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RESULTS OF EXPLORATORY SHRIMP FISHING OFF WASHINGTON AND OREGON (1958)

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SUMMARY

The ocean pink shrimp fishery off Grays Harbor, Wash., which began in 1956, expanded rapidly following the introduction of mechanical shrimp peelers. Landings in Washington increased from 40,000 pounds in 1956 to an estimated 6.5 million pounds in 1958. To further help the growth of that fishery, four exploratory cruises were conducted off the coasts of Washington and Oregon during 1958 with the U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb.

Explorations extended from Cape Beale, Vancouver Island, B.C., to Newport, Oreg. During the four cruises a total of 233 otter-trawl drags was made at depths ranging from 49 to 275 fathoms. Off the Washington coast, good catches were made between Destruction Island and LaPush; and moderate catches were made northwest of Cape Flattery. Off Oregon, commercial concentrations of ocean pink shrimp (Pandalus jordani) were located west of Tillamook Head, Manhattan Beach, and Cape Lookout. Trawling off Tillamook Head yielded catches at rates up to 2,800 pounds heads-on shrimp an hour.

Drags between 61 and 90 fathoms resulted in the highest catch rates, although fishing was also productive between 91 and 120 fathoms. Green mud or green mud and sand bottom characterized areas in which good shrimp catches were made. Bottom temperatures ranged between 42.1 and 46.7 degrees F. in the areas fished.

Fish taken during shrimp trawling included predominantly smelt, small "soles" and eelpouts. On one occasion 4,000 pounds of dogfish were taken in a half-hour drag.

A fishery for ocean pink shrimp (Pandalus jordani) began off Grays Harbor, Washington, in 1956. Expansion of the fishery followed the introduction and successful use of mechanical peeling machines in the fall of the same year. The machines lowered the cost of processing and increased the capacity of processing plants. Subsequently, the demand for shrimp increased, and catches of ocean pink shrimp in Washington increased from 40,000 pounds in 1956 to 2.3 million pounds in 1957 (Robinson et al 1958). Preliminary data indicate that the ocean pink shrimp catch for 1958 exceeded 6.5 million pounds.

An excellent demand for the "cocktail-size" shrimp resulted in an increase in the number of vessels participating in the fishery: from 5 trawlers in 1957 to about

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25 trawlers in 1958. It was soon evident that the relatively small area being trawled would not fulfill the needs of the expanding industry. For this reason, four exploratory cruises were conducted during 1958 aboard the U. S. Bureau of Commercial Fisheries vessel John N. Cobb (fig. 1) outside the area of the known commercial fishing grounds. The cruises, carried out in cooperation with the fisheries agencies of the States of Washington and Oregon, were designed to acquire information concerning sizes, quantities, and availability of shrimp inhabiting offshore waters from northern Washington to central Oregon. The 1958 exploratory shrimp work began in March and terminated in November.

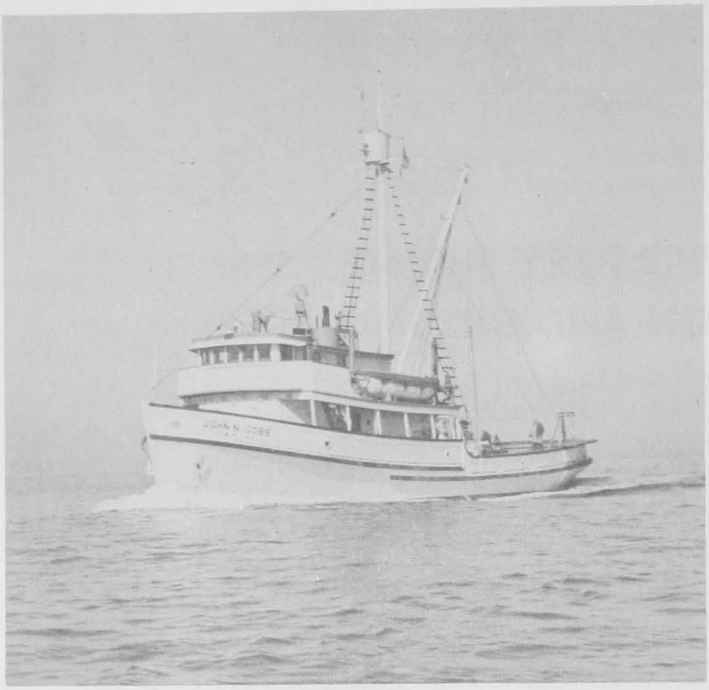

Fig. 1 - The U. S. Bureau of Commercial Fisheries exploratory fishing vessel John N. Cobb.

