

Pacific Northwest

Marine Fishes



Otter Trawling On Puget Sound

State of Washington
Department of Fisheries
Seattle, Wash.

Washington Sea Foods

Excluding hydro-electric power, the food fisheries of Washington state rank as its third largest natural resource. It is a particularly valuable resource because of its great variety and self-perpetuating character. With the help of the state through management regulations and protection of natural habitat, it automatically renews itself year after year without the necessity of tillage or prolonged reseeding.

Commercial utilization of the fisheries began on a trading basis at least as early as 1825, when Hudson Bay Company established Fort Vancouver. Salmon were the main article of this commerce. The first state salmon cannery was built at Eagle Cliff on the lower Columbia in 1866. Seines and fish traps were introduced on Puget Sound in the mid-1880's and the basis laid for an industry which has thrived ever since.

The commercial fisheries in 1951 produced \$41,481,000 worth of food fish and shellfish; the investment in fish canneries, vessels, gear, oyster lands and marine yards totaled \$77,518,000; and another \$35,624,000 was spent by processors and fishermen for wages, operating expenses and provisions.

In addition, a sizeable sport fishery has developed on salmon, and during 1951 an estimated 200,000 fishermen spent \$8,444,000 on fishing trips and gear. The value of salt water fishing resorts and boathouses amounted to \$11,013,000.

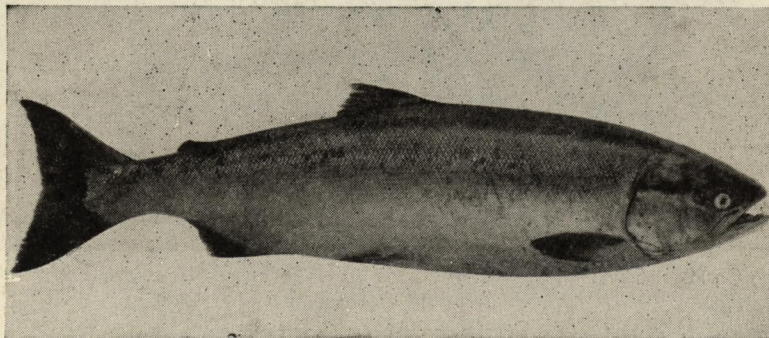
In this booklet some of the species which support the fisheries industry are discussed.

Pacific Salmon

Salmon are the most valuable fisheries resource of the state of Washington. Five of the six species of Pacific salmon are produced in Washington streams and caught by fishermen in salt and fresh waters of the state. Pacific salmon have been assigned to the genus *Oncorhynchus* (meaning hooked nose) and are distinguished from the Atlantic salmon, *Salmo*, chiefly by the fact that the latter may spawn more than once while Pacific salmon always die after spawning. The steelhead and other species of trout also belong to the genus *Salmo*. Pacific salmon are anadromous, that is they are hatched in fresh water, descend to salt water, attain most of their growth there, and then return to the streams to spawn. They have a well-developed homing instinct, practically all of them returning to spawn in their streams of origin. When spawning time approaches the fish undergo such drastic changes in color and body proportions that they are hardly recognizable to an inexperienced observer. Spawning occurs in well-percolated gravel beds where the fish bury the eggs to protect them from predators and from the elements. The eggs hatch in the gravel and the young fish live there for a time subsisting on the yolk material from the egg, which remains attached to the fish's belly. When the yolk is exhausted, early the following spring, the young fish emerge from the gravel and begin to swim actively about.

Sockeye Salmon

This species, *Oncorhynchus nerka*, is also known as the red salmon in Alaska and the blueback salmon in the Columbia river. Its landlocked form is called the kokanee, redfish, or "silver trout." Sockeyes average about 5 to 7 pounds in Puget Sound and



Sockeye salmon. Actual size; 6 pounds; 24 inches. Age 4.

[2]

3 to 4 pounds on the Columbia river. The landlocked forms usually weigh less than a pound when mature. Sockeye are commercially important from the Columbia river to Asia. Mature fish are from 3 to 6 years old but 4 years is the predominant age. Mature three-year-old fish are invariably males and are known as "jacks."

The spawning migration from the sea occurs chiefly in June, July, and August and spawning takes place in streams flowing into lakes or in the lakes themselves. When the fry emerge from the gravel in the spring they make their way to the lakes where the majority remain for a little over a year, feeding on minute invertebrates.

The Fraser river in British Columbia is the most important contributor of sockeye salmon to Washington commercial fishermen. Sockeye headed for this river are taken by purse seines, reef nets, and gill nets fishing in the San Juan Islands and at Point Roberts. The Columbia river also has a sizeable run of this species and it is fished by gill nets and Indian dip nets. Several other Washington rivers have smaller runs of sockeye. The sockeye has rich, red flesh and for this reason is highly prized for canning. The Fraser river sockeye runs are under the jurisdiction of the International Pacific Salmon Fisheries Commission, an organization sponsored jointly by the United States and Canada. This species rarely takes a hook and is thus of little importance as a sport fish. Washington's average annual commercial catch of sockeye salmon ranges from 2 to 3 million fish.

