

THE PETRALE SOLE

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INTRODUCTION

Petrале sole are taken commercially from Santa Barbara, California, to Hecate Strait, British Columbia. These large deep-bodied flounders are one of the major contributors to Oregon's trawl fishery, as well as those of Washington, British Columbia, and California. Only the Dover and the English soles appear in greater quantities. This species is sometimes called "rich man's sole"--the petrale's size and excellent quality as a fillet product cause it to command the highest price of any Pacific coast flatfish, excepting only halibut.

REPRODUCTION

The length at which a petrale sole matures depends on the fish's sex and where on the coast it lives. Fifty percent maturity (the length [or age] at which half the fish in an area are mature) off the Columbia River is 13-3/4 inches (34.8 cm) at 4 years for male and 15-1/2 inches (39.7 cm) at 5 years for female sole. Further south fish mature at a slightly smaller size while further north they are larger and older. The youngest petrale sole reported spawning were a 11.7 inch (29.7 cm), 3-year-old male and a 12.5 inch (31.7 cm), 4-year-old female. At the other end of the scale, a female at 18.5 inches (47.0 cm) at 9 years of age and a male at 15.2 inches (38.6 cm) at 8 years have been found immature.

Sexes of most flatfish, including petrale sole, can be discerned by holding the fish against a light, termed "candling". The female's ovary can be seen as a long shadow extending toward the tail from the stomach area.

Petrале sole spawn between November and April, with most activity occurring from January to early March. Studies on market samples have shown that more females than males occupy the sites early in the season and that this ratio switches as the season progresses.

A 16-1/2 inch (42 cm) female petrale sole produces about 400,000 eggs and a 22-1/2 inch (57 cm) fish, over 1,200,000.

EARLY LIFE HISTORY

Eggs and Larvae

Development of the petrale sole is known largely from laboratory work and inference based on oceanographic data and commercial landings. Spawning occurs, depending upon the spawning site, in water about 150-250 fathoms (274-457 meters) deep. Fertilized eggs, averaging 1.25 mm (about 1/16 inch) in diameter, are less dense than the cold, high salinity water surrounding them at that depth. Eggs are believed to ascend slowly to a level in the water column where they are neutrally buoyant, a depth determined by the temperature and salinity of layers through which they pass. Laboratory observations show that this depth is normally in the upper layers of water. Here the eggs hatch and are transported by surface currents. Since prevailing winds at the time of spawning are from the southwest, eggs and larvae are dispersed northward and inshore from spawning locations. In the laboratory, eggs hatch in about 8-1/2 days at 7 C (42.6 F).

Larvae are about 3.0 mm (1/8 inch) long at time of hatching. Yolk sacs are absorbed by the tenth day following. Captures of larvae at sea have been sparse--

less than 100 during the past 18 years. Times of captures and stages of larvae taken point to a 5-6 month pelagic existence. During this time the left eye migrates to the right side of the fish (a process called metamorphosis) as the baby sole are prepared for a benthic lifestyle.

Juveniles

Bottom-dwelling post-metamorphosis petrale sole are found almost as infrequently as larvae. The few captures, off Newport, Oregon, Crescent City and San Francisco, California, and off British Columbia, indicate that these young fish inhabit shallow to mid-shelf depths of about 20 to 90 fathoms (36 to 66 m.) during summer months following metamorphosis. It is possible that juvenile petrale sole are not restricted to a benthic existence, or that most of their time is spent on bottoms too rocky for trawling.

ADULT LIFE HISTORY

Distribution and Abundance

Petrале sole range from northern Baja California to northwest Alaska; however, they occur in sufficient density to support commercial fisheries between San Barbara, California, and Hecate Strait, British Columbia.

Depth of occurrence is seasonal. From roughly April to October they are taken between 20-100 fathoms with heaviest commercial catches occurring at 40-70 fathoms. In winter (November through March) the most common depth range is 170-250 fathoms.

An Oregon Department of Fish and Wildlife (ODFW) trawl survey, conducted in late summer and early autumn of 1971-74 off the Oregon coast north of Cape Blanco, found more petrale sole over sand than over mud bottom with many taken adjacent to untrawlable areas. Petrале sole at winter spawning depths occur over predominantly mud bottoms.

In Oregon commercial trawl landings of petrale sole rank third among the flatfish after Dover and English soles. The previously mentioned Oregon trawl survey found an estimated 9-13 million pounds (4083-5900 m.t.) of petrale sole out of 176-188 million pounds (79,855-85,300 m.t.) of combined flatfish inhabited the continental shelf and upper slope off the Oregon coast.