BACKGROUND

The earliest shrimp fishing on the Pacific Coast of the United States reportedly began in San Francisco Bay during 1869 (Bonnot 1932). Italian fishermen with small beach seines fished the shallow waters of the southern bay for two species of small brown shrimps (Crangon franciscorum and Crangon nigricauda). Several years after the inception of that fishery, Chinese-American fishermen introduced a set net which proved superior to seines and became the major method of capture. The brown shrimp fishery has persisted since its inception, and production varied between 0.25 and 1.7 million pounds annually (California Division of Fish and Game 1949). Until recent years, California shrimp fishing remained an "inside" fishery and failed to expand to coastal regions, except for a small pot fishery for spot shrimp (Pandalus platyceros) that was attempted by Monterey fishermen during the early 1930's. Difficulties in fishing deeper than 100 fathoms, the depth at which the shrimp were found, and heavy trap losses due to a severe storm proved costly, and that fishery was eventually discontinued.

A fishery for the two species of pink shrimp (Pandalus jordani and Pandalus borealis) began in Puget Sound in about 1888 (Smith 1937), and as in the early California fishery, beach seines were used to make the catches. Beam trawls pulled by steam tugs soon replaced seines, and after the turn of the century the fishery expanded rapidly. Smith (1937) reports that over 429,000 pounds of Pandalid shrimp were landed from Puget Sound in 1903, and catches remained good between 1903 and 1915. Between 1915 and 1922, the catch fell off and remained at a low level until the development of an offshore shrimp fishery in 1956.

PREVIOUS EXPLORATORY FISHING: Shrimp explorations conducted by State and Federal research agencies have played an important role in initiating the offshore shrimp fisheries of the Pacific Coast. Between 1950 and 1953, the California Department of Fish and Game carried out offshore shrimp explorations between Los Angeles and Crescent City, Calif. (Squire 1956). Those explorations located commercial concentrations of ocean pink shrimp in six areas. Best catches were made off the northern part of the State between Bodega Bay and Crescent City.

The Oregon Fish Commission initiated shrimp explorations in the fall of 1951. A total of 80 drags was made between the Columbia and Rogue Rivers (Pruter and Harry 1952) and catches of ocean pink shrimp were reported from "practically all areas explored where the bottom consisted of green mud and where the depths ranged between 60 and 80 fathoms." That report suggested that shrimp were present in sufficient quantities to support a commercial fishery.

Explorations off the west coast of Vancouver Island were begun in 1955 by the Fisheries Research Board of Canada. Using a small otter trawl, 150 experimental drags were made at depths between 48 and 112 fathoms. Best results were reported off the mouth of Nootka Sound, west of Esteban Point, Vancouver Island. The investigators concluded, however, that "shrimp were not present in sufficient quantities to support a fishery" (Butler and Dubokovic 1955b). Investigations conducted by the Canadians along the east coast of Vancouver Island resulted in reports of commercial concentrations of shrimp in the bays and the inlets of this area (Butler and Legare 1954, Butler and Dubokovic 1955a).

During the fall of 1955 and the spring of 1956, the U. S. Fish and Wildlife Service, in cooperation with the State of Washington Department of Fisheries, conducted explorations to determine the species and availability of shrimp off the Washington coast (Schaefers and Johnson 1956). Exploratory fishing was carried out between Cape Alava and Willapa Bay. Excellent catches were made off Grays Harbor at depths between 60 and 85 fathoms. A further contribution resulting from those explorations was the introduction of the Gulf shrimp trawl as an efficient gear for capturing ocean shrimp on the Pacific coast (Stern 1957).

The exploratory work conducted by those fisheries agencies led to the development of the commercial shrimp fisheries, and ocean pink shrimp are now harvested off the coasts of California, Oregon, Washington, and British Columbia.

FISHING METHODS AND GEAR

A Gulf of Mexico-type flat trawl, 43 feet along the footrope[1/] and of $1\frac{1}{2}$-inch mesh was the principal gear used in the explorations (fig. 2). The trawl, similar to that described by Schaefers and Johnson (1957), was towed from a single warp using a 25-fathom bridle. Doors used with this net measured $2\frac{1}{2}$ by 5 feet and weighed 160 pounds each. No "dandy line" gear was used as the net was attached directly to the back of the doors by 2-foot extension straps (fig. 3). The gear was set and hauled directly over the stern of the vessel. The cod end was hauled to the stern with a lazyline as the net was retrieved, and the catch was hoisted aboard.

A 72-foot Gulf of Mexico-type semiballoon trawl was occasionally used. That net has been described by Greenwood(1959). The net was rigged in a manner similar to standard West Coast otter trawls, with single warps to each door, but only 12-foot extensions were used between the net and the doors. Trawl doors used with the net measured $3\frac{1}{2}$ by 8 feet and weighed 385 pounds each.

