a cursory fashion.

A large amount of work needs to be done in order to make the bull counts of the future satisfactory. Concrete markers should be placed at regular intervals of at least 100 feet (better every 50 feet) on the following rookeries: Gorbatch, Reef, Kitovi, Lukanin, Polovina, Morjovi, Vostochni, Zapadni, Little Zapadni, and Tolstoi. A marker 3 feet long, 1 foot square at the base, and 6 inches square at the top is suggested. It could be buried a foot in most places. It would be very desirable also to have a piece of 1-inch galvanized pipe 6 feet long set into each to facilitate handling the block and to make it much easier to see at the long distance from which counts must ordinarily be made.

Overhead runways for the observer to walk out to the crest of the beach line should be provided on most of the rookeries mentioned above. They need not be elaborate. All that is needed is a trestlework 6 feet high and a walkway 1 or 2 feet wide. No hesitation need be felt because of the effect these structures would have on the seals. In 1919 two boats remained on Reef Rookery throughout the season and the seals paid not the slightest attention to them.

This construction work which has been recommended must be done at the earliest possible moment if satisfactory census figures are desired. It can not be done now, however, in time for use in 1920. The bulls arrive in May, which is earlier than men can ordinarily get to the islands. Snow then usually covers the ground and would prevent work of the character outlined. Such work, which would involve a considerable amount of labor, must be done after August 10 if it is to be done at all, during the season when the island force would be busy at other work. It is recommended, therefore, that at least five assistants be supplied the man who directs this work. One of these should be a good carpenter who could act as foreman, and the others should be laborers. All should be taken from the States. During the sealing season there is an abundance of work elsewhere on St. Paul for them to do. As stated, they would not be needed on the rookeries until after August 10.

Too strong emphasis can not be placed on the need of the work outlined above and on the absolute necessity of its being provided for wholly by outside labor.

It may be asked, why the large St. Paul rookeries can not be counted from a boat. It is not always possible to get out on the water for this purpose, but when it is I have chosen the means in preference to the ladder for Zapadni, Little Zapadni and Tolstoi. However, these rookeries are becoming so deep that it is practically impossible to get an accurate count of bulls from a boat. The areas are too broad and the seals are too campact therein.

As the number of bulls is reduced in the herd the counting of pups will become easier and the work can be undertaken somewhat earlier. If the force of men recommended is supplied in 1920 doubtless some of the larger rookeries can be counted again. But unless a thoroughly accurate and satisfactory count of harems can be made on a rookery the count of pups is not so valuable as it otherwise would be.

PUPS.

Distribution of Pups in 1919.

Rookery.	Date of counts.	Living pups.	Dead pups.	Total pups.	Per cent dead.
ST. PAUL ISLAND.					
Kitovi	....	3,512	53	a 3,565	1.49
Lukanin	....	2,712	76	a 2,788	2.73
Gorbatch	....	11,878	430	a 12,308	3.49
Ardiguen	....	1,130	20	a 1,150	1.74
Reef	....	21,871	586	a 22,457	2.61
Sivutch	....	6,840	175	a 7,015	2.49
Lagoon	Aug. 11	430	15	445	3.37
Tolstoi	....	15,668	359	a 16,027	2.24
Zapadni	....	13,921	379	a 14,300	2.65
Little Zapadni	....	9,817	328	a 10,145	3.23
Zapadni Reef	Aug. 12	581	23	604	3.81
Polovina	Aug. 13	5,486	308	5,794	5.31
Polovina Cliffs	Aug. 14	2,148	61	2,209	2.76
Little Polovina	....	1,189	14	a 1,203	1.16
Morjovi	Aug. 14	2,953	88	3,041	2.89
Vostochni	....	29,480	1,383	a 30,863	4.48
Total	....	129,616	4,298	133,914	3.21
ST. GEORGE ISLAND.					
North	....	8,584	218	a 8,802	2.48
Staraya Artil	Aug. 2	5,582	164	5,746	2.85
Zapadni	Aug. 5	846	11	857	1.28
South	Aug. 5	68	....	68	....
East Reef	Aug. 4	2,345	22	2,367	.93
East Cliffs	....	5,297	121	a 5,418	2.23
Total	....	22,722	536	23,258	2.30
Total, both islands	....	152,338	4,834	157,172	3.07

a Based on estimated average harem.

The number of dead pups was ascertained on each rookery counted at the time the count was made. On those rookeries on which the cows and pups were estimated the number of dead was computed from the percentage of dead used in the 1918 report. The small increase in the average harem, especially on St. George, should have reduced the percentage of dead pups to a slight extent. On St. Paul, conditions were so little changed in this respect, however, that the difference would not overbalance variations due to the laws of chance. Therefore until average harems become as large as they have been in some former year (as 1916 for instance) when the death rate was determined for all of the rookeries it seems best to make no change in the percentages. The rookeries which were counted in 1919 gave no data upon which to base a reduction. In fact there was in some cases evidence of a slight increase in the number of dead pups.

INCREASE OR DECREASE IN NUMBER OF PUPS IN 1919 FROM 1918.

Rookery.	Total pups, 1918.	Total pups, 1919.	Numerical increase.	Increase (+) or decrease (−).
ST. PAUL ISLAND.				*Per cent.*
Kitovi	2,540	3,565	1,025	+40.35
Lukanin	2,235	2,788	553	+24.74
Gorbatch	9,486	12,308	2,822	+29.74
Ardiguen	792	1,150	358	+45.20
Reef	19,398	22,457	3,059	+15.76
Sivutch	6,325	7,015	690	+10.90
Lagoon	512	445	− 67	−13.08
Tolstoi	16,725	16,027	−698	− 4.17
Zapadni	11,460	14,300	2,840	+24.78
Little Zapadni	9,089	10,145	1,056	+11.61
Zapadni Reef	536	604	68	+12.68
Polovina	5,343	5,794	451	+ 8.44
Polovina Cliffs	1,882	2,209	327	+17.37
Little Polovina	1,491	1,203	−288	−19.31
Morjovi	3,335	3,041	−294	− 8.81
Vostochni	31,468	30,863	−605	− 1.92
Total	122,617	133,914	11,297	+ 9.21
ST. GEORGE ISLAND.				
North	7,011	8,802	1,791	+25.54
Staraya Artil	5,440	5,746	306	+ 5.62
Zapadni	806	857	51	+ 6.32
South	61	68	7	+11.47
East Reef	2,120	2,367	247	+11.65
East Cliffs	4,860	5,418	558	+11.48
Total	20,298	23,258	2,960	+14.58
Total, both islands	142,915	157,172	14,257	+9.97

A casual inspection of the foregoing table discloses a great variation in the growth of the various rookeries. It ranges from a loss of 19.31 per cent in one case to a gain of 45.20 per cent in another. Some of this variation might be attributed to the defects in the method of arriving at the number of pups on rookeries not actually counted, but it can not explain it all. A constant rate of increase simply is not a phase of rookery development, and this is the greatest objection to the use of a single breeding area as a type in census calculations.

COWS.

NUMBER.

The number of breeding cows is by inference the same as the number of pups, since but a single young is born annually. Although a birth of twins is unknown in the species, it is not believed to be entirely impossible from an anatomical standpoint and may on very rare occasions occur.

The figures for the pups show that there has been an increase of cows of 9.97 per cent from 1918. This figure is to be compared with 11.63 per cent for 1918.

The figures show that the average annual increase is between 9 and 10 per cent under present conditions. This is an exceedingly slow rate of growth for animals which live as long and breed as often as fur seals. It emphasizes the enormous loss the species suffers annually from some enemy of which we know practically nothing. It now seems certain that 50 per cent of all animals born are lost before they attain the third year. Since an exceedingly small proportion is weak physically, it seems evident that the great loss is due to a predatory animal.

LOSS.

The loss of cows on the islands due to rookery conditions continues to be large, but a decrease from 1918 is noted. This result would naturally be expected from the increase in the average harem, although small, and the consequent less crowded condition. The dead cows found on five St. Paul rookeries numbered 15. The total alive on the same areas was 12,093. This proportion (0.001240) applied to the entire herd indicates a total loss of 195 cows. This number is to be compared with 213 for 1918, 129 for 1917, and 39 for 1916. With an increase in the average harem to about 40 there should be a material reduction in this loss.

The practice of killing seals up to August 10 grew up when the herd was smaller and much time could be taken in the segregation of the animals. The natives were thus provided with fresh food 10 days longer. At the present time the practice can hardly be excused on these grounds. The males which would ordinarily be taken in this period can be secured before, at least in large part, by a slight speeding up of the work.

AGES.

The maximum age of cows is yet unknown. Animals of the 1902 series (branded 1896 to 1902 inclusive) were observed in 1919 to the number of nine. This is a larger number than has been previously recorded for several years. Close watch was kept for them. This is considered a large number in view of the fact that the youngest are at least 17 years old and have passed through at least 10 years of pelagic sealing. The number branded of which records are available was 19,587. St. George brandings from 1898 to 1902, inclusive, are not available.