Chinook Salmon

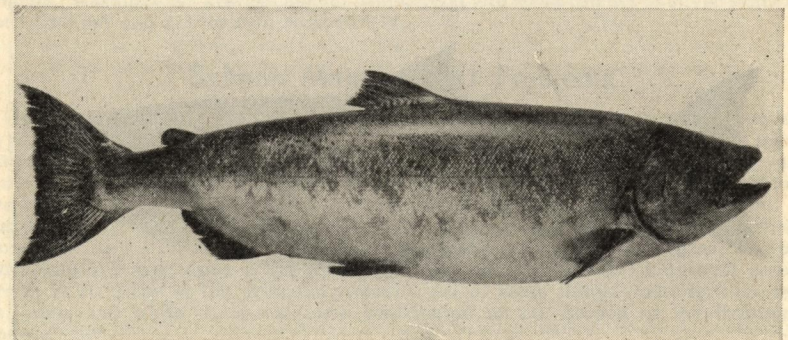
The chinook, *Oncorhynchus tshawytscha*, is the largest of the Pacific salmon. It averages about 20 to 25 pounds when mature, and is commercially important throughout its range from northern California to Asia. Mature fish are usually 4 to 5 years old (measured from the time the egg is fertilized) in Washington. Other common names for chinooks are king, spring, tyee and blackmouth.

The main spawning migration takes place in the late spring and early fall. The early run, called spring chinooks, spawns in the late summer; fall chinooks spawn as soon as they reach their spawning grounds in the autumn. The young fall chinooks, after emerging from the gravel, feed a short time in the streams and then descend to salt water. The bulk of the young spring chinooks tend to remain in the streams an additional year before going to sea.

In the ocean the chinooks migrate far up and down the coastline but generally tend to go north of their streams of origin. Thus Sacramento river fish are taken off the Washington coast and Columbia river fish off Alaska. Many chinooks of Puget Sound origin remain in the sound throughout most or all of their salt water existences and grow at a slower rate than do those in the open ocean. Young chinooks feed on small invertebrates in fresh and salt water while larger chinooks feed mostly on fish, particularly herring.

Washington's most important chinook-producing river system is the Columbia, which supports large gill net and Indian dip net fisheries and an important sport fishery. It also contributes substantially to the extensive ocean troll fishery which operates on fish originating in streams from California to Alaska. Other Washington streams are of less importance as far as growing chinook salmon is concerned. Troll-caught chinooks are sold fresh or mild cured while chinooks caught in the Columbia river are usually canned.

The chinooks reared in Puget Sound streams form the basis for an extensive sport fishery inside the sound where most are taken as immature blackmouths. Large sport fisheries have developed in recent years in various coastal areas in Washington, such



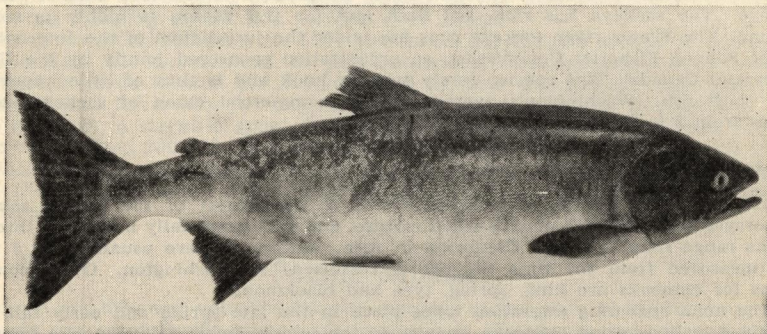
Chinook salmon. Actual size: 45 pounds; 38 inches. Age 5.

[3]

as off Cape Flattery and Grays Harbor, where large fish from the Columbia and Fraser rivers forage. Washington's average annual commercial and sport catches of chinook salmon are about 560,000 and 165,000 fish, respectively.

Pink Salmon

This species, *Oncorhynchus gorbuscha*, is commonly known as the humpback salmon, and averages 5 to 6 pounds when mature. It is commercially important from Puget Sound to Asia, and is the most abundant of all species. Pinks invariably mature at 2 years of age and the spawning migration from the sea takes place chiefly in August and September. Although spawning usually occurs near the mouths of tributary streams, pink salmon often go well up into the larger rivers. The young pinks, after emerging



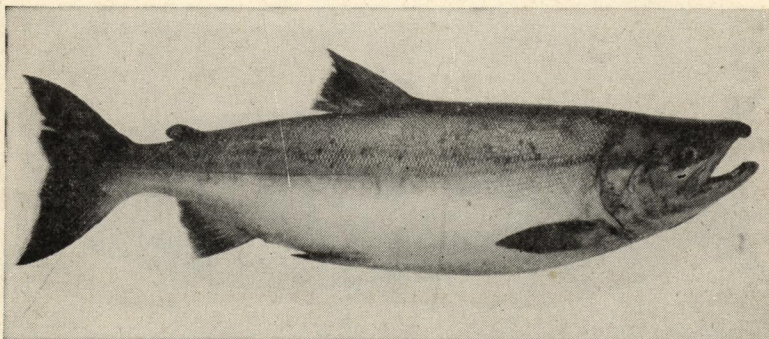
Pink salmon. Actual size: 6 pounds; 23 inches. Age 2.

from the gravel in the spring, go immediately to salt water. The adults are caught almost exclusively in odd years in the Puget Sound area. Large odd and even-year runs coexist in other areas, such as Southeast Alaska, and there is no known reason why they should not thrive if once started in Puget Sound. Efforts toward establishment of such runs are being conducted by the Washington Department of Fisheries.