1/ All net sizes given in this report represent footrope lengths.

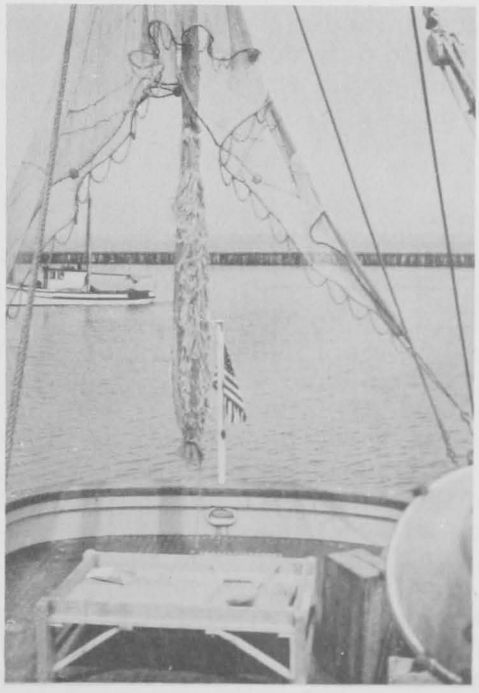

Fig. 2 - A 43-foot Gulf of Mexico-type shrimp trawl drying in the rigging of the M/V John N. Cobb. The sorting table is shown below the net.

Three fathoms of towing warp were used for each fathom of depth (a "scope" ratio of 3 to 1). Towing speed averaged about 2.8 knots, and drags were normally 30 minutes long.

Catches were spilled onto a sorting table on the stern of the vessel and fish, miscellaneous invertebrates, and trash were removed. The shrimp were then washed and weighed.

Random samples of shrimp were taken from the catches for study by biologists of the Washington Department of Fisheries or the Oregon Fish Commission or were collected for them by vessel personnel.

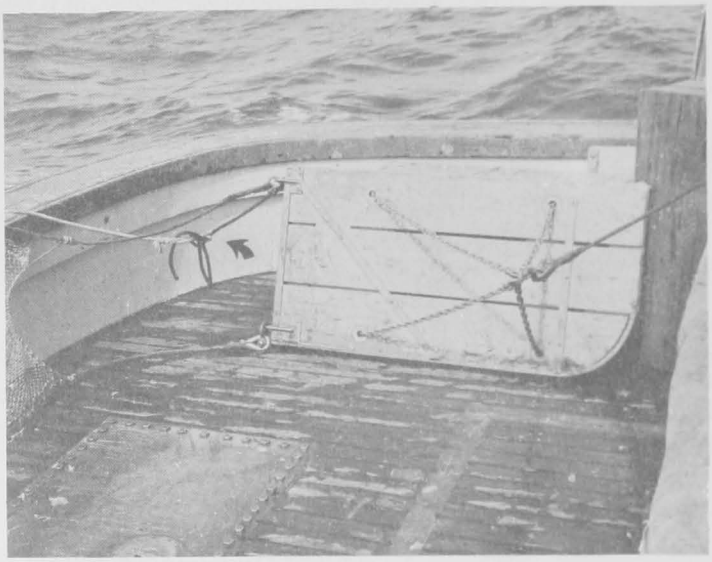

Fig. 3 - Port-side otter board showing method of net attachment. Note lazyline attached to upper door shackle.

In planning and conducting the explorations, consideration was given to bottom characteristics shown on the U. S. Coast and Geodetic Survey charts. Studies of previous investigations showed that trawling in areas between 40 and 90 fathoms on green mud or mixed green mud and sand bottom yielded best catches of ocean pink shrimp. Such areas were, therefore, intensively investigated. Exploratory drags were also made in waters deeper than 90 fathoms in attempts to determine the availability of other species of shrimp.

Information on the bottom type and bottom water temperature immediately above the bottom was obtained at the end of each drag. Oceanographic data collected during the cruises are available from the U. S. Bureau of Commercial Fisheries North Pacific Exploration and Gear Research field station at Seattle 2, Wash.

AREAS OF EXPLORATION

The cruises covered a region that extended approximately 250 miles north and south along the Washington and the Oregon coasts and to a maximum of 38 miles offshore. The continental shelf in the region explored, averages about 20 miles in width and contains large portions exceeding 50 fathoms with terminations close to 100 fathoms (Shepard 1948). Sandy bottom predominates near shore, while mud, mud and sand, and occasionally gravel characterize the bottom at depths between 50 and 100 fathoms.