Feeding Habits

The petrale is a large-mouthed flounder with a strong double row of teeth in the upper jaw and a single row in the lower. It takes primarily fish and pelagic invertebrates as its food. For much of the coast's population, the most common food item is Euphausiids or "krill", which are small shrimp-like animals often occurring in great abundance in the water column. Other important food items include herring, shrimp, juvenile rockfish, and, in the northern part of their range, sand lance. Off California, anchovies, juvenile hake, and other flatfish also figure prominently in their diet.

Age and Growth

Aging of petrale sole is accomplished by counting winter "bands" on their otoliths, or ear bones. Alternate translucent and opaque bands, like rings on a tree, appear

as the fish grows. Each translucent band corresponds to a winter season, a time of slow growth.

Both male and female petrale grow rapidly for the first few years. Sole as young as two years (7.5-9.5 inches, or 19-24 cm) are seen in the commercial catch, but most fish do not become large enough to be retained by normal trawling gear until age four or five (12.5-14 inches, or 31.7-35.5 cm). The bulk of Oregon commercial landings consists of petrale aged 5-8 years and 14-17 inches (35.5-43.2 cm) long.

The oldest recorded petrale sole were a 25.25 inch (64 cm) female aged 25 years and a 19.75 inch (50 cm) male aged 19 years. The longest fish, ages unknown, were a 27.5 inch (70 cm) female and a 21 inch (53 cm) male.

THE FISHERY

Oregon's trawl fishery expanded greatly in the late 1930's and during World War II. At this time the petrale fishery was a summer inshore operation. Catch patterns varied for specific areas but generally Pacific coast landings were at their peak in post-war years and declined steadily throughout the early 1950's.

A boost to the northern fleets trawl landings came with the discovery by the Washington trawlers of the Esteban Deep winter spawning grounds off southern Vancouver Island. Because of the heavy spawning concentrations, large numbers of fish were taken in a very few weeks. The inshore fisheries continued to decline to such an extent that an international agreement was reached in 1957 to restrict winter fishing on petrale spawning aggregations. By this time fishermen no longer sought petrale sole exclusively, but had begun the multi-species effort still in effect today. The restriction was lifted in 1967, when it was decided that the winter fishery had probably not been the cause of the declining summer inshore fishery. The primary factor governing abundance of petrale sole is thought to be naturally caused fluctuation in annual spawning-recruitment success.

Subsequent discoveries of other spawning grounds such as the Willapa Deep, off southern Washington, and the Heceta Bank Deep, off central Oregon, have augmented the catch to some extent. However, it has never approached the peak of the late 1940's.

Oregon's catch of petrale sole has vacillated between 1.6 and 2.7 million pounds (in 1968 and 1974, respectively) in the period between 1966-1975, with a ten-year mean of 2.1 million pounds (952 m.t.). Landings in 1976 were 1.7 million pounds (771 m.t.) out of a Pacific coast total estimate of 7.8 million pounds (3,540 m.t.).

MIGRATIONS AND TAGGING

Information regarding migration patterns of fish species is obtained by tagging experiments. Petrale sole taggings have been conducted in all areas where they are of commercial importance. They are performed largely to find out where summer inshore populations go to spawn, and where spawning stocks move for their summer feeding migrations.

Virtually all tag returns show that these fish are divided into relatively discrete (separate) populations which generally assemble to spawn at the same site year after year and disperse northward and inshore during spring and summer months

to feed. Populations mix frequently during feeding migrations in summer but few individuals spawn at sites other than that of their own group. Pedersen (1975) delineated the migration territories of the spawning populations of Esteban, Willapa, and Cape Flattery Spit Deeps (Figure 1).

A study of Oregon's major petrale sole population, tagged during spawning on the Heceta Bank Deep by ODFW (southeast of Heceta Bank off central Oregon), shows that this group adheres to a similar pattern. Most summer migrants (84%) bearing these tags were taken from waters inshore of the spawning site to off Cape Flattery, Washington. All spawning ground recoveries came from the Heceta Bank Deep.

Two taggings of inshore fish in spring were also conducted by the ODFW. One was just inshore of Heceta Bank Deep and the other about 75-90 nautical miles (139-166 km) north of the spawning ground. Spawning ground recoveries from these indicate that Heceta Bank Deep and Eureka Deep (off Eureka, California) spawners are sharing inshore feeding grounds in spring and summer, yet are probably returning to their own sites for spawning. Returns from autumn inshore taggings off northern California by the California Department of Fish and Game substantiate this conclusion.

Fish from all three Oregon studies were found on spawning sites in winter up to four years after tagging had taken place. One fish, caught in the summer inshore fishery, remained free for 11 years--long enough for the number to have worn off the tag.

Most tagging studies have shown no preference by petrale sole of one age-class or gender to migrate as a group. The exception is the previously noted tendency for females to arrive at and depart from the spawning site earlier than males.

Tagging studies have yielded estimates of speed of migration for petrale sole. These are obtained by dividing the number of miles traveled by the number of days of freedom of fish captured soon after release. Results from various studies indicate a speed of 1.0-3.8 miles per day. This is a minimum speed, as fish are unlikely to travel in a straight line.