The Stillaguamish, Skagit, Snohomish, Puyallup and Nooksack watersheds are Washington's chief producers of pink salmon. Adult pink salmon are taken by sports fishermen at resorts on Whidbey island and in the Port Susan-Port Gardner area, while in the spring large catches of the immatures are taken off Point Defiance near Tacoma. Washington's average odd-year commercial catch of pink salmon is about 5,000,000 fish.

Chum Salmon

Chums, *Oncorhynchus keta*, are also known as the dog salmon or fall salmon. When mature, they average about 10 to 12 pounds. They are commercially important from Oregon to northern Asia. Mature fish are usually 4 years old in Washington, but some may be 3 or 5 years old. The spawning migration takes place chiefly in October, November, and December. The young chums, after emerging from the gravel in the spring, go almost immediately to salt water.

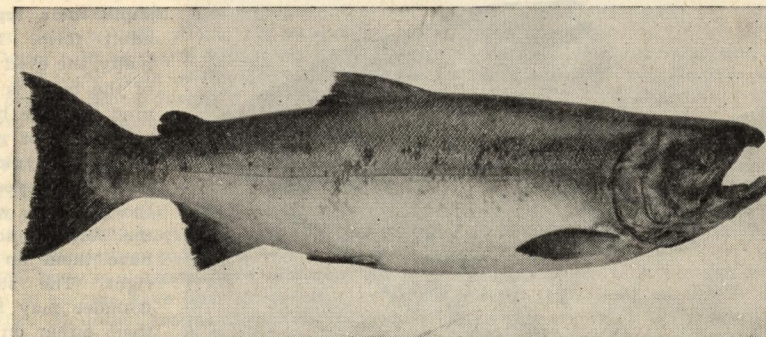


Chum salmon. Actual size: 13 pounds; 29 inches. Age 4.

Chum salmon are taken chiefly by purse seines on Puget Sound, especially in Admiralty inlet, the San Juan Island region, and Skagit bay. They are also taken by gill nets in Puget Sound, and exclusively with that type of gear in the Columbia river and coastal areas. Washington's average annual commercial catch of chum salmon is about 870,000 fish.

Silver Salmon

Silver salmon *Oncorhynchus kisutch*, are also known as the coho or silverside. Immature silvers are sometimes called "salmon trout" by sports fishermen. Silvers average about 8 to 10 pounds when mature and are commercially important from northern California to Asia. Mature fish are mostly 3 years old in Washington but a few may be 2 or 4 years old. Two-year-old mature fish are always males and are called jacks. The spawning migration from sea occurs chiefly in September and October but may extend into December. Silver salmon spawn in virtually every stream in Washington but are most abundant in small lowland streams and main river tributaries. The young, after emerging from the gravel in the spring, remain in the streams to feed for a little over a year before migrating to salt water. Their migrations in the ocean cover less area than those of chinooks but there is a considerable interchange between Washington and adjacent waters. Many silvers of Puget Sound origin remain in the sound through part or all of their lives, and, like the chinooks, grow much slower than those migrating to the open ocean. Small invertebrates are the principal source of food for silver salmon in fresh and salt water, although they consume considerable quantities of small fish in their final summer.



Silver salmon. Actual size: 10 pounds; 30 inches. Age 3.

Silvers are taken commercially by trolling gear in the ocean, by purse seines in Puget Sound and at Cape Flattery, and by gill nets in Puget Sound, the Columbia river, and coastal areas. Troll-caught silvers are usually sold on the fresh fish market while most of those taken in purse seines and gill nets are canned. Sport fishing for silver salmon is a major enterprise in Washington. In the spring and summer the Puget Sound sport fishery operates on smaller, residential stocks of silvers, but in the fall large, mature "hook-nose" silvers, migrating in from the ocean, are taken in large numbers. Washington's average annual commercial and sport catches of silver salmon are about 1,100,000 and 218,000 fish, respectively.

Salmon Management Problems

Because they are dependent upon fresh water streams for perpetuation, salmon are one of the most difficult fish to manage and maintain. They must have free access between spawning grounds and the sea, stable flow conditions and clean water to survive and reproduce at their maximum level. The years of growth undergone by Washington state since 1890 have brought many changes in the salmon's stream environment. The great lumbering era swept across western Washington; cities and highways expanded throughout the state; irrigation on a major scale was introduced; industries multiplied; hydro-electric power dams to supply the growing communities and industrial economy were built on many of the principal streams. All of these things—deforestation, pollution, dams and water diversion—have contributed to the burden of maintaining the resource.