A broad bank, extending approximately 50 miles seaward, lies south and west of the Swiftsure Lightship at depths of 60 to 80 fathoms. Large boulders limit trawling in the area.

A deep trough breaking the continental shelf extends from Cape Flattery in a southwesterly direction (figs. 5, 6, and 7). Sections of the trough range from 150 to 200 fathoms in depth. From Cape Flattery south to the Umatilla Lightship, the continental shelf is about 10 miles in width, and from a depth of about 50 fathoms it slopes steeply into the trough.

From the Umatilla light to Destruction Island, the shelf broadens and the slope between 50 and 100 fathoms is gradual with more area available for trawling. The shelf narrows briefly near Point Grenville and then broadens again and is about 30 miles in width as far south as Willapa Bay. Between Cape Flattery and Columbia River, the offshore slope (deeper than 100 fathoms) is relatively steep and irregular.

Off the mouth of the Columbia River, the continental shelf is broken by a prominent submarine canyon that extends inshore to about 60 fathoms. The side slopes of the canyon are steep but can be trawled in many areas. Between the Columbia River and Cape Falcon the shelf broadens to about 30 miles, narrowing again south of the Cape. From Cape Falcon to Cape Foulweather, Oreg., the slope of the continental shelf becomes more gradual and a considerable area suitable for trawling exists between the 100- and the 300-fathom contours.

FISHING RESULTS

Ocean pink shrimp were the only species found in commercial quantities during the four cruises. Larger pandalid shrimps--sidestripe (Pandalopsis dispar), spot shrimp (Pandalus platyceros), and coonstripes (Pandalus hypsinotus)--were few in number. The brown shrimp (Crangon sp.) was present in many catches but never in commercial quantities.

Fig. 4 - A large catch about to be spilled onto the sorting table on the deck of the John N. Cobb.

Ocean pink shrimp were caught in commercial quantities off the coasts of Northern Washington and Central and Northern Oregon. Best catches off the Oregon coast were made west of Tillamook Head. Fishing in that area yielded catches at rates up to 2,800 pounds heads-on shrimp an hour. Catches of commercial significance were also made west of Cape Lookout and Manhattan Beach. (Fig. 4.)

Off the Washington coast, good catches of ocean pink shrimp were caught between Destruction Island and LaPush. Somewhat smaller catches were taken northwest of Cape Flattery.

During the four exploratory cruises, 233 drags were made at depths ranging from 49 to 275 fathoms. For convenience, the region explored has been divided into three areas: Cape Beale, Vancouver Island, to Point Grenville, Wash.; Point Grenville to Cape Falcon, Oreg.; and Cape Falcon to Newport, Oreg. The position and number of each tow is shown in figures 5, 6, and 7. Drags have been arbitrarily numbered from north to south. The following discussion is generally confined to drags which yielded promising results.

CAPE BEALE TO POINT GRENVILLE (fig. 5): A total of 69 exploratory drags was made between Cape Beale, Vancouver Island, and Point Grenville, Wash. The bottom in that area is generally free of snags, and in most areas sampled, consists of green mud or green mud and sand.