C. E. Crompton reported seeing a cow on Staraya Artil Rookery August 2, 1919, with the one bar across the back characteristic of the 1902 series and, in addition, a longitudinal bar on the left side. No record of such a brand was made on St. Paul Island, so it is probably a St. George seal.

Cows of the 1912 series were especially in evidence, possibly because branded animals were being searched for. Four were seen in one day on St. George. They have been seen on rookeries occasionally where it is known they were not born. This lends weight to the theory that the cows wander considerably from place to place, whereas it is known that adult males do not do so to nearly the extent that was formerly supposed. In less than half a dozen cases have males of this series been seen away from parent rookeries since they became 6 years old.

BULLS.

HAREM AND IDLE BULLS.

The count of bulls, harem and idle, made at the height of the breeding season furnishes the most reliable data obtainable at present upon which to base the census. From this the average harem can be computed on the several rookeries with a reasonable degree of accuracy, providing the number of cows is ascertained for some of them; and it is possible to determine fairly well about what the average harem will be from the proportion of idle bulls found at the height of the season.

The enumeration of the bulls is conducted with increased difficulty each year. It seems likely that unless some means are devised whereby the animals on the large rookeries can be brought within view the work must be given up in a few years, except on the smaller areas and sections. If the plans which are under consideration, however, are carried out it is believed that in a few years it will be possible to make this count accurately regardless of the growth of the herd. In no other way is it believed possible to keep a sufficiently accurate check on the herd to determine quotas for killing in advance with the provision of just enough reserve for breeding purposes.

Owing to adverse weather conditions it was not possible to make a count of bulls on Sea Lion Rock (Sivutch Rookery). The number was taken as the same as found in 1918 since this area being circumscribed by natural limits forbids any great amount of annual change.

The following table shows the results of the count:

HAREM AND IDLE BULLS AND PERCENTAGE OF IDLE BULLS TO HAREM BULLS COMPARED TO AVERAGE HAREM, 1919.

Rookery.	Date.	Harem bulls.	Idle bulls.	Total.	Idle bulls to harem bulls.	Average harem.
ST. PAUL ISLAND.					*Per cent.*	*Per cent.*
Kitovi	July 16	155	75	230	48.38	23.00
Lukanin	...do....	110	80	190	72.72	25.34
Gorbatch	...do....	362	95	457	26.24	34.00
Ardiguen	...do....	46	18	64	39.13	25.00
Reef	...do....	720	162	882	22.50	31.19
Sivutch	(a)	230	90	320	39.13	30.50
Lagoon	July 17	17	6	23	35.29	26.18
Tolstoi	...do....	538	154	692	28.62	29.79
Zapadni	...do....	546	246	792	45.05	26.19
Little Zapadni	...do....	344	145	489	42.15	29.49
Zapadni Reef	...do....	28	6	34	21.42	21.57
Polovina	July 15	192	102	294	53.12	30.18
Polovina Cliffs	...do....	96	48	144	50.00	23.01
Little Polovina	...do....	38	23	61	60.52	31.66
Morjovi	July 14	147	87	234	59.18	20.69
Vostochni	...do....	1,004	821	1,825	81.77	30.74
Total		4,573	2,158	6,731	47.19	29.28
ST. GEORGE ISLAND.						
North	July 21	225	21	246	9.33	39.12
Staraya Artil	...do....	124	14	138	11.29	46.34
Zapadni	...do....	27	6	33	22.22	31.74
South	...do....	5	3	8	60.00	13.60
East Reef	July 19	75	23	98	30.66	31.56
East Cliffs	...do....	129	14	143	10.85	42.00
Total		585	81	666	13.84	39.76
Total, both islands		5,158	2,239	7,397	43.40	30.47

a Count of 1918.

The most significant fact to be noted in the foregoing table is the falling off of the number of bulls. This was greatly desired by all who had the welfare of the herd in mind. Later counts showed that it was accompanied with an increase in the size of the harem, not a great deal to be sure, but more than had been expected. It was not thought that the enormous excess of males which had been in reserve owing to the closed season of 1912–1917 could be noticeably reduced in a single season of commercial work; yet it was done and speaks well for the conduct of the business by the island authorities. It should be noted that not only the total number of bulls was slightly reduced but that the percentage of idle bulls to harem bulls grew less. This is the best evidence that the reasoning was sound which led to the conclusion in former years that a proportion of one idle bull to two harem bulls produced the minimum average harem; and that this latter is very close to 26, regardless of amount of male life, is a foregone conclusion.

AVERAGE HAREM.

The counting of pups on certain of the rookeries enabled the determination of the average harem on the rookeries counted. The information derived therefrom, coupled with observation on the ground, led to the results given in the table below. For purposes of comparison the average harems in 1918 are given, showing graphically the increase in size of harems.

AVERAGE HAREM IN 1919 FOR ALL ROOKERIES.

Rookery.	Breeding cows.	Harem bulls.	Average harem, 1919.	Average harem, 1918.
ST. PAUL ISLAND.				
Kitovi	3,565	155	a 23.00	a 20.00
Lukanin	2,788	110	a 25.34	a 22.35
Gorbatch	12,308	362	a 34.00	a 31.00
Ardiguen	1,150	46	a 25.00	a 22.00
Reef	22,457	720	a 31.19	b 28.19
Sivutch	7,015	230	a 30.50	a 27.50
Lagoon	445	17	b 26.18	b 20.48
Tolstoi	16,027	538	a 29.79	a 26.76
Zapadni	14,300	546	a 26.19	a 23.19
Little Zapadni	10,145	344	a 29.49	a 26.49
Zapadni Reef	604	28	b 21.57	b 19.85
Polovina	5,794	192	b 30.18	b 28.88
Polovina Cliffs	2,209	96	b 23.01	a 20.23
Little Polovina	1,203	38	a 31.66	a 28.67
Morjovi	3,041	147	b 20.69	a 23.00
Vostochni	30,863	1,004	a 30.74	a 27.74
Total	133,914	4,573	29.28	26.59
Total for rookeries counted	12,093	480	25.19	27.88
ST. GEORGE ISLAND.				
North	8,802	225	a 39.12	a 26.75
Staraya Artil	5,746	124	b 46.34	a 34.00
Zapadni	857	27	b 31.74	b 18.74
South	68	5	b 13.60	b 7.62
East Reef	2,367	75	b 31.56	b 21.41
East Cliffs	5,418	129	a 42.00	a 30.00
Total	23,258	585	39.76	27.65
Total for rookeries counted	9,038	231	39.42	19.91
Total, both islands	157,172	5,158	30.47	26.74

a Estimate. b Pups counted.

The most significant information bearing upon the average harem is furnished by Polovina Rookery. In 1918 it had 185 harems and

5,343 cows, an average of 28.88. The number of harems on the entire island of St. Paul was less in 1919 than in 1918, but Polovina increased by 7. This, together with field observations, indicates that there was an excessive influx of bulls on this rookery, which operated to prevent the average harem in 1919 becoming as much larger than the general average as it otherwise would. In the light of the knowledge acquired on the migration of adult seals in 1919 it seems very plausible that the limited driving and killing from this place would tend to preserve here a larger excess than on rookeries where commercial operations are more extensive. In other words, the absence of driving and killing of males on a rookery hauling ground seems in general to tend to preserve a surplus which in later years floods the rookery. The same factor would be in operation at Northeast Point, which was not driven during the closed season and not fully driven in 1918.

SIZES OF BULLS.

The actual size of some adult bulls which appear in the early drives of the season has been variously estimated. There is great variation in animals full grown both in weight and length. The heaviest bull weighed 604 pounds after being bled; many of them exceed 550. One animal measured 87 inches from the tip of the nose to the base of the tail, and practically all that approached maturity exceeded 72 inches. These results lead to the conclusion that the maximum size of early-arrived full-grown rookery bulls is about 7½ feet in length and 700 pounds in weight. The average is about 6½ feet in length and 550 pounds in weight. It therefore seems clear that the 7-year-old animals of the 1912 branded series were not in 1919 nearly grown. It now seems to be true that an animal able to hold a harem on a crowded rookery must be at least 10 years old. No 7-year-old was noted in 1919 which would even come into the category of idle bulls.

SURPLUS BULLS.

The surplus-bull class is fast disappearing, and 1919 is probably the last year it will be of sufficient importance to be considered. In addition to the old-age loss of 20 per cent which has been allowed, it seems altogether probable that 50 per cent has been lost through natural causes. Of course this has not all taken place in the one year, but is the cumulative loss, of an individual age class, for instance, from the fourth to the seventh year. Heretofore there has been absolutely no basis for the computation of such a loss; it was considered to be small and did not enter into the computations. After 1920 it is believed information will be available which will enable the loss to be stated fairly accurately for the third to the fourth years and less so subsequently; possibly it will necessitate a revision of the losses arbitrarily adopted below the third year. It will probably not materially change the loss of 50 per cent the first three years, however, as each year's work seems to indicate that this is very close to the actual condition.