The Department of Fisheries, besides controlling the amount of fish taken by fishermen, is attacking the problems of salmon management through an emphasized

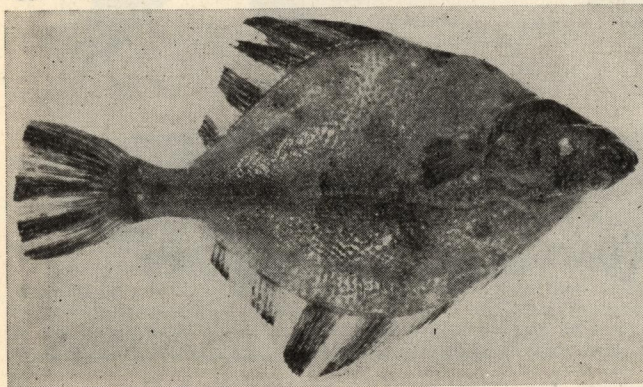
program of stream rehabilitation. Fishways are being constructed to open previously inaccessible spawning grounds and to permit migration above man-made structures. Irrigation systems have been screened, and a variety of stream obstructions removed. Pollution controls are being tightened with the help of research into the effects of pulp and other chemical wastes on fish life. Teams of engineers and biologists are seeking means of safely passing adult and young migrants up and down over power dams. It now appears that some areas shut off for decades by such dams can be restocked with salmon, thus recapturing large blocs of lost production.

Washington's salmon stocks remain in a fairly abundant condition and as many as 10,000,000 fish are being caught in a year by sport and commercial fishermen. Perpetuation of this resource can be insured by a continued strong program of rehabilitation and management, and a public policy of equal recognition for fish in all water development projects.

Sole and Flounder

The species of "sole" landed in Washington are not true sole, Soleidae, but belong to the flounder family, Pleuronectidae, or, as in the case of the sand dab, to the family Bothidae.

All the species are commonly called flatfish and are readily distinguished by their flat body shape and eyes, both of which are on the same side of the head. When the eggs hatch the larval fish have an eye on each side but one soon migrates to the opposite



Starry flounder. Actual size: 15 inches.

side and the fish assume their typical adult form. Normally, the eyed side of the body is colored and the blind side white or gray. Sand dabs typically have their eyes on the left side, while the "soles" typically have them on the right. The starry flounder may have them either on the right or left side.

Spawning generally occurs during the winter and early spring months, each female commonly producing several hundred thousand eggs each spawning season. The eggs are free-floating and the young are almost completely at the mercy of the currents and predators for some time after hatching. After they assume the adult form they settle to the bottom where they spend the rest of their lives.

The principal species landed in Washington are petrale, English, and Dover soles, listed in order of their value to the fishermen. Other species of considerable importance are the starry flounder, rock sole, and sand sole. All are caught almost exclusively by otter trawl gear. They are commonly taken in waters of 5 to 150 fathoms in depth. Washington landings have accounted for about 28 per cent of the average annual Pacific Coast total in recent years. Almost all are filleted to be sold fresh or frozen. The development of quick-freezing and packaging techniques has greatly increased their popularity and they now find a market throughout the United States.

Petrals Sole

The petrale, *Eopsetta jordani*, is the most valuable of any of the soles. It has a coastwise range from Southern California to Alaska but is almost completely absent from Puget Sound. It averages about 17 inches in length and 2½ pounds in round weight in the commercial fishery. The fish is distinguished by a wide body, a moderately large mouth, small body scales, and a normally brown or olive-brown color.

Petrals sole are caught at all times during the year but the largest catches are made during the spring and summer months. About 4,000,000 pounds are landed annually from offshore trawling grounds.

English Sole

The English sole, *Parophrys vetulus*, ranks second to petrale in value and usually exceeds the landings of all species in volume. It ranges from Southern California to Alaska and is the most common flatfish taken commercially in Puget Sound. The species is smaller than petrale, averaging about 15 inches in length and slightly over ¾ of a pound in weight in the commercial landings. It is distinguished by a pointed and prominent snout, smaller jaws than the petrale sole, and a ridge in the narrow space between the eyes. The color is pale brownish to brown.

Slightly more than 4,000,000 pounds have been landed annually during recent years. While caught at all times during the year, most landings occur during the late winter and early spring months. Puget Sound catches amount to about 20 per cent of the total annual landings.

Dover Sole

Dover or slime sole, *Microstomus pacificus*, are found from Southern California to Alaska, but are taken in Puget Sound only in limited quantities. They have a narrow body, blunt snout, small mouth with weakly developed jaws, and brown color sometimes blotched with lighter or darker shades.

Dover sole are larger than English sole, averaging about 19 inches in length and 2¼ pounds in weight when they reach commercial size. They are found in deeper water than most of the other flatfishes, usually in depths exceeding 60 fathoms and commonly at 200 fathoms.

Until recently an insignificant amount was landed in Washington. However, the development of packaging and freezing techniques and the increased scarcity of other species has resulted in rapid growth in demand. Whereas practically no Dover sole were landed prior to 1950, about 1,500,000 pounds were landed in 1951.

Dover sole normally appear on the fishing grounds in quantity in May and early June and leave again in October and November. Presumably they migrate into depths that are not fished during the winter months. This period of low availability closely corresponds to their spawning period.