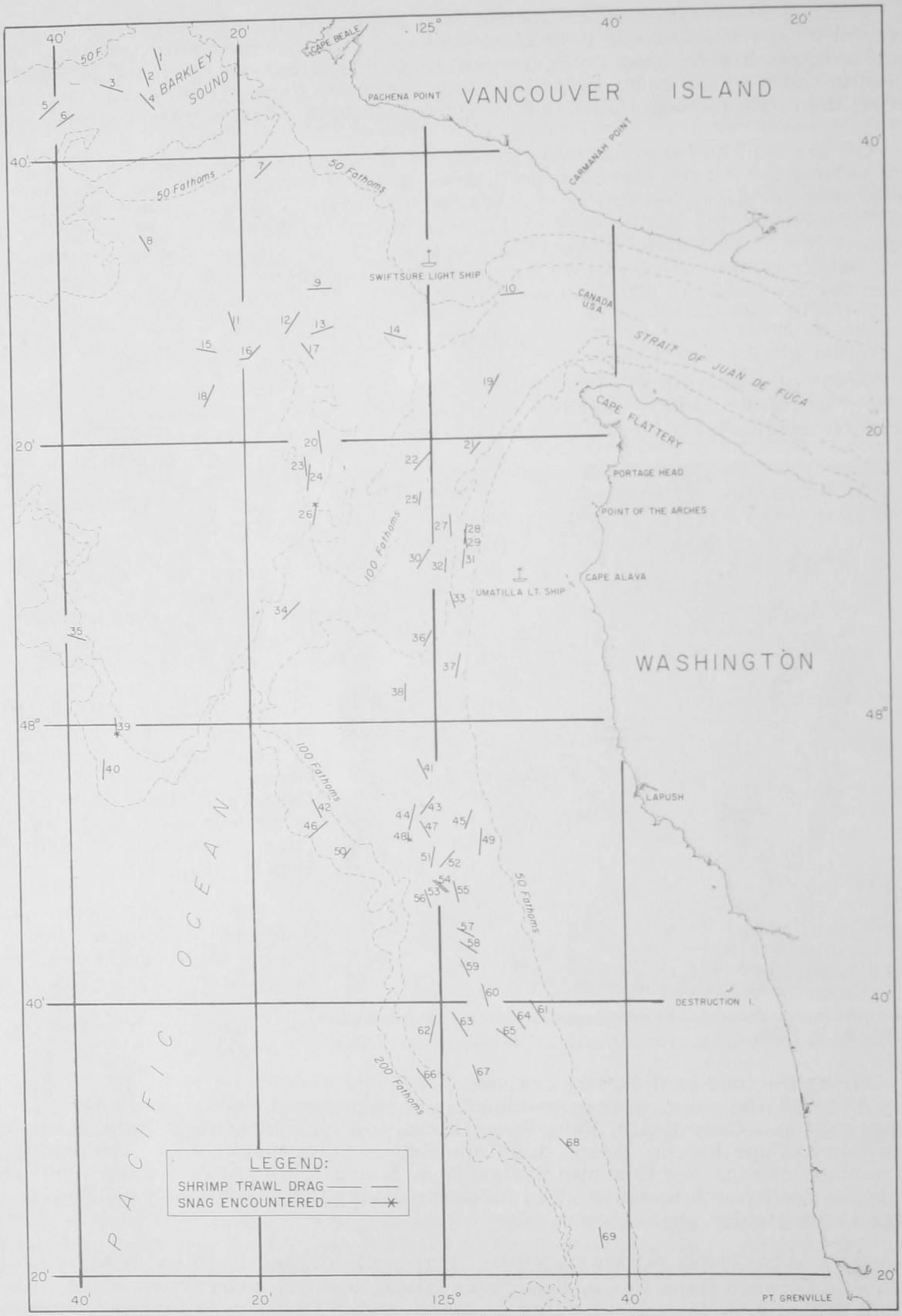

Fig. 5 - Exploratory shrimp drags made by the John N. Cobb between Cape Beale, Vancouver Island, and Point Grenville, Wash.--1958.

Best catches were made between LaPush and Point Grenville, Wash.[2/] Of 29 drags made in that area during May 11 drags caught heads-on pink shrimp at rates ranging from 400 to 1,500 pounds an hour--averaging about 200 to the pound.[3/] The shrimp in the area were most concentrated between 61 and 70 fathoms, and drags made in shallower or deeper water were not commercially productive.

Moderate catches of ocean pink shrimp were made during May about 20 to 30 miles off Cape Flattery. Six drags (numbers 8, 11, 12, 16, 17, and 23) made in that area, at depths ranging from 68 to 107 fathoms, resulted in heads-on shrimp at catch rates of 233 to 650 pounds an hour. Average shrimp counts ranged from 102 to 135 heads-on shrimp per pound. Other drags made in the same general area and depth range were less productive. The area west of Cape Flattery appeared to offer a potential for commercial use, although catches contained considerable amounts of fish.

One drag (number 2) made west of Cape Beale in 64 to 66 fathoms resulted in a catch of 200 pounds of ocean pink shrimp that averaged 107 count, but other drags in the area did not produce commercial quantities of shrimp. Thirty pounds of side-stripe shrimp (56 shrimp to the pound) were taken west of Cape Beale (drag 3), and represented the largest catch of that species made during the explorations.

A number of drags were made in the deep-water trough running southwest from Cape Flattery and on the offshore continental slope. No commercial concentrations of shrimp were found in those deep-water tows.

POINT GRENVILLE TO CAPE FALCON (fig. 6): A total of 81 exploratory drags was made between Point Grenville, Wash., and Cape Falcon, Oreg. Fishing activities were concentrated in the area between Columbia River and Cape Falcon, because most of the northern part of the area was investigated during 1956 (Schaefers and Johnson 1957). No snags were encountered during exploratory trawling at depths shallower than 100 fathoms, although the net was fouled several times when trawling in deeper water.