The assumption of five breeding years for the males does not seem as yet to need revision. Certainly when bulls are abundant and there is great strife on the breeding grounds an animal must be well developed and at least 8 to 10 years of age before he can hold a position, and five years of fighting will probably wear him out. When they are less numerous and there is but little fighting to be done the breeding period is certainly much longer. A 7-year-old bull is sufficiently developed sexually to have a harem, and it is not doubted they will do so when the average harem shall have increased to about 40. When this occurs it will necessitate the assumption of less than 20 per cent annual old-age loss of bulls.

ENEMIES.

The only enemy of which we can be sure is the killer whale. The voracious attacks of this animal on the fur-seal pups have been too well described to need repeating here, but they would not have to continue long to account for the entire loss.

The urgent need of combating this animal is easily seen. Out of 150,000 animals born in 1919, 75,000 are sure to perish before they are of any value to the herd or to man. At the present value of furs these would be worth over $5,000,000. Of course all of the enemies could not be eliminated in any one year, but it is quite evident that it would be financially profitable to make a determined start.

It also is desirable in this connection to point to the paucity of information about the fur seals at sea. The animal is so exceedingly valuable that it is very desirable to have its habits and habitats thoroughly investigated. There may be other enemies just as bad as the killer, but any such conjecture emphasizes our ignorance.

INTERISLAND MIGRATION OF MALES.

In 1914 and 1915 it was determined beyond question or doubt that 2 and 3 year old males haul out indiscriminately on any hauling ground on either island. This was learned by clipping the hair from the heads of branded seals. On St. Paul the right side was clipped and on St. George the left; this made it possible at a later date to identify the animals which had been handled. The same thing had been determined, perhaps less satisfactorily, a great many years before by clipping the ears of pups.

It was supposed from this that there was indiscriminate mixing among the older classes, and little attention was given the subject until 1919.

In the commercial operations of 1918–19 it has been noted that only in two or three instances have branded males of the 1912 series been seen on rookeries other than those upon which they were marked in 1912; but they have appeared in respectable numbers on those.

The absence of large males on the St. George hauling grounds in 1919 in the numbers which were expected led to a close inquiry into the subject. Constant effort was made to secure a quota which had been tentatively set, but the 6-year-olds and over were not available. Upon my arrival from St. Paul in census study this was particularly noticeable and was borne out in the bull counts and average-harem computations.

COMPLETE CENSUS OF FUR SEALS AS OF AUGUST 10, 1919.

Pups, counted and estimated		157, 172
Breeding cows, 3 years old and over, by inference		157, 172
Harem bulls, counted		5, 158
Idle bulls, counted		2, 239
Yearlings, male and female, estimated:		
Pups born in 1918	142, 915	
35 per cent deducted for natural mortality	50, 020	
Yearlings, both sexes, beginning 1919	92, 895	
Yearling females, 50 per cent, Aug. 10, 1919	46, 447	46, 447
Yearling males, beginning of 1919	46, 448	
Yearling males killed in 1919	4	
Yearling males, Aug. 10, 1919		46, 444
2-year-olds, male and female, estimated:		
Yearling females, Aug. 10, 1918	41, 608	
20 per cent deducted for natural mortality	8, 321	
2-year-old females, Aug. 10, 1919		33, 287
Yearling males, August 10, 1918	41, 595	
Yearling males killed, fall of 1918	2	
Yearling males, end of 1918	41, 593	
20 per cent deducted for natural mortality	8, 318	
2-year-old males, beginning of 1919	33, 275	
2-year-old males killed in 1919	194	
2-year-old males, Aug. 10, 1919		33, 081
3-year-old males, estimated:		
2-year-old males, Aug. 10, 1918	30, 159	
2-year-old males killed, fall of 1918	14	
2-year-old males, end of 1918	30, 145	
5 per cent deducted for natural mortality	1, 507	
3-year-old males, beginning of 1919	28, 638	
3-year-old males killed in 1919	15, 042	
3-year-old males, Aug. 10, 1919		13, 596
4-year-old males, estimated:		
3-year-old males, Aug. 10, 1918	9, 117	
3-year-old males killed fall of 1918	552	
3-year-old males, end of 1918	8, 565	
5 per cent deducted for natural mortality	428	
4-year-old males, beginning of 1919	8, 137	
4-year-old males killed in 1919	2, 390	
4-year-old males, Aug. 10, 1919		5, 747
5-year-old males, estimated:		
4-year-old males, Aug. 10, 1918	7, 114	
4-year-old males killed fall of 1918	229	
4-year-old males, end of 1918	6, 885	
5 per cent deducted for natural mortality	344	
5-year-old males, beginning of 1919	6, 541	
5-year-old males killed in 1919	1, 259	
5-year-old males, Aug. 10, 1919		5, 282

6-year-old males, estimated:		
5-year-old males, Aug. 10, 1918	11,941	
5-year-old males killed, fall of 1918	148	
5-year-old males, end of 1918	11,793	
5 per cent deducted for natural mortality	589	
6-year-old males, beginning of 1919	11,204	
6-year-old males killed in 1919	2,213	
6-year-old males, Aug. 10, 1919		8,991
Surplus bulls, counted and estimated:		
Breeding bulls in 1918	7,788	
20 per cent deducted for old-age loss	1,557	
1918 bulls remaining in 1919	6,231	
Breeding bulls in 1919	7,397	
1918 bulls remaining, deducted	6,231	
Increment of new bulls in 1919	1,166	
6-year-old males in 1918	13,755	
Surplus bulls in 1918	17,110	
Total surplus bull stock for 1919	30,865	
Deduct number killed, fall of 1918	64	
Surplus bulls at end of 1918	30,801	
20 per cent deducted for old-age loss	6,160	
Remaining surplus for 1919	24,641	
7-year-olds and over killed in 1919	4,238	
Total surplus in 1919	20,403	
Increment of new breeding bulls in 1919 deducted	1,166	
Surplus bulls in 1919	19,237	
Estimated 50 per cent loss due to fighting and natural causes	9,618	
Surplus bulls, Aug. 10, 1919		9,619

RECAPITULATION.

Pups	157,172
Cows	157,172
Harem bulls	5,158
Idle bulls	2,239
Yearling females	46,447
Yearling males	46,444
2-year-old females	33,287
2-year-old males	33,081
3-year-old males	13,596
4-year-old males	5,747
5-year-old males	5,282
6-year-old males	8,991
Surplus bulls	9,619
Total	524,235

SPECIAL INVESTIGATION OF SALMON FISHERY IN CENTRAL AND WESTERN ALASKA.

By C. H. Gilbert and Henry O'Malley.

LETTER OF TRANSMITTAL.

September 20, 1919.

The Commissioner of Fisheries,
Washington, D. C.

We inclose herewith a report on the salmon fisheries of central and western Alaska, based on our observations in the field during the past summer, taken in connection with the history of the district in former years.

We have stated at length our conviction that the industry has now reached a critical period, in which the salmon supply of Alaska is threatened with virtual extinction, unless a radically new administrative policy be substituted for the one now in force.

The crisis is made more acute by the exhaustion of the salmon fisheries in Puget Sound, due to prolonged overfishing in the face of persistent warnings like the one we here present concerning Alaska. The numerous well-equipped canneries of this southern district are confronted by the necessity of suspending operations in the near future. Their supplies and machinery will become available for the Alaska field, which they will certainly invade wherever promising sites can be obtained. Unless effective governmental control can be secured to prevent further invasion of a district which already suffers the evil results of unrestricted competition, certain disaster will befall the salmon fisheries of Alaska.

Respectfully submitted.

C. H. Gilbert, *Special Assistant.*
Henry O'Malley, *Field Assistant.*

GENERAL SITUATION AND SUGGESTED REMEDIES.

During the season of 1919, the writers visited the Copper River, Cook Inlet, Bristol Bay, Ikatan and King Cove, the Karluk River, and Kodiak. With the exception of Chignik, which was not visited, these localities comprise all the most important fishing districts in central and western Alaska. They form the home par excellence of the most important species of Alaska salmon, the sockeye or red salmon; and they produce some 90 per cent of the entire Alaska sockeye pack. Also, they are wholly dependent on this species. In central Alaska, it is true, not unimportant packs of pinks and chums are now put up, but it remains true of central Alaska, as it does to an even greater extent of western Alaska, that the continued existence of the salmon industry is dependent on the preservation and maintenance of the red-salmon runs.

These have been drawn on heavily since the earliest days of the salmon industry in Alaska. The red salmon alone was then sought as the only species having any considerable commercial value. Other species were taken incidentally or to fill out the pack where red salmon in a given year were not to be obtained in adequate numbers. A market for chums and pinks was developed progressively but slowly with later years. Not until 1911 did the combined packs of all the other species slightly exceed that of the red salmon alone.