Starry Flounder

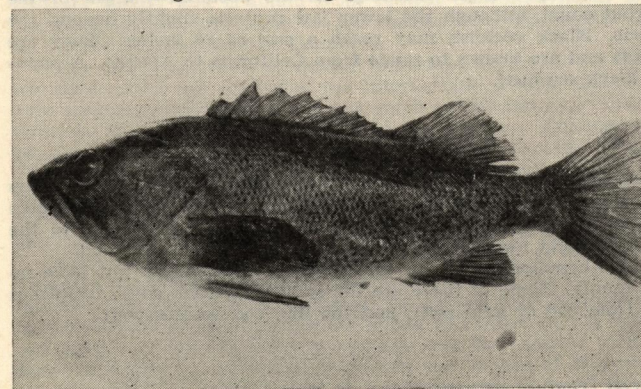
The starry flounder, *Platichthys stellatus*, may be easily recognized by the black bands on the fins and by the small spinous stellate plates which cover the colored side of the body. This species is very abundant in the shallow waters of Puget Sound and off the Washington coast.

The body is elongate, deep, and very compressed. Lengths up to 3 feet and weights up to 20 pounds have been recorded. The fish spawn in the winter and early spring months. Flounders frequently enter fresh water and have been taken as far as 80 miles upstream in the Columbia river. They are found from Southern California to Alaska.

Starry flounders usually are taken with otter trawls and beach seines. Approximately 1,000,000 pounds are landed annually.

Rockfish

The rockfish belong to a group of fishes known as the Scorpaenids. Thirty-three species have been recorded in Washington waters. The body is usually elongate and stout with a large head bearing prominent ridges and spines. The anterior-most fin



Black rockfish. Actual size: 16 inches.

on the back has strong spines which may inflict serious wounds if the fish are not handled carefully. Rockfish have been taken from near the surface to depths exceeding 80 fathoms. The various species resemble each other quite closely in body shape but may differ radically in color pattern. Species inhabiting shallow waters generally

have a more drab coloration, while those from deeper waters may be brightly colored with various shades of red.

Rockfish are unusual among marine fishes in that they give birth to living young. The females may contain in excess of 1,000,000 developing eggs. Most species spawn during the winter. Little is known regarding the early life history of these fish; however, some varieties are known to have a pelagic-type young which may range considerable distances offshore from the banks where the adults are found. The young of one species live in kelp beds and others in tide-pools.

Species of rockfish such as the Pacific ocean perch, *Sebastes alutus*, and the lobe-jawed rockfish, *Sebastes diploproa*, rarely exceed a weight of 3 pounds; others like the red rockfish, *Sebastes ruberrimus*, and the salmon rockfish, *Sebastes paucispinis*, may attain weights in excess of 30 pounds.

Rockfish are often called rock cod and sea bass, but they have no close relationship to either the cod or sea bass family. The majority of rockfish landed in Washington ports are caught by otter trawl and set line boats. Small amounts also are caught by trollers and sport fishermen. Annual commercial landings approximate 11,000,000 pounds.

Orange Rockfish

The orange rockfish, *Sebastes pinniger*, ranks high in commercial landings of bottom fish. It is caught chiefly with otter trawl nets and is sold as fresh or frozen fillets. The body is deep and the jaws are about equal; the color is a bright orange-red with three orange stripes across the head. The fish reaches a length of about 30 inches and ranges from California to Southeast Alaska.

Pacific Ocean Perch

The Pacific ocean perch, *Sebastes alutus*, is taken by otter trawlers fishing in depths ranging from 90 to 200 fathoms. Until 1948 the species was rarely landed in Washington but is now economically important. Pacific ocean perch are a variety of rockfish which inhabits relatively deep water, and is not a true perch. They also are referred to erroneously as rosefish, a popular designation for a number of deep-water rockfish. The body is very elongate and the lower jaw strongly projects, entering the upper profile of the fish. A large knob is present on the lower jaw. The color is carmine red with traces of black on the back. Sizes range from 11 to 18 inches in length and average about 14 inches. Three pounds is a common weight. The fish has been recorded from California to Western Alaska.

Red Rockfish

The red rockfish, *Sebastes ruberrimus*, is one of the more highly desired rockfishes. Most are caught by set line vessels fishing in the vicinity of rocky banks. The body is brick red and very deep, and the head is heavily spined. The species ranges from California to Alaska. Also known as red snapper, it is not closely related, however, to the true Atlantic red snapper.

Black Rockfish

The black rockfish, *Sebastes melanops*, is common along rocky shore areas and is frequently taken on trolling gear and hand lines. The body, which is rather deep, is covered with small crescent-shaped black markings on the posterior margin of the scales. The jaws are about equal, although the lower jaw projects slightly beyond the upper in older specimens. Black rockfish may reach a size of 20 inches. They are common in shallow waters and are known to range from California to Alaska. A popular name for the species is black sea bass.

Cods

The fishes in the true cod family, Gadidae, are very common in Washington waters and include the pollack, tom cod, and true cod. The true cod is the only one marketed extensively and the others generally are regarded as a nuisance, particularly to the sport fishermen. A seldom-caught member of this family is the long-finned cod.

Several of Washington's common fishes are erroneously called "cods" but have no relation to the true cod family. Some of these are the sablefish (black cod), rockfishes (rock cods), greenlings (tom cod or kelp cod), and the ling cod (cultus cod).

True Cod

The true or gray cod, *Gadus macrocephalus*, is abundant from Oregon to the Bering sea. Its color varies from brown to gray with numerous brown spots on the

back and sides to white or grayish white on the belly. There is a long barbel or whisker-like projection under the lower jaw. Spawning occurs in the winter and early spring. The eggs float freely until hatched and are not deposited on the bottom.