Best shrimp catches during the explorations were made between the Columbia River and Cape Falcon, Oreg., where a total of 74 exploratory drags was made. The largest catch (drag 121) in the area resulted in an hourly rate of 2,804 pounds of heads-on shrimp that averaged 100 count. A 72-foot semiballoon trawl was used for that drag which was made west of Tillamook Head in 82 to 83 fathoms. Seventeen other drags made during March and April at depths from 70 to 91 fathoms, between Columbia River and Cape Falcon, yielded heads-on shrimp at rates from 600 to 1,350 pounds an hour. Those shrimp ranged in size from 88 to 126 a pound. Six of the latter drags (numbers 99, 103, 119, 123, 126, and 149) were made with the 72-foot semiballoon trawl. The majority of the larger catches in the area were obtained in a relatively narrow depth range, i.e., between 82 and 86 fathoms.

Catches between Point Grenville and the Columbia River were generally poor, and deep-water tows through that area and south to Cape Falcon yielded only trace amounts of shrimp.

CAPE FALCON TO NEWPORT (fig. 7): A total of 83 exploratory drags was made between Cape Falcon and Newport, Oreg. The bottom was clear in areas fished, and only 2 snags were encountered.

Good catches of pink shrimp were made in the general area off Cape Lookout during June at depths between 90 and 114 fathoms. Seven drags (numbers 170, 171, 173, 174, 177, 185, and 186) in that area produced heads-on shrimp ranging from 81 to 138 per pound, at rates from 380 to 850 pounds an hour. Four other drags in the same area and depth range were less productive.

2/Subsequent to exploratory work conducted in 1958 the commercial fishery expanded to include this area, as well as the grounds off northern Oregon.

3/Counts given in this report are the number of whole shrimp (heads-on) per pound.