With this species at first the only salmon in demand, it is natural that the streams of central and western Alaska were among the earliest exploited. Canneries entered the field in 1882, when one was constructed on the Kussilof River in Cook Inlet and another on the Karluk River, Kodiak Island. Others followed in rapid succession. In 1899, 25 canneries were operated in central and western Alaska: The Copper River supported 4; Cook Inlet, 2; the Karluk River, 6; Alitak, 2; Afognak Island, 2; Chignik, 3; Orzenoi, 1; Thin Point, 1; and Nushagak, 4. In many of these localities, salteries had been in operation for a number of years before the canneries were built. Thus the principal red-salmon districts of central and western Alaska were already occupied at that date and have been assiduously fished for 30 years or more. The question of how well the sockeye colonies have sustained the exactions of the commercial fisheries during this long term of years is pertinent.

The subject is complicated and difficult to handle. Each stream in this vast area has its own wholly independent run of fish and has had its individual history. One stream may have been overfished to the point of exhaustion, while others in the same district may have maintained their runs unimpaired. So long as undeveloped territory remains and may be gradually drawn on, the total or mass statistics from a given district give no answer to the question of depletion. Nothing short of individual stream statistics are adequate, and even these must extend over a term of years, during which the manner of fishing and the amount of fishing gear employed each year are accurately given. Unfortunately, no such statistics are published and available, yet they would form the essential foundation for any well-considered scheme of conservation. Without such a body of statistics, legislation to protect and maintain the fisheries must be a groping in the dark. The Bureau of Fisheries should at once proceed to gather annually, under a skilled statistician, a well-planned body of data, referring where possible to individual streams. These should be collated in tabular form, digested, and published.

The preservation of the salmon supply to the rivers of Alaska concerns most vitally the body of consumers which constitute the general public. It is contrary to their interests that the fisheries be ruthlessly exploited and an important source of highly valuable food be placed in jeopardy, greatly diminished, and in time totally destroyed. The importance of sea foods will increase with the years, as grazing lands grow more and more restricted and flocks and herds continue to diminish. Yet now, in a period of comparative abundance, through sheer heedlessness and childish improvidence, this country is in danger of permitting the virtual destruction of the most important sea food it posesses—one which the ocean provides without cost and brings to its very doors.

The trend of events, at least, should be ascertained and an opportunity given wisely to safeguard paramount interests before irretrievable harm has been done. To this end it is essential that wherever possible stream statistics be prepared and that they be made public year by year. It will then be possible to learn how well the public trust is being administered. Should such statistics prove a progressive depletion of the salmon supply in any or in all districts, it is to be hoped public sentiment will be aroused and would find expression, demanding adequate protective legislation.

There has been no time in the history of the industry when precautionary measures have been so imperatively demanded as at the present. Development in the early days was often delayed and checked by the low price of the canned product and the ease with which the market could be overstocked. But during the later years, and especially since the beginning of the Great War, with unlimited demand for canned salmon and unheard-of prices prevailing for all the grades, there has been an unexampled expansion of the business. Whereas, in 1914 there were 82 canneries operating throughout Alaska, in 1918 the number had increased to 135. Everywhere, capital was seeking new cannery sites. Competition for the existing supplies of salmon was greater than ever before. New fields were entered where such could be found. But for the most part, the old fields were further invaded, although they were already fully occupied and carried no reserve supplies that could safely be spared. With the price of raw fish greatly advanced, the fishermen became more eager. They could afford to carry on their operations later in the season when the run was at the ebb, and constantly they gleaned more closely. No one can doubt that larger proportions of the spawning runs during this period have been captured for commercial uses, while smaller and smaller contingents have been able to win their way to the spawning grounds, there to make necessary provision for all future runs. It has been and still is a situation full of danger.

Even before the recent startling expansion of the industry, all disinterested observers held that in central and western Alaska a safe level of production had been reached, if indeed in many localities it had not already been passed.

Does anyone doubt that the wonderful Karluk River has suffered impoverishment since the days when it was easily able to produce year after year without interruption packs of 150,000 to 200,000 cases of red salmon? A comparison of the early days with the average packs of the last years is convincing that, whether or not on the Karluk bad is now giving place to worse, the river is consistently on a lower level of production than formerly. It is as though a wheat field should be held down to half its normal yield because the seed was begrudged.

Is the Copper River run not rightly considered in a precarious condition with adequate remedial measures not yet in sight? And are there not poor prospects ahead, now that fierce competition recently has been permitted for the small but highly productive red-salmon streams in Olga Bay? The Chignik has also been a wonderful stream and is still a valuable property despite the abuses to which it has been long subject. But does anyone believe it could stand the further drain of sharp rivalry which may at any time accompany the advent of an additional cannery?

Have not Ikatan and Morzhovoi Bay already suffered with six canneries contending with purse seines and traps for their not unlimited supply?

Mention need only be made of the formerly productive stream that enters Nelson Lagoon; and of the Bear River and Sandy River, which formed the main dependence of the canneries at Port Moller and in Herendeen Bay. Everyone knows they are far along the road toward depletion, even though they may exhibit an occasional flare-up into a season of greater activity.

These are all clear-cut cases of overfishing with the resultant partial destruction of the runs of fish. And the end is not yet. So long as the high price of canned salmon continues, be assured that aggressive capital will seek an opening. Wherever a run of any size remains and may be further exploited, or wherever apparently an opportunity presents itself to force with profit an entrance into a field already overdeveloped, this will be done, and invariably the result will be a sharper rivalry for fish and a further decline in the run.

It is customary in these discussions to lay the responsibility for depletion at the doors of the canners, and to criticize them sharply for their rapacity. Something can be urged, doubtless, for this point of view; especially in the earlier days was this true when competition was in its infancy and fish were to be had for the taking, yet nevertheless streams were barricaded to prevent the ascent of the salmon, and other practices were indulged which constituted a cut-throat policy, foolishly and needlessly adopted.

But despite all this, the responsibility has rested from the beginning and now rests fairly and squarely on the shoulders of the Congress and the general public. The present administration of the fisheries appears based on the expectation that men will hold back their hands where a further profit can be made. It is witless to expect them to do so. The administration of public affairs can not be made to depend for success on men's voluntarily foregoing a profit. There are those, doubtless, who would relinquish private gain in the public interest, but it need not be contended that they are in the majority. And whereas it might appear that in the salmon business private interests would counsel moderation in the hope of securing the perpetuation and the permanency of the industry, such in fact is not the case. It would boot them nothing to permit most liberal numbers of salmon to escape their nets. So long as the public throws this field open to unrestricted competition, and so long as there results keen rivalry for every fish that swims, no individual canner can accomplish anything toward the protection of the streams. Whatever he spares for spawning purposes, his competitors will thankfully accept and place in cans. He is powerless to conserve either the public interest, or even—should he be sufficiently enlightened to see it—his own private interests, by listening to any counsels of moderation. If fishing grounds or fishing rights could be leased or assigned, and property rights acquired which would become valueless should the fishing greatly decline, cooperation with the authorities to preserve the fisheries could confidently be counted on. But so long as the present policy is maintained, and the canners have only what they can seize and can hold with every man's hand against them, there can be but one final outcome. Total exhaustion of the fisheries will occur; if not to-morrow, then the day after.

It can not be too often nor too strenuously insisted on that the dangers which confront the Alaska salmon industry are inherent in the very plan which the Congress has adopted for its administration. The only effective remedy lies in altering the groundwork of this plan, in treating the fishery resources in practice as well as in theory as the property of the public, and in administering them in the interests of the public rather than apparently in the interests of those who seek to exploit them.

They could be so handled as to insure their permanency and yet leave their operation in private hands. Treat the canneries as exercising quasipublic functions. License them to operate within restricted limits and on a specified scale, neither of these to be modified without direct authorization. Let no more operate within a given field than can do so while still maintaining the run at its *maximum of production.* Produce readjustments as these are shown necessary. Permit further expansion wherever evidence shows that this can safely be done. Restrict the output further wherever the danger point is approached. Permit all the salmon to be taken for commercial purposes that can with certainty be spared, but maintain a constant safety factor in favor of the spawning beds. *Maintain the runs at their maximum of production.* The salmon that could safely be spared from such runs would be vastly more than the utmost gleanings when depletion has occurred. Whenever restriction of the output becomes necessary, recognize the equity of the operators in that region as soon as the policy adopted shall again permit a degree of expansion. In this manner, the packers would cooperate with the Government under such conditions that it would be to their interests, equally with those of the public, to conserve the runs of salmon.