The cods are one fishery resource which is not yet fully utilized. They are marketed mostly as a frozen fillet product but small quantities are dried, salted, or placed on the fresh fish market. Catches are made largely by otter trawl gear. In recent years Washington's true cod landings have risen sharply and now represent one-fourth of all the trawl-caught fish landed. Landings are made throughout all the months of the year with slightly heavier landings in the spring and fall. The fish are taken in both shallow and deep water at sizes ranging up to 3 feet.

Ling Cod

The ling cod belongs to the family Ophiodontidae and is the only member found in Washington waters. They possess elongate, slender bodies, double nostrils, and a large mouth armed with canine-like teeth. Their backs are usually a mottled dark-kelp brown and their undersides cream colored; however, the color may vary depending upon the habitat from black, brown, blue, or cream to green.

Ling cod have been taken up to 5 feet in length. They are common from Southern California to Northwestern Alaska, with their center of abundance being British Columbia waters. They are found near the bottom of the intertidal zone near kelp beds or reefs, particularly in areas of strong tidal currents. The females deposit clusters of adhesive eggs in sheltered waters just below normal low tide lines. Approximately 170,000 to 475,000 whitish colored eggs are released in a single spawning and frequently may be observed attached to boulders during extreme minus tides. The males fertilize the eggs, protect them against intruders, and "fan" them with their fins to aid circulation of water about the eggs. The principal spawning season is from December to March. Ling cod feed upon herring, flounders, hake, cod, whiting, young squid, young octopus and small salmonoids.

Otter trawlers harvest the greatest amount of this extremely palatable fish, landing about 2,000,000 pounds annually. Another 700,000 pounds are taken by set line, hand line and troll gear. The livers are a source of Vitamin A.

Sea Perch

Sea perch belong to the family Embiotocidae. They are shallow water fish which abound around the wharves, kelp beds and beaches of Puget Sound and along the ocean coast from Alaska to California. They differ from other common fishes in giving birth to large, well-developed young. A number of species are found in Puget Sound, the most common being the pogie or shiner, which does not grow very large, the blue sea perch and the dusky or silver perch. They constitute the bulk of the common shallow water fishes and can be recognized easily by their compressed body, thick, fleshy lips, and the presence of a furrow on each side of the dorsal fin base.

Halibut

The Pacific halibut, *Hippoglossus stenolepis*, is a large flatfish belonging to the flounder family and is found from central California north to the Bering sea and as far south as northern Japan on the Asiatic side. The center of abundance appears to be off the coast of British Columbia.

This fish supports an extremely important fishery in the northeastern Pacific which has been under the control of the International Pacific Halibut Commission since 1924. This organization establishes seasons, catch quotas and gear limitations, and has been very effective in improving and maintaining production. Approximately 60 per cent of the Pacific coast halibut catch is taken by fishermen operating from Washington ports.

Halibut are caught on set lines laid out in units called "skates." Each skate is essentially a bottom line 1,800 to 2,100 feet long. To it are attached, every 9 to 13 feet, short lines called gangions which have hooks commonly baited with herring. The gear is laid out and anchored on offshore banks 10 to 150 fathoms below the surface.

Halibut spawn in the winter on the ocean floor in depths from 150 to 225 fathoms. The eggs are free floating and drift passively with the currents at depths down to 375 fathoms. As development proceeds the larvae drift shoreward and by early spring transformation is complete and the young fish settle on the bottom of the shallow bays and inlets. As they increase in size and age they appear to move into deeper waters. Males may attain a weight of 40 pounds and an age of 25 years. Females, which grow much larger than males, mature between the ages of 8 and 16 years and may live more than 35 years and reach a weight of 500 pounds.

Smelt

Smelt belong to the family Osmeridae and are a group of small fishes essentially marine but with some anadromous species ascending rivers to spawn. They generally are found in large schools, are very rich in oil, and are regarded as an excellent food fish. There are two important species in Washington waters, the surf smelt, *Hypomesus pretiosus*, which spends its entire life cycle in salt water, and the Columbia river smelt, which ascends the river to spawn.

Also known as the silver smelt, particularly in Puget Sound, the surf smelt is found from California to Northwestern Alaska. At maturity, which usually is 2 years, but may be either one or 3 years, the smelt average 5 to 6 inches long. Spawning occurs in sheltered bays and coves or in the mouths of tidal streams. It takes place near the high water mark on beaches characterized by uniform small gravel. The eggs adhere to the gravel and after 2 to 4 weeks the fully hatched smelt are carried to open water by the tide.

Columbia River Smelt

This species, *Thaleichthys pacificus*, locally is called eulacheon, hooligan, oolichon, or candlefish. Their oil once was used by Indians for candles.

Most smelt spawn and die at the age of 3 years, although recent studies indicate that 20 to 30 per cent of a run may be composed of 4-year-old fish. The eggs are deposited and fertilized in the water by mass spawning over a river bottom of fine pea-sized gravel. The eggs adhere to the bottom, and hatch into minute, almost invisible fry after an incubation period of about 30 days. The fry are carried by the river current seaward and are fed en route by the yolk material stored adjacent to the stomach. In the ocean, the smelt feed on minute organisms which they strain from the water by means of filamentous gills, and in turn are fed upon by rockfish, cod, sharks, and other fishes.