Fish tagging studies are only as valid as the information returned. Notation of date and area of capture, tag number and length of a recovered tagged fish help biologists build a picture of a population which can in turn aid in development of good management practices. It is also helpful to give the tagged fish to the tagging agency for determination of age and sex.

ACKNOWLEDGMENTS

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LITERATURE CITED

Pedersen, M. 1975. Movements and growth of petrale sole (*Eopsetta jordani*) tagged off Washington and southwest Vancouver Island. J. Fish. Res. Board Can. 32(11):2169-2177.

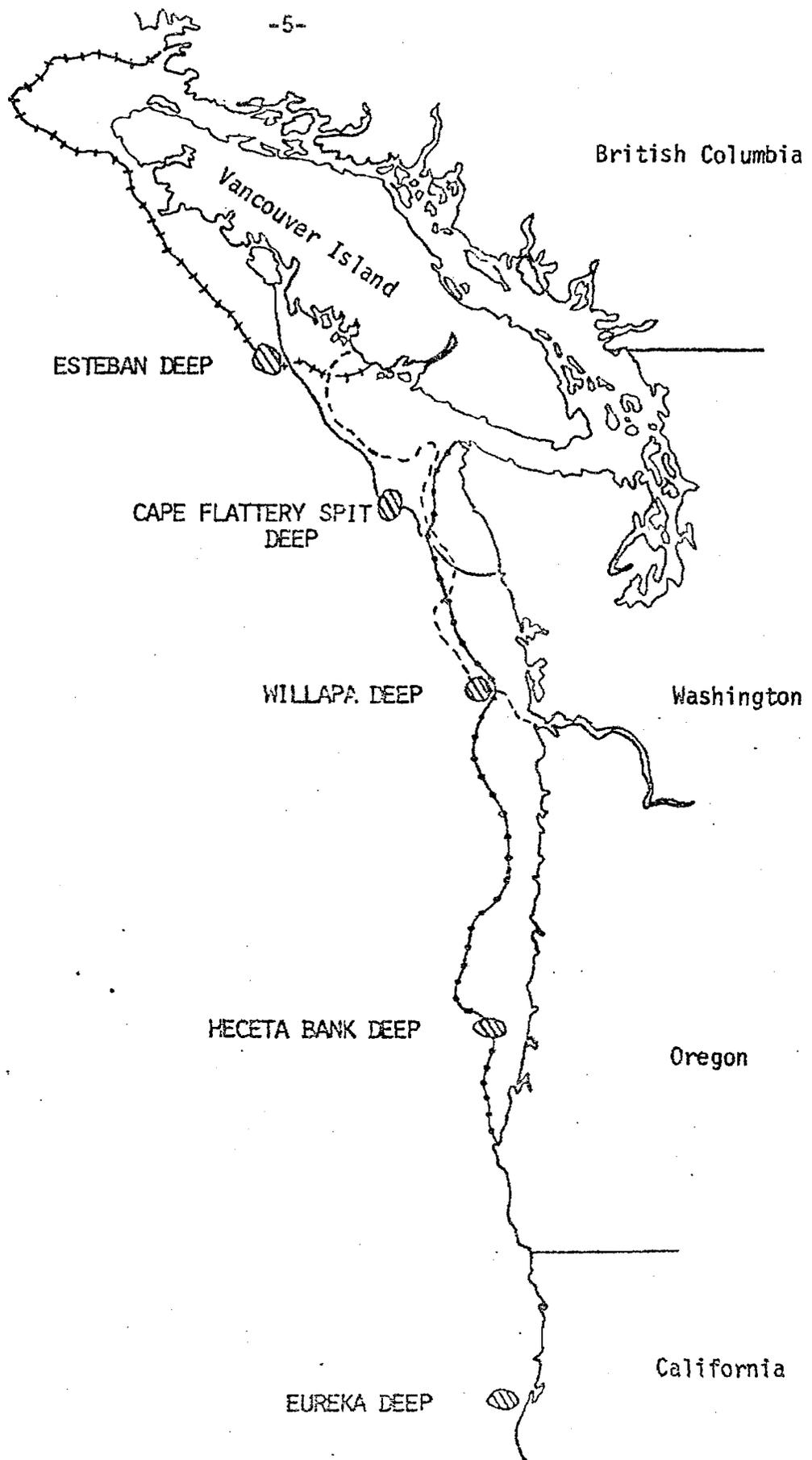


Figure 1. Deepwater spawning grounds of major petrale sole groups occurring off the northern Pacific coast. Lines extending from each circle delineate primary range of summertime occurrence of adults from each spawning group. Proposed range of distribution of Hecate Bank group is based on preliminary tag recovery analysis.