It may be urged that however meritorious such a plan might appear if the industry were in its infancy, it would be wholly impracticable to apply it under conditions as they now exist. But if the principle be once accepted, work can gradually be directed in the desired direction with immediate benefit to the situation. The present laws can be modified so as to diminish predatory competition. It can be required that existing canneries shall secure a license to operate in specified territory with a given amount and kind of gear. It should be discretionary with the Secretary of Commerce to license or refuse to license new canneries, or to permit or refuse to permit further expansion on the part of those already operating. And if on full investigation it should appear that any region is being dangerously drawn on, the Secretary should have authority to curtail production to any necessary extent. At present his jurisdiction covers only the streams themselves and a narrowly limited area about their mouths. But in many districts the harm is caused by excessive fishing in salt-water channels and in other restricted bodies of water which form the approaches to the streams.

Provision should be made in the laws that fishery sites can be licensed under suitable conditions, and that property rights vest in such sites under prescribed regulations. The nature and the amount of gear that may be operated on such site should be specified in the license. They should include trap locations, set-net and stake-net locations, fish-wheel locations, and seining beaches. Unless certain conditions were met these locations should revert to the public; otherwise they should be the property of the licensees so long as they could be operated without detriment to the salmon supply. But it should be within the discretion of the Secretary to limit or entirely to suspend the use of any location when such course should appear necessary.

Some of these provisions are already in force in the States of Oregon and Washington, where the discretionary power lodged in the

Commissioner of Fisheries exceeds that conferred on the Secretary of Commerce.

Further improvements can be made in the Alaskan field by making more adequate provision for the enforcement of the laws. Not only are our fishery statutes now pitifully inadequate, but they are unusually and unnecessarily made difficult of enforcement. The Commissioner of the State of Washington and those authorized by him exercise the power to arrest violators of the fishing ordinances, and they can seize any fishing appliance, including boats, traps, nets, and fish wheels, used in violation of the provisions of the act. But the agents of the Bureau, intrusted with the enforcement of the Alaska laws, have neither power to arrest nor authority to seize illegal gear. If it had been deliberately planned to hamper them in the interests of violators of the laws, it could not have been done more effectually.

BRISTOL BAY AND RED-SALMON RUN OF 1919.

The season of 1919 has proved the most complete failure in the history of Bristol Bay. Not only was the run smaller than ever before chronicled, but it was almost equally deficient in all the streams of the district. This has usually not been the case heretofore. The poor Nushagak run of 1907 was accompanied by fully average packs on the Kvichak and the other streams of the east side of the bay. In 1911 there was a poor Nushagak run and also a rather poor pack on the Naknek-Kvichak, but the Ugaguk had the largest pack ever made to that date. The Nushagak was far below average in 1912 and the other rivers all well ahead of all previous records. Only the Kvichak was deficient in 1915 and only the Nushagak in 1916.

From this it appears that the runs have varied independently of one another, thus favoring the assumption that in each instance the cause of failure was local in its nature, and not general. But in 1919 the situation seems different. The decrease in numbers of red salmon was marked, almost without exception, throughout central and western Alaska. Throughout the red-salmon district a marked deficiency was shown, which culminated in Bristol Bay. To account for this, it seems necessary to assume some widely distributed agency, which probably operated throughout these districts during the life of the salmon in the sea. It appears impossible to conceive that there should have been such a wide coincidence in unfavorable local conditions as would be required to explain the occurrence.

The run of 1919, in all the affected areas, was derived in part from the brood of 1915, but more largely from the brood of 1914. So far as is indicated by the pack of 1914, no cause can be assigned for the 1919 shortage. The pack was near its maximum in every Bristol Bay river except the Ugashik. If the four-year period and the season of 1915 be considered, a better case can be made out; for the Kvichak-Naknek pack of 1915 was reduced nearly to half that for the preceding three years; and although the Nushagak yield of 1915 was above the average, the escape to the spawning grounds, tallied at the Wood River weir, was the smallest ever reported. However, in 1915, both the Ugaguk and the Ugashik made favorable records, and when it is considered that throughout this district the red salmon mainly mature at 5 rather than at 4 years of age, the improbability is manifest of explaining the shortage of 1919 by anything which occurred in 1915. The question whether in general the Bristol Bay streams give evidence of overfishing must now be considered.

HAS THE KVICHAK-NAKNEK DISTRICT BEEN OVERFISHED?

There is an unbroken series of pack statistics for the Nushagak River, reaching back to 1893, and for each of the other rivers of Bristol Bay since 1904. Some allowance must be made for a certain degree of inaccuracy, because fish were in some measure reported in favor of the district in which they were packed, regardless of where they were captured. No attempt is made to disentangle the Kvichak-Naknek complex, for the fishery is conducted to a large extent in the open off the mouth of the Naknek River and farther to the south, and contains Naknek and Kvichak fish in unknown proportions. This is equally true at both the Ugaguk and the Ugashik Rivers, for the great Kvichak migration sweeps past the mouths of these rivers, and fishing in these cases also is partly done in the open. It can not be said then that stream statistics for the eastern shore of Bristol Bay are wholly reliable, the element of doubt increasing as the mouth of the Kvichak is approached. The three rivers are very similar in their lower courses, with wide stream beds at high tide, choked with sediment; and at low water having extensively exposed sand and mud flats with greatly restricted channels. Fishing has always been freely permitted, practically without restriction, in all these streams, and while the statistics do not of themselves give reliable data, there are probably few who will assert, and fewer yet who believe, that these rivers now carry the body of salmon they formerly produced.

But in spite of inaccuracies, which detract from their value as stream statistics, they constitute a highly valuable record. Extending as they do over a period of 15 years, during all of which intensive fishing has been in progress, it would seem they should furnish unequivocal evidence of general serious depletion, if such had occurred. Had the manner of fishing and the amount of fishing gear employed remained relatively constant during this period, most valuable deductions could have been drawn. But the amount of gear employed has more than doubled and the fishing grounds have been pushed farther and farther into the open bay. What the effect of these changes has been must remain in some degree a matter of speculation. The Ugaguk responded to the more intensive fishing in 1911 and the Kvichak-Naknek in 1912, with greatly increased outputs; and these were maintained at the higher level for seven successive years, with the single exception of 1915, which was a partial failure on the Kvichak. The Kvichak-Naknek produced in 1912 nearly 14,000,000 red salmon, whereas 9,500,000 had been the largest number previously obtained during any year. Approximately the same number were captured the following year in 1913. From the eggs that were furnished in these two years of increased pack there resulted the run of 1917, when the Kvichak-Naknek yielded over 15,500,000 red salmon. The fact that a largely increased pack was thus possible, and that it could be maintained without serious interruption into the second cycle, when the effects of the increased pack should become apparent, indicates that these rivers had not been fished to their full capacity prior to 1911 and 1912. It seems clear that more than 9,500,000 fish could be spared from the spawning beds without imperiling the run. But it does *not* indicate that the new level of production is a safe one, and can be maintained indefinitely. What could be safely spared in excess of 9,500,000 fish may have been taken, and a considerable number in addition. The new level has not been arrived at through any reasonable process. There was no knowledge of the situation which warranted such increase with any assurance it would not be fatal to the future runs. No precautions whatever were taken in the matter. Everything was haphazard, in accordance with the customary policy. All the fish which could be caught were taken without any heed to the future. It was known that it was impossible to catch them all, and it was vaguely hoped—if the matter was given thought at all—that, whatever be done, enough would escape to keep the run going. Fishing was conducted without limitations of any kind. The amount of gear was limited only by what could be profitably employed. Fishing was permitted in all the rivers as well as in the open bay. There was no close season to afford needed protection. Such has been and still is the policy. If a new method of fishing could now be applied which would make it possible to capture 20,000,000 fish from the Kvichak, the 20,000,000 fish would be cheerfully captured annually for five years until returns would be had in the next cycle of years, and then the damage would be appraised.

Fear that the danger point may have been reached on the Kvichak-Naknek is based on the fact that all efforts that have been made to increase the yield during the last seven years have been without result. Fully one-third more gear has been used in subsequent years than was used in 1912, and the only result has been to divide the fish more finely among a larger number of fishermen. Each net averages for the season a smaller number of fish, and the grand total is not increased. Such a result always indicates dangerous ground. It usually means that the use of increased quantities of gear is necessary in order to maintain the pack at the high level which it has once reached. In most cases a reduction to the earlier number of gill nets would entail a marked decline in the pack, showing that the total run of fish has suffered a reduction. Do the packers in the Kvichak-Naknek district believe that they could reduce their boats and nets to the numbers employed in 1912 and still continue to catch 14,000,000 or 15,000,000 red salmon in a season? If they maintain that they could do so, it seems strange indeed that they continue to incur this enormous additional expense each year in the certainty that it brings no returns. If the present number of nets is, on the contrary, essential, it means that each year there is a closer and closer gleaning from the spawning run in order to maintain the pack, and it means, furthermore, that the spawning run is already so greatly reduced that with the utmost efforts no considerable contribution can be secured from it.