Upon re-entering fresh water as adults, the female smelt are silvery, smooth-bodied fish capable of carrying more than 25,000 eggs. The males exhibit an external roughness comparable to fine sand paper, and are normally dark green on the back. Smelt migrate in schools at speeds up to 25 to 35 miles per day.

For as long as commercial statistics are available the Columbia river catch has exceeded 1,000,000 pounds annually, and has been nearly 6,000,000 pounds during peak years. The fish are taken with fine mesh gill nets in the main Columbia, principally below Vancouver, and with dip nets in the Grays, Cowlitz, Kalama, Lewis and Sandy rivers, which are the main smelt producing tributaries. Other rivers which support runs include the Fraser and Nooksack rivers.

The Herring Family

Herring, sardines, shad and anchovies belong to the family Clupeidae. All have a bright silvery appearance and large scales, and have a common tendency to travel in dense schools. Herring is the only member of any frequency in Washington's inland waters. Shad are abundant in the Columbia river.

Pacific Sardine

The Pacific sardine or pilchard, *Sardinops caerulea*, is a herring-like fish which ranges from the Gulf of California to Southeastern Alaska, with a center of abundance off Southern California. It is pelagic, traveling in "schools" in the upper layers of the ocean and feeding on a multitude of minute plants and animals known as plankton. It seldom exceeds 13 inches in length.

Spawning occurs in the open sea primarily in the spring and early summer months. An intensive spawning area lies between Point Conception and San Diego; little, if any, spawning occurs off the coast of Washington. Each female lays an average of 35,000 eggs and may spawn up to 3 times in one season. The eggs hatch in 3 days and the young drift with the currents until the yolk is absorbed. Then the young sardines become free-swimming and commence feeding. They gather inshore on so-called "nursery grounds" off Southern California. Sardines become available to the California fishermen when they are 2 or 3 years old and 8 or 9 inches in length. There is an annual north-south movement, with the older fish migrating under normal conditions as far north as Alaska.

Failures have characterized the fishery along the coast in recent years. Washington state landings fell from 34,000,000 pounds in 1941 to none in 1950.

Herring

Herring, *Clupea pallasii*, belong to the family Clupeidae and are very common from Southern California to Northwestern Alaska.

Puget Sound herring populations spawn mainly in the winter and spring months with each female depositing large quantities of pale-amber, adhesive eggs on eelgrass, gravel, piling, oyster dykes, live oysters, water logged fir boughs, anchor lines and other objects found in sheltered water. The eggs may be deposited between the upper limits of high tide and a depth of 30 feet, but the main spawning takes place in the intertidal zone and a few feet below low tide. They hatch in 10 to 14 days depending on the water temperature. The larvae are small, thin and nearly transparent. At this stage they are at the mercy of the currents and subject to heavy predation by sea birds and other fish. Maturity is attained in the second or third year and an age of 8 years is about the maximum for herring in this region. Normally they do not die after spawning but spawn each successive year.

Herring feed on planktonic crustaceans and appear to have an annual migration from the inshore spawning grounds to the open-ocean feeding areas. Relatively few remain in Puget Sound throughout the entire year.

They are captured in the commercial fisheries by brush weirs, drag seines, purse seines, dip bag nets, gill nets, and rakes, mostly for sale as bait. An average of 250 tons are taken annually from the Puget Sound region. This is a very meager figure when compared to the 197,000 tons taken by the Canadian herring fishery annually.

Shad

The shad, *Alosa sapidissima*, is the largest member of the herring family. It is not native to the Pacific coast as are the herrings, pilchards and anchovies, but was introduced into the Sacramento and Columbia rivers from the Atlantic coast in 1871 and 1886, respectively. The shad now ranges from southern California to northwestern Alaska with the center of abundance between San Francisco bay and the Columbia river. The annual shad production on the entire Pacific coast approaches 3,000,000 pounds with a value of slightly less than \$1,000,000.

An anadromous fish like the salmon, the shad enters fresh water streams in the spring to spawn, the peak of the run coming in early summer. In contrast to the Pacific salmon, shad do not die after spawning. The average female of 4 pounds bears about 30,000 eggs although the number may vary from 25,000 to 156,000 depending upon the size of the fish.

The average age of spawning female shad is 6 years, while the males generally mature one year earlier. Shad spawn at night, the eggs being extruded in small numbers near the surface where they remain until fertilized. Afterwards they slowly sink to bottom and become lodged in crevices or upon aquatic vegetation. The incubation period is 3 to 6 days.

At present shad are taken commercially in the Columbia river by gill nets. The fishery is virtually confined to the spawning migration which occurs primarily in June. The females are the most valuable because roe is in great demand and commands a high price. The flesh is not widely used for food in the west.

Albacore

Albacore, *Thunnus germon*, occur from Southeastern Alaska to lower California, and through the temperate Pacific to Hawaii and Japan. It is a small member of one of the fastest swimming fish families in the world—the tunas. They are distinguished from other tunas by long pectoral fins which extend to the anal fin. Coloration is dark steel blue above, shading into dull silver below.