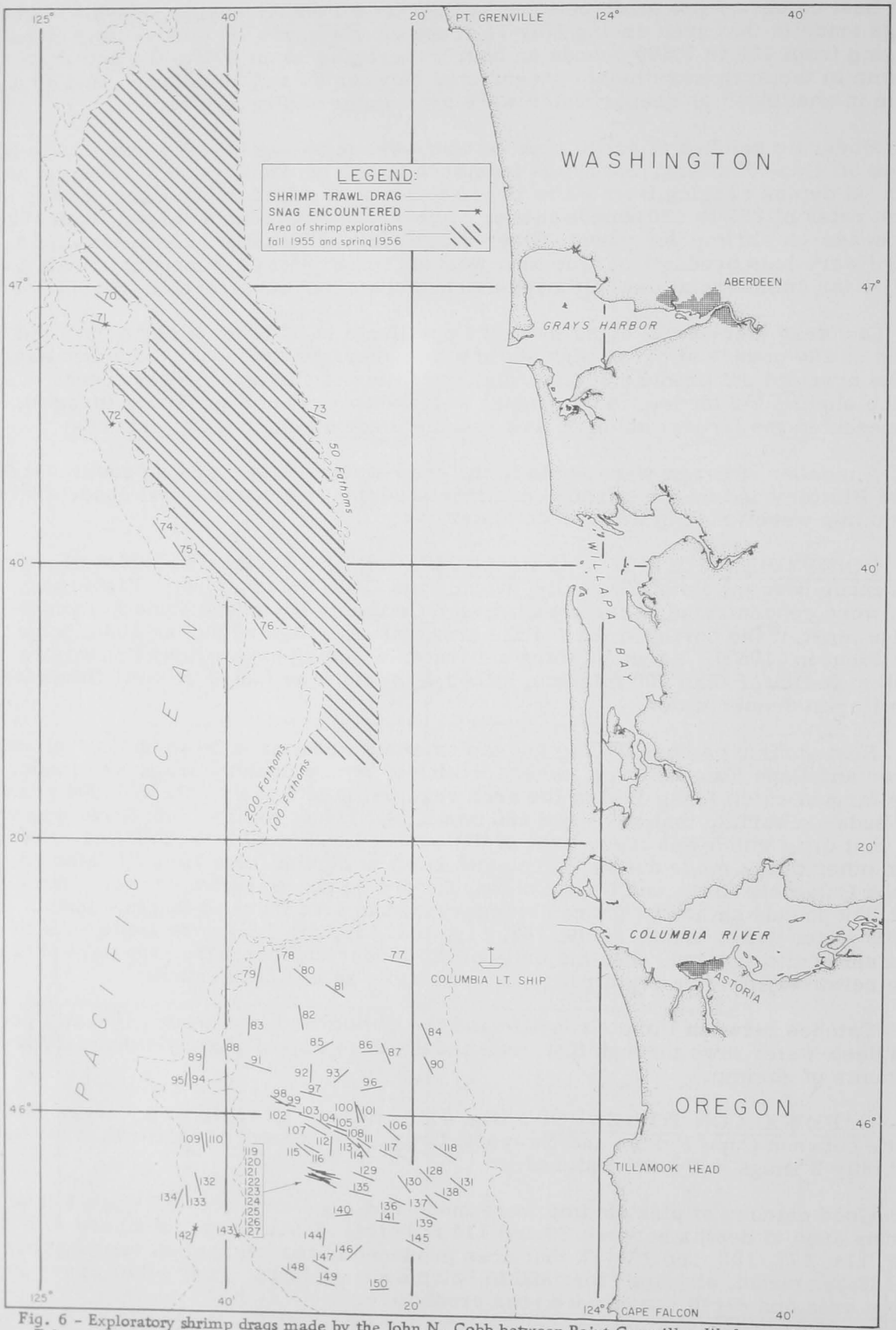

Fig. 6 - Exploratory shrimp drags made by the John N. Cobb between Point Grenville, Wash., and Cape Falcon, Oreg.--1958.

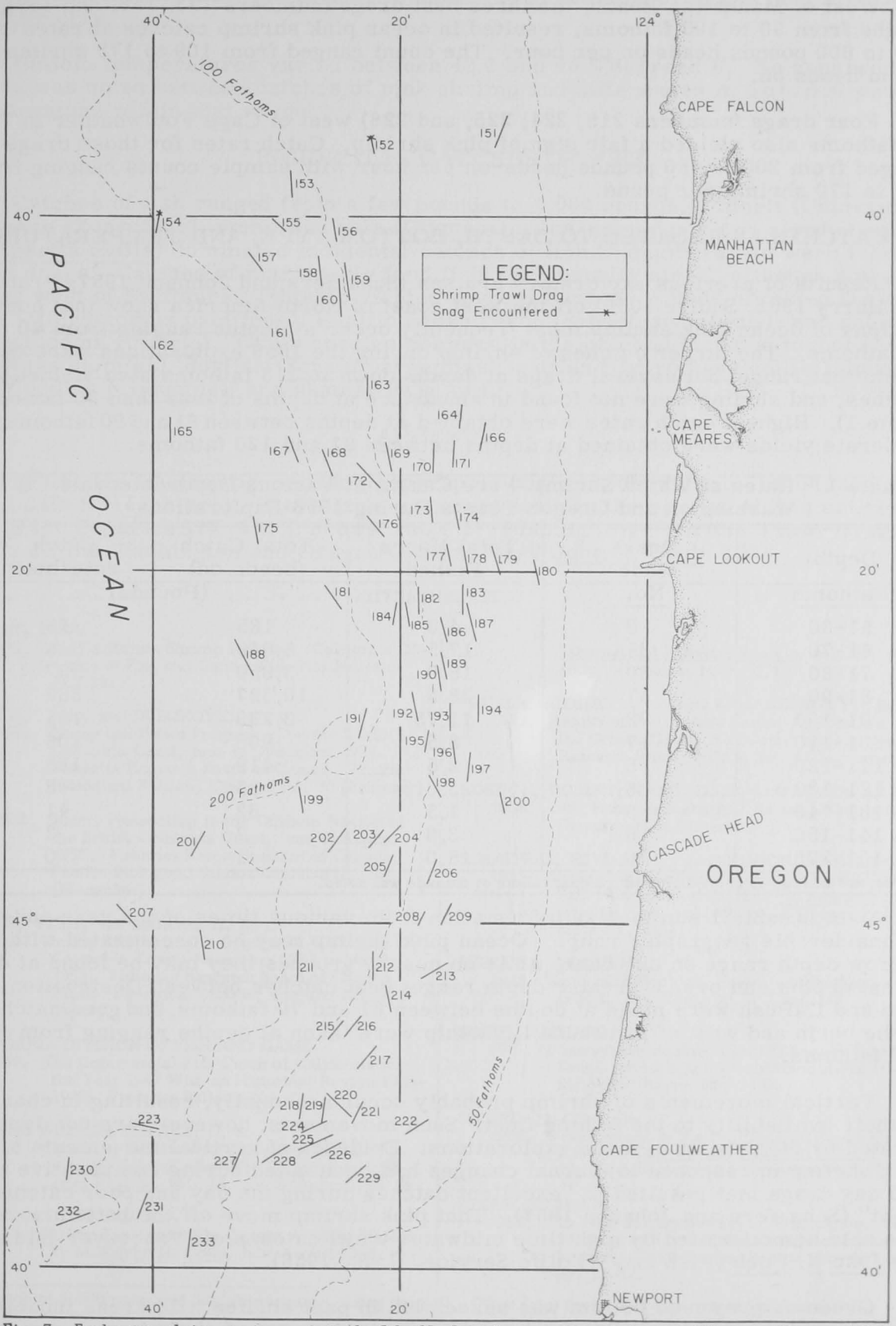

Fig. 7 - Exploratory shrimp cruise made by the John N. Cobb between Cape Falcon and Newport, Oreg.--1958.