This must be considered a dangerous situation, which can not continue without finally producing a greatly diminished run of fish to these rivers. It is not known what is the least number of spawning fish which will keep up a run to full size in any district, but such a minimum would vary widely in different years. Some seasons are far less favorable than others, both on the spawning beds in the lakes, where the fingerlings live for one or two or three years, and in the sea. The number of spawning fish which would be adequate in favorable years, it must be recognized, would fail utterly to produce a run when the eggs, the fingerlings, and the growing fish in the sea had been exposed to unusually severe conditions and to more formidable attacks from their innumerable enemies. This is not unsupported theory. It is a necessary deduction from all the observations and all the experiences of those who have studied the sequence of the seasons in the fisheries.

A safety factor on the spawning beds is for this reason essential. Unfavorable seasons come without warning. They may be scattered, with wide intervals between, or two or more may come in quick succession. Unless there is spared each year for spawning purposes a number materially greater than are ordinarily sufficient, unfavorable seasons will declare themselves as failures which otherwise would have been saved by what in ordinary seasons constitutes an excess production of young. Such excess production must be maintained in order to be safe.

When increase of gear fails to produce material increase of pack there is danger that the safety factor has been abolished, if indeed no worse has been done. On the Kvichak-Naknek the 1917 yield of nearly 16,000,000 fish does not demonstrate that 15,000,000 could safely be taken in 1912. Other river basins have been watched during the progress of depletion. The sequence of events is always the same. Decreased production is accomplished by increase of gear. Fluctuations in the seasons become more pronounced. Good seasons still appear in which nearly maximum packs are made. But the poor seasons become more numerous When poor seasons appear no attempt is made to compensate by fishing less closely. On the contrary, efforts are redoubled to put up the full pack. The poorer years strike constantly lower levels, until it is apparent to all that serious depletion has occurred.

It can not be affirmed with certainty that the extremely poor season of 1919 has been due to a combination of overclose gleaning and of unfavorable general conditions, but it is believed that such has been the case. The year in any event might have been one of less than average yield, but the extent of the disaster would have been mitigated if a generous safety factor had been hitherto provided. The result of the year can not be foretold. The escape to the spawning beds must have been far below the average of recent years. It may have fallen below the minimum which is necessary to keep up the run even in favorable years. If so, the results will be serious in 1923 and 1924—bad even if the general conditions meanwhile prove propitious, far worse should they again prove unfavorable. Bad years more certainly reproduce themselves when spawning has been dangerously reduced.

The dangers of the situation with the present scale of operations continued have been pointed out, but on the Kvichak-Naknek there is danger of further increase. The region is recognized as the last great stronghold of the red salmon, the greatest producer in the world. Other canneries continue to appear; all are likely to increase their scale of operations; more gill nets will constantly be employed The prospects are unfavorable unless restrictions are imposed while yet there is time.

NUSHAGAK RIVER AND WOOD RIVER CENSUS.[a]

The Nushagak River has had a different history from that of the Kvichak and the smaller rivers which enter along the eastern shore of Bristol Bay. It was the first to be exploited and very early reached its maximum of production. The five years from 1900 to 1904 produced a slightly greater yield than the succeeding five, from 1905 to 1909. From 1910–1914 there was a material reduction of about 3,000,000 fish below the preceding period, and the five-year period which came to a close with 1919 shows approximately the same reduction. Yet during these periods there has been great increase in gear and a complete shifting of the fishing grounds to the channels outside Ekuk. Not only has increased fishing produced no increased returns, it has been accompanied by a small but unmistakable falling off in the pack. To this extent the situation on the Nushagak is more disquieting than on the Kvichak.

The decreased packs on the Nushagak, as seen in five-year periods, are due to the more frequent appearance of poor years. From 1900 to 1904 the poorest yield of any year was 4,125,000, which was not far below the average of the last two periods. From 1905 to 1909 the poorest yield during one year was 2,500,000. From 1910 to 1914 there was one year with less than 4,000,000 and one with less than 3,000,000; while in 1915 to 1919 there is one year with less than 4,000,000 and another probably with not to exceed 2,000,000—the latter certainly the smallest yield in 20 years, despite the enormously increased gear.

No one can doubt that there is here evidence of close gleaning from an early period, with the percentage of escape reduced to smaller dimensions and with little provision made for any safety factor. When in any stream the crests of the pack grow lower and the troughs deeper, retrenchment is called for. It is our belief that this condition is now declaring itself on the Nushagak.

The Wood River census of salmon which have escaped the commercial fisheries and are about to enter the spawning area of the river has been taken annually since 1908, with the exception of 1914. The actual number of fish escaping and the proportion these bear to the total run have varied widely during these years. Omitting from consideration the year 1908 and making allowance for an escape, of which there is no record in the Nushagak, the Igushik, and the Snake, the percentages of escape may vary approximately from 7 to 25, with an average perhaps in the neighborhood of 15 per cent. It is this 15 per cent only which would be subject to further inroads resulting from increase in amount of fishing gear. As the spawning reserve grows less and less, the capture of any considerable part of it becomes more and more difficult by open fishing of the kind employed at Nushagak. Some amount of escape is nearly always provided by adverse weather conditions, which usually slow up fishing at some time during the season and may even cause its virtual suspension for a short period. In addition a few fish pass around and through the forest of nets, impossible as that may appear, and some pass through the nets themselves. Many show net marks, indicating the manner of their escape, and many others must pass through the meshes unscored; for the average size of the fish captured in the upper bay, or reaching the weir at the foot of Lake Aleknagik, is much below the

[a] Upon recommendation of Dr. C. H. Gilbert, it has been decided to discontinue the Wood River census. See p. 33.

average for the fish captured in the outer bay. Where thus selected for their small size there will be more four than five year fish and more females than males. The latter may present an added source of danger, for if in the escape females largely predominate they may be unable to find males with which to pair, and their eggs may remain sterile. There are no observations on the spawning grounds which cover this point. It is possible that the male remains active for a longer period and will mate repeatedly, but it is not known that such is the case.

The escape through nets must present a fairly constant factor, but the amount of escape attendant on unfavorable fishing weather varies widely with the season. Some years are much more conducive to close gleaning than others. In 1915 the commercial capture was above the average, amounting to more than 5,500,000 fish; but the escape of less than 260,000 fish was the smallest then reported. The cannery pack of 1917 was practically the same as in 1915, but the escapement in 1917 was four times as great; in 1916 the escapement was nearly twice as great, although the commercial yield in 1916 was only about three-fifths that of 1915.

One reason is here apparent why such indifferent success is met with in predicting future runs on the basis of commercial packs of salmon. It is the number that escape to the spawning beds that have their influence on a subsequent generation, not the number sealed in cans, and the latter would often give a very erroneous basis for estimating the former.

It would seem, however, that where the escapement itself has been reliably ascertained for a number of years, a basis should be at hand for successful prophecy, with a fair degree of accuracy. The belief is generally held that increase in number of spawning fish up to the full capacity of the spawning beds will result in an increased run. The spawning beds of the Wood River chain of lakes to which there must have resorted in the old days 5,000,000 fish or more, can not be held fully populated by any number that have escaped the nets during recent years. A million fish at least should certainly find room to spawn in this great watershed without serious interference with one another's nests.

If they can do so, then the larger the number that spawn within these limits, or any more extensive areas of profitable spawning, the greater should be the resulting schools of fingerlings that pass out to sea in the spring and summer and the larger the returns in adult salmon when these come back to spawn.

If it should be assumed, however, that only half a million or a quarter of a million could profitably spawn, and that any larger number merely increased the wastage on the spawning beds and contributed nothing to the crop of fingerlings, on this basis and this basis only could a complete failure to establish a relation between increased spawning escapements and the larger size of the resulting runs be understood.

The Wood River experiment was inaugurated for the purpose of throwing light on this and on other problems, among them some of the most important that confront the commercial fisheries and fish propagation. If the experiment could establish the percentage of returns which could be expected under natural propagation from a given number of spawning fish; or, stated differently, the lowest percentage of escape that could be relied on to maintain the run intact, a sound basis would be laid for scientific handling of the fisheries. The results, both scientific and practical, would be far-reaching, and the conduct of the experiment all the more should be above question. It was most unfortunate, for this reason, that Wood River was selected for the purpose. Its disadvantages were clearly seen and were discussed by Marsh and Cobb, in their report of the operations during 1908. The Wood River is not the only red-salmon stream tributary to Nushagak Bay. The main Nushagak, the Igushik, and the Snake also contribute their quota to the schools of fingerlings passing seaward through Nushagak Bay, and each of them receives its percentage of the escapement from the fisheries conducted in the open bay. It is not known what their respective percentages amount to. The streams have never been racked and the escapement tallied. It is currently believed that their runs, individually or even combined, are less important than the Wood River run, but the approximate number that must be added to the Wood River tally to produce the annual escapement from the entire fishing district is wholly a matter of conjecture. The salmon bound for these four streams enter Nushagak Bay together and are indistinguishable. Those captured by the commercial fisheries include members of all four colonies commingled, in their due proportions. What these proportions are no one knows. The chronicled escapement is for Wood River alone. It is evident that the total escapement from the commercial fishery and the proportion which this escape bears to the total run can only be obtained by assuming certain values for three unknown streams. Marsh and Cobb have done the best that can be done with a bad situation by assuming what they consider maximum and minimum values for the escapements to the unknown rivers. Interesting results are obtained in a field in which previously there has been no information, but the elements of uncertainty which reside in all conclusions based on the incomplete data of this experiment unfit them for either practical or strictly scientific purposes. Had it been practicable to rack each of the rivers and to obtain a census of the escapement into each, there would now be something certain on which to build. But the enterprise would be unnecessarily arduous. The desired results could be more easily achieved by abandoning the Wood River experiment and choosing for the purpose some river like the Chignik or the Karluk, where all the spawning fish of a given fishing district enter a lake or lakes through a single channel. But the Wood River census has not given us with any certainty the number of spawning fish which are necessary to maintain the Nushagak run, nor is the number known even approximately.