The egg, larval, juvenile and adult stages of the albacore are, as far as it is known, pelagic. Albacore with ripening eggs have been captured in the Hawaiian commercial fishery and they probably spawn in oceanic waters in many places. The fish generally travel in schools. While individuals may reach a maximum of 30 pounds, those taken commercially usually average from 9 to 25 pounds. Dominant food of the albacore off this coast appears to be juvenile rockfish, saury and squid.

The fish usually appear in the warmer surface waters off the Pacific coast in the spring or early summer and disappear in the late fall. Most of the catch is taken from July through October. The albacore is the only tuna taken off the coast of Washington. In 1937 Washington's troll fleet first recorded a catch of albacore and the fishery began to grow. Until 1950 the catch varied from one to 11 million pounds, but since 1950 the albacore have failed to appear in any quantity.

Sablefish

The sablefish, *Anoplopoma fimbria*, is known by several different names along the Pacific coast, the most common of which is black cod. The term "cod" is misleading since the sablefish is not a true cod but is a member of the skiffish family. It ranges from southern California to Alaska where it is caught at depths between 30 and 200 fathoms.

Sablefish attain a length of more than 3 feet. The average size is about 30 inches in length and 8 pounds in weight. Spawning occurs during the winter months when the eggs are released to float free in the ocean. Small larvae have been captured at the surface some 100 to 200 miles off the coast. Several hundred thousand eggs may be produced by each female but mortalities are extremely high.

The main Washington fishing grounds are located between Destruction island and Barclay Sound, Vancouver island. For the past 40 years sablefish have provided a late summer and fall operation for a fleet of set line vessels which fish for halibut during the spring. It also composes part of the otter trawler's catch, possessing the highest value of all species caught by that gear. In Washington, sablefish contribute about 5 per cent of the total annual landed value of the catch of all species, not including halibut and salmon. Annual landings in Washington from 1941 to 1952 averaged 2,500,000 pounds. Washington landings have accounted for about 25 per cent of the average 9 million pounds landed on the Pacific coast in recent years. The liver is a source of both Vitamin A and D.

Sturgeon

Several species of sturgeon occur throughout the Northern hemisphere. Some are confined to lakes and streams while others are anadromous like salmon and shad. The only two species present on the Pacific coast are *Acipenser transmontanus*, the white sturgeon, and *Acipenser medirostris*, the green sturgeon. Both species range from northern California to northwestern Alaska, but white sturgeon center on the Columbia river. Small populations exist in Grays and Willapa harbors. The white sturgeon is one of the largest freshwater fishes in the world and the largest in North America. One specimen taken on the Pacific coast weighed 1,800 pounds. The green sturgeon is a smaller relative, reaching a maximum of 7 feet and having inferior quality flesh.

The female sturgeon matures between 15 and 20 years of age. At this time they weigh approximately 100 pounds and are about 6 feet long. The males mature earlier and do not grow to the size of the females. Spawning is believed to occur in the spring. The slow growth of these fish and relatively great age at maturity requires that they be more rigidly protected than some other commercial fishes. Fishery regulations protect fish less than 30 inches and over 72 inches in total length, the latter because of their enormous egg-bearing potential.

During the late 1800's the demand for caviar and smoked sturgeon increased greatly and made fishing for sturgeon a highly profitable enterprise. There was neither proper management nor regulation of the fishery at that time and disastrous overfishing resulted in the almost complete elimination of the breeding stocks. Today it is uncommon to catch a sturgeon larger than 500 pounds in the Columbia. The commercial catch of white sturgeon in recent years has ranged from $\frac{1}{3}$ to $\frac{1}{2}$ million pounds in contrast with 3 to 6 million pounds taken in the 1890's. Both gill nets and set lines contribute to the commercial catch.

Sharks and Skates

Sharks and skates are closely related because they have cartilaginous skeletons and so are different from the bony fishes. They have paired nostrils, 5 to 7 pairs of gill slits, and the males have modified pelvic fins to permit fertilization of the eggs within the body of the female. They are both regarded locally as predator fish.

Dogfish, *Squalus acanthias*, is the most common of all sharks in Washington waters. It is particularly numerous in Puget Sound, and ranges along Pacific ocean shores to Japan. It also is found in the North Atlantic temperate and subarctic areas.

The dogfish bears its young alive after a gestation period of from 16 to 26 months. Generally from 3 to 14 young are produced. This species grows slowly to about 5 feet in length, and has a long life span as compared to the common bony fishes.

With the decline in vitamin liver oil prices, the Washington shark fishery has shrunk in importance from its wartime stature. The catch now is mostly incidental to the established hook and net fisheries. Shark carcasses are reduced into meal and the livers utilized for vitamin products. In 1952 more than 500,000 pounds of shark livers were landed in Washington.

The other shark relatives, the skates, have a dorso-ventrally depressed body and large pectoral fins. They live on the bottom, sometimes feeding in shallow water where they may be observed swimming slowly, pectoral fins undulating. Unlike the dogfish, skates lay egg cases containing from one to several eggs, depending on the species. The young develop within the egg case and emerge as small skates closely resembling the adults.

Otter trawling in the Gulf of Georgia supplies the bulk of the commercial catch. The small amount utilized for human consumption is marketed fresh as skate wings or scallops; the remainder is reduced into fish meal.