West of Manhattan Beach, the three best drags (numbers 153, 158, and 159), at depths from 96 to 105 fathoms, resulted in ocean pink shrimp catches at rates from 440 to 600 pounds heads-on per hour. The count ranged from 109 to 175 shrimp per pound heads on.

Four drags (numbers 215, 224, 225, and 226) west of Cape Foulweather in 76 to 99 fathoms also yielded a fair sign of pink shrimp. Catch rates for those drags ranged from 200 to 450 pounds heads-on per hour with sample counts ranging from 129 to 170 shrimp per pound.

CATCHES AS RELATED TO DEPTH, BOTTOM TYPE, AND TEMPERATURE

Results of previous exploratory cruises (Schaefers and Johnson 1957, Pruter and Harry 1952, Squire 1956) off the west coast of North America show that concentrations of ocean pink shrimp most frequently occur at depths ranging from 40 to 90 fathoms. The larger catches of shrimp during the 1958 explorations were caught within that range, but several drags at depths down to 115 fathoms also yielded good catches, and shrimp were not found in abundance at depths of less than 60 fathoms (table 1). Highest catch rates were obtained at depths between 61 and 90 fathoms, and moderate yields were obtained at depths between 91 and 120 fathoms.

Table 1 - Rates at Which Shrimp Were Caught at Various Depth Intervals Off the Washington and Oregon Coasts During 1958 Explorations[1/]

Depth	Drags Made	Total Hours Fished	Total Catch (heads on)	Catch rate/hour
Fathoms	No.		(Pounds)	
51-60	8	4.0	185	46
61-70	35	17.5	6,049	346
71-80	30	15.0	3,859	257
81-90	57	28.5	10,327	362
91-100	23	11.75	2,239	191
101-110	17	8.5	903	106
111-120	5	2.5	419	168
121-130	6	3.0	25	8
131-140	3	1.5	62	41
141-150	6	3.0	7	2
151-275	30	15.0	1	0

1/ Does not include 13 drags during which gear failure or damage was noted.

Data in table 1 summarize information from various times of the year and over a considerable geographic range. Ocean pink shrimp may be concentrated within a narrow depth range on one bank, while on nearby grounds they may be found at different depths and over a greater depth range: best catches between Destruction Island and LaPush were made at depths between 61 and 70 fathoms, and good catches to the north and west of Swiftsure Lightship were taken at depths ranging from 68 to 107 fathoms.

Vertical movements of shrimp probably occur seasonally, resulting in changes in their availability to the fishing fleet. Such movements, however, are not demonstrated by the data from these explorations. Evidence of vertical movements of pink shrimp in response to diurnal changes has been noted during comparative night and day drags that resulted in "excellent catches during the day and poor catches at night" (Schaefers and Johnson 1957). That pink shrimp move off the bottom at night was also demonstrated by nighttime midwater trawl catches off Vancouver Island by the John N. Cobb (Fish and Wildlife Service, U. S., 1956).

Green or gray mud bottom was associated in past studies with areas inhabited by pink shrimp, and in all drags where 50 pounds or more of shrimp were caught

during the 1958 cruises, the bottom consisted of green mud or green mud mixed with sand or clay.

Bottom temperatures varied between 42.1 and 46.7 degrees F. No apparent relation was noted between catches of pink shrimp and differences in bottom water temperature within that range.

INCIDENTAL CATCHES OF FISH

Catches of fish ranged from a few pounds to 4,000 pounds.[4/] Smelt (Osmeridae), eelpouts (Zoarcidae), small rex sole (Glyptocephalus zachirus), and slender sole (Lyopsetta exilis) dominated incidental catches of fish in numbers and were taken in most drags. Catches of marketable food fish were usually small, although some drags west of Swiftsure Lightship yielded several hundred pounds of mixed Dover sole (Microstomus pacificus), Pacific ocean perch (Sebastodes alutus), and sablefish (Anoplopoma fimbria). Other species common in the catches included turbot (Atheresthes stomias), dogfish (Squalus acanthias), ratfish (Hydrolagus colliei), hake (Merluccius productus), and skates (Raja sp.).

APPENDIX

A detailed fishing log, showing geographic position, depth, date, catch, and related data for each drag, is available as an appendix to the reprint of this article. Write for Separate 574, which shows Table 2--Fishing Log--Shrimp Trawl Drags Made off the Washington and Oregon Coasts--M/V John N. Cobb, 1958.

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4/A catch of 4,000 pounds of dogfish was taken during drag 10. Other drags took lesser amounts of incidental fish.