Marsh and Cobb have stated that although the census figures may not have absolute value, they can safely be used for purposes of comparison between one year and another. If this were true, we could still use them for purposes of prediction, as discussed in a preceding paragraph. If the total escapement from the Nushagak fishing grounds was always, year after year, the Wood River escape multiplied by a constant factor, the Wood River figures would be just as valuable for purposes of prediction as though we knew what the factor in question was. If the Wood River escape in a given year were half that of the previous year, we could then be assured that the entire escape for the district was half that of the previous year. But unfortunately, even for this purpose, the figures are unreliable. No constant factor can be assumed. Such assumption would register belief that the runs to the four rivers would in different years always vary in the same direction and to the same amount.

The mere statement of the case disproves it. Even the tributaries of one river vary widely year by year in the proportion of the total run which enters each of them. If this be true of the tributaries of a single river, how much more probable of four separate rivers, which join only at their mouths. It is certain that they would vary independently and that the oscillation might be of large dimensions. Due to manner of fishing, one of these rivers might experience a progressive reduction of its run that was not felt by the others. Prior to 1908, the Wood River fish ran the same gantlet in the outer bay as did those bound for the other rivers, and in addition were subjected to further reduction by traps and gill nets operating the entire length of Wood River. The main Nushagak and the Snake Rivers, at least, were wholly free from this further drain; their proportion of escape was demonstrably higher, and their runs should have fared better. In this complicated case, then, not only the natural oscillations in the runs to the different rivers, which might be at any given time in opposite directions, but also the possibility of progressive changes in the run of any of them, due to its different history must be contended with. If the Wood River run should for a term of years diminish relatively to the others, its escapement would diminish relatively to the escapement to the other three streams.

For these reasons, there has not been an attempt to establish a relation between the size of the Wood River escapements and the size of the resulting runs of salmon to the Nushagak with any high degree of expectation. There are too many unknown factors entering into the equation. Only on the assumption that the Wood River run so far overshadows the sum of all the others that the latter may be considered negligible, is the expectation warranted that close positive results can be achieved.

It is noted at the outset that the recorded escapement from 1908 to 1912 showed an alarming progressive decrease both in actual numbers of fish and in percentage of escape, but the five-year period that follows gives scant evidence of correspondingly decreased runs. It is also noted that the largest escapement by far—that of 1908—was responsible for the four-year fish of 1912, and the latter was one of the very poorest runs within the 10-year period under investigation. The 1908 spawning escape was recorded as 1,600,000 fish. The year 1912 had the very low record of 325,000 to reach the spawning beds, yet it produced the five-year contingent of the run of 1917, which furnished the largest run of any year since 1908. These are glaring failures, and indicate clearly enough that no such close relation exists between spawning escape on Wood River and the Nushagak run as will warrant predictions regarding the latter.

But if search is made for correspondences, which have a high degree of probability in their favor, such can be found. The years 1911 and 1912 were jointly responsible for 1916, when the total recorded run was the next to the smallest during the period of 10 years. The escapes both in 1911 and in 1912 were far below the average; in fact, with one exception they were the two poorest recorded escapes in the 10-year period. Whatever may be thought of the higher escapes, it looks as though the 325,000 of 1912 and the 354,000 of 1911 were sufficiently below an acceptable minimum to make a decided impression on the total run to Nushagak Bay. The possibility of a chance coincidence can not be eliminated here, and there is no similar case with which to check up. No other instance is recorded in the series in which two exceptionally undersized escapements were in sequence, so that one would produce the four-year fish and the other the five-year fish of a later run.

The smallest escapement of the series was in 1915, when only 259,000 fish passed the Wood River weir. These furnished the four-year fish for 1919, the worst of all years on the Nushagak. Unfortunately, there is no record of 1914, the source of the five-year fish for 1919, so it can not be told whether two very small escapements again cooperated.

One other instance is worthy of attention. There is no record of the escapement in 1907, which was the year before the series began, but as the commercial returns of that year were the smallest from 1900, when fishing began on a large scale, to 1919, it is fair to assume that the escape in that year was very small. But 1907 produced the four-year fish for 1911, which was the next smallest year on record, and the five-year fish for 1912, which was the third smallest year. In this connection, the year 1920 on the Nushagak will possess unusual interest as showing how many five-year fish will have been produced by the smallest escapement of the series, that of 1915.

While admitting the possibility in all these cases of the chance association of numbers and giving due weight to that possibility the entire series is impressive as indicating on the whole a causal connection between size of spawning escape and size of resulting run; but the relation seems sometimes modified and sometimes effectually masked by the intervention of the other factors discussed on previous pages.

RECOMMENDATIONS FOR BRISTOL BAY.

Reasons have been assigned for the belief that the red-salmon pack in Bristol Bay has reached, where it has not passed, its maximum. It is believed that it is in danger of decline with the present scale of operations continued unchanged, and it seems probable that the present scale will be augmented. It is contended that some of the usual precautions should be taken to provide a larger spawning escape in this district. In no other salmon fisheries, except in certain portions of Alaska, are all effective restrictions removed, and unlimited fishing permitted, without seasonal or weekly close seasons, or protected areas. It is recommended:

1. That the Bureau of Fisheries seek to have the present law amended in such way that no Alaska districts will be relieved from the requirement of a weekly close season of 36 hours, during which no fishing is permitted. Bristol Bay is now one of several specifically exempted regions. No valid reason aside from the desires of the salmon packers can be assigned in any of these cases. All are in need of the protection that would be afforded by this regulation.

2. That all the Bristol Bay rivers be closed to commercial fishing at all points above their mouths, and that the mouths of these streams be determined by the Secretary of Commerce in his discretion, and that suitable marks be erected.

3. That a further attempt be made to enforce the provision that fish should be canned or otherwise preserved within 48 hours after their capture. One of the worst and most wasteful features of the Bristol Bay fisheries is the custom, during heavy runs, of permitting the daily capture of fish far in excess of the capacity of the cannery, with resulting daily accumulation of stale fish. This is done in anticipation of a slackening of the run, which will permit the cannery to catch up with its hoard of fish. But the run sometimes continues

for an unexpected period, and the weather may turn exceptionally warm. Then the stalest fish of the accumulated lot must be canned each day, or one or more days' catch must be thrown away. The regulation should be so enforced that not more than one day's surplus shall be on hand at any time. This would remove all dangers from the Bristol Bay pack and would at the same time be a powerful aid to conservation of the fisheries.

PORT MOLLER AND HERENDEEN BAY.

These localities could not be visited during the past summer, but one of the authors investigated the source of the runs of red salmon to this region in 1918, and found that contrary to the opinions of some packers the Bear River and the Sandy River produced, during that year at least, all the red salmon there captured. The Bristol Bay run in 1918 was very large, but no part of it skirted close in shore as far to the southward as Port Moller. Whether it ever has done so must now be judged by indirect evidence. For three years in succession, including 1919, yields of red salmon from this district have been very poor. Still, the amount of the decline is not as great as appears from the pack report of the only company which has operated for a term of years in the Bear River region. The Pacific American Fisheries captured about 1,125,000 red salmon off Port Moller in each of the years 1915 and 1916. In 1917 their capture was reduced to about a quarter of a million, and in 1918 it had recovered to half a million. But 1917 is the year in which the three canneries of Herendeen Bay began to compete for the Bear River and Sandy River salmon, which prior to that date had been solely at the disposal of the Pacific American Fisheries. If prior to 1917 the latter company were in fact, as seems probable, capturing a very large percentage of the available fish and if the total escape were very small the advent of the new companies could do little more than subdivide the year's product among the four participants. Making comparison on this basis, it is seen that whereas the catch in 1915 and 1916, by the Pacific American Fisheries was about 1,125,000 fish, in 1917 the combined captures of the four canneries were nearly 800,000 red salmon and in 1918 over 950,000 red salmon.

While the reduction in these years is notable and, in connection with the reduced pack which has followed in 1919, gives ground for grave apprehensions concerning the future yields of Bear and Sandy Rivers, it was not unexampled. Fully as great has been the falling off in many other overfished rivers. From this point of view, there is no necessity for assuming in explanation of the occurrences the former participation of any portion of the Bristol Bay run.

From another point of view, such participation becomes improbable. It is alleged to have occurred in 1915 and 1916, two years in succession, and then in subsequent years to have failed to make itself felt at the mouths of these rivers. According to this theory, the stream of Bristol Bay fish moved farther from shore and became inaccessible to this part of the coast on the very year in which new canneries began operations there, and this diversion of the run has continued each year since that time, irrespective of the size of the Bristol Bay run, which was larger in 1917 and in 1918 than in the two preceding years.

Taking all the known facts into consideration, it is believed that the red-salmon captures in the Bear River region have been local fish bound for Bear and for Sandy Rivers and that the reductions which have undoubtedly occurred in these runs have been the result of previous overfishing.

A partial suspension of the fishing operations in this region is recommended to permit a recovery of the run, but there seems to be no way of enforcing more stringent restrictions under the present law. No fishing is conducted in Bear or in Sandy Rivers, nor within the prescribed distance outside the mouths of these streams. But owing to the favorable configuration of the beaches and offshore slopes, and the considerable stretches of coast off which these fish school up before entering fresh water, the purse seines are very effective. These, with the two traps located at the legal distance either side of the mouth of Bear River, come perilously near effectually blocking the passageway to the river.

This is another instance of the hopeless insufficiency of the present law, which places beyond the jurisdiction of the Secretary of Commerce the salt-water approaches to the mouths of the rivers, however seriously the form of fishing there may menace the salmon supply.

IKATAN AND MORZHOVOI BAYS.

A brief visit to this district produced certain observatious in continuation of those made by one of the authors the preceding season.

No red-salmon stream exists in Ikatan Bay, or in the immediate vicinity, toward which the red salmon captured in that region are headed. The heavy schools which pass near the Ikatan beaches are bound elsewhere and dip into the bay for unknown reasons. Similar movements of migrating salmon are known elsewhere, as for example, considerable numbers of Karluk fish which school off the southern shore of Uyak Bay. At Ikatan their movements may conceivably have some relation to the opening of False Pass into the upper end of Ikatan Bay. False Pass is the only channel east of Unimak Pass, which connects the Pacific with Bering Sea. Tidal currents rush through this pass with great velocity, and a certain admixture of the waters of the two seas undoubtedly occurs. Whether any physical feature is here presented which forms a passing attraction to the migrating fish, can not be stated.

Although the Ikatan fish are bound elsewhere, they are not bound for Bristol Bay, nor is it believed they traverse False Pass in any numbers. They belong to the southern side of the peninsula and find their spawning grounds principally in Morzhovoi Bay and at Thin Point. So, although not spawning in Ikatan waters, they are local communities of fish destined for small streams which are at no great distance. In all cases of this kind, care must be exercised not to overfish the district and exhaust the runs. The danger of doing this is always magnified when local conditions render the schools of salmon particularly susceptible to attack. In many districts, the spawning runs first become evident when they school immediately off the mouth of the river. If fishing conditions are there unfavorable the percentage of escape will probably be large. But the Morzhovoi and Thin Point fish, which school up off Ikatan, pass before long beaches in which traps can be driven, and in waters where the purse seines are effective. They sustain a double attack, either of which is of great magnitude. Here again, it seems impossible adequately to protect an important school of fish, because no authority to restrict fishing along the salt-water channels has been conferred on the Secretary of Commerce. Yet it is believed possible wholly to destroy this run for commercial uses by continuing the policy of unrestricted competition which now exists. A third cannery has recently been constructed to draw on this run and is planning an increase in its operations. And three other canneries, situated unfortunately where adequate supplies were locally not available, have sent fleets of purse-seine boats to Ikatan. It is believed the district can not sustain fishing on such a scale, but it is not possible, under the existing law, to devise a remedy.

KARLUK RIVER AND LAKE.

An examination of Karluk Lake and River was made July 25 and 26, the observers walking across the trail from the head of Larsen Bay to a point on the Karluk River, proceeding thence by boat and on foot to the lake. After inspection of all the spawning beds along the lower half of the main lake, the river was descended to its mouth, by boat. It was regretted that time did not permit an examination of the upper half of the main lake and of the smaller lake and its tributaries.

On the way up river from the portage to the lake but few salmon were seen, but at the narrowed lower end of the lake, immediately above the outlet, a large school of salmon was found, consisting of fish that were not yet completely ripe and ready for spawning. These fish were lying relatively still, unless disturbed, when they would rush off in a body, with a great roar of breaking water. It was estimated that there were between 2,000 and 3,000 fish in this school.

Passing along the western shore of the lake, scattered salmon were found, and schools of no great size were about the mouths of all the small creeks that dash down the abrupt slopes on that side of the lake. Salmon were trying to ascend all these small streams, making frantic efforts to pass up through the broken water which forms a series of waterfalls and rapids among great rocks and coarse bowlders. These streams seemed wholly unfitted for spawning. They were short, violently rapid wherever seen, and appeared to be without quiet gravelly reaches where spawning could be successfully accomplished. The shallower portions of the lake, in depths where fish frequently spawn, were on the west side also for the most part totally unsuited for spawning. The bottom was thickly covered with coarse cobblestones and bowlders, without finer materials in which nests could be excavated. Here and there were gravelly or sandy beaches of small extent, but none of those on the west side of the lake gave evidence of being extensively used by the salmon.

Crossing to the eastern shore, there were found larger and longer streams, rapid brawling creeks, with coarse bowldery beds, but far more practicable than the creeks of the west side. As the mouths of the streams were approached, dead salmon that had drifted out after spawning lay thick on the bottom of the lake, and upon wading up the rough beds of the creeks, dead salmon were found lying everywhere, lodged among the bowlders or stranded on the shallows. Spawning, however, was vigorously in progress. The creeks were fairly beset with living fish seeking to spawn among their dead comrades, while off the mouths were small schools, from which a constant series of recruits passed up the rocky incline to take the place of those exhausted and dying. No gravel bars or quiet reaches were seen, and while these streams were the least unfavorable of those observed entering the lower half of the lake, it seemed incredible that any large number of salmon could successfully conceal their eggs in the narrow sand intervals between the rocks. As a matter of fact, loose eggs were seen passing down the current to the lake.

The eastern shore of the lake in its lower portion has long stretches of sandy and gravelly beaches, which seem well suited to serve as spawning beds, so far as the nature of the sediment was concerned. But the salmon did not congregate along this shore except at the entrance of larger or smaller creeks, and there was no evidence that these beach gravels were availed of to any considerable extent.

One of the lowest streams to enter on the eastern or right shore of the lake had a very different character from the others. It was a short stream, apparently not more than a mile in total length, and was spring-fed. Near the upper end it expanded to cover a basin which contained several acres, and at that time was 2 or 3 feet deep. Below this so-called lake, the channel was gently inclined, with a series of pools connected by gently-flowing stretches. Near the mouth the slope became steeper, but the stream was never turbulent.

This creek has certain characteristics that on cursory examination seem to fit it for hatchery purposes. Natives affirmed that it does not freeze in winter, being unlike all the other creeks in this respect. It contained but few spawning salmon, however, fewer than any other stream examined, a circumstance that can not be accounted for, unless possibly the temperature of the spring-fed stream was lower than is found in the other tributaries of the lake.

The salmon seen near the outlet of the lake, those around the shores, and those living, dead, and dying in and about the streams, are estimated at 5,000 or 6,000. It is impossible to give any opinion as to the adequacy of the escape to the lake during the present season.

On the way down the river, especially in the very rapid portion below the point where the trail makes off to Larsen Bay, many fresh-run red salmon were seen working their way up against the current, or resting under the lee of the coarse bowlders, which almost everywhere form the bottom of this portion of the river. There were no eddies of consequence along the banks, and the salmon were distributed throughout the width of the river. It was impossible to form any estimate of the numbers present, but there must have been many hundreds of them in the river.

The writers were impressed with the unfavorable nature of the grounds examined, by their small extent, and by the unbroken succession of spawning fish which continue to occupy these small creeks during the long season. Enormous waste of eggs must accompany this condition, and as the test of the efficiency of any hatchery lies in its advantage over natural propagation, under the local conditions in which it operates, it is believed that a red-salmon hatchery on Karluk Lake would operate to the very material advantage of the salmon run.

It is recommended that a thorough survey be made of the lake and river during the fishing season of 1920 by a party of two, one member being a practical hatchery man and the other a scientist. A survey should be made of a transportation route from Larsen Bay to the lake, a hatchery site should be selected with full knowledge of the conditions throughout the year, and the distribution of the salmon should be studied throughout the lake spawning beds. As accurate a census as possible should be made of the spawning fish.

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