

History of the Fishery

The lingcod (*Ophiodon elongatus*) has long been an important source of food for people living along the West Coast of North America, although current catches are low due to overexploitation of the stock. Archaeological studies of native American habitations along the central California coast indicate that between 6200 BC and AD 1830, large inshore species such as rockfishes, lingcod, and kelp greenling comprised more than half of the fishes caught on the open coast. American Indians used spears, nets, weirs, traps, and lures of wood with bone hooks to catch lingcod. Early Caucasian settlers caught lingcod as well. Fishing methods in the 1800s were similar to the hook-and-line techniques currently used to catch lingcod in the small boat jig fishery.

Catches of lingcod have been reported as a separate category since 1916 in California. Commercial landings from 1916 through 1929 ranged from 400,000 pounds to 1.2 million pounds. Landings in the first half of the century reached a peak in 1930 at 1.3 million pounds, and then declined to a low of 314,000 pounds in 1942. The California lingcod fishery grew again from 1943 through 1950, as landings ranged from 719,000 pounds to a high of 2.1 million pounds in 1948, due primarily to strong markets for liver oil and seafood. For the next two decades, landings averaged 1.2 million pounds per year, and then began to increase in the 1970s, due to the burgeoning west coast trawl fishery.

During this period of rapid fishery growth, lingcod landings in California almost tripled. From 1972 through 1982, commercial landings of lingcod averaged almost three million pounds per year. After a decline in the mid-1980s, landings rebounded to a high level again in 1989. Since then, however, commercial catches have rapidly declined, partly due to management restrictions enacted to rebuild depressed stocks. In 1999, commercial landings were only 313,000 pounds, valued at \$283,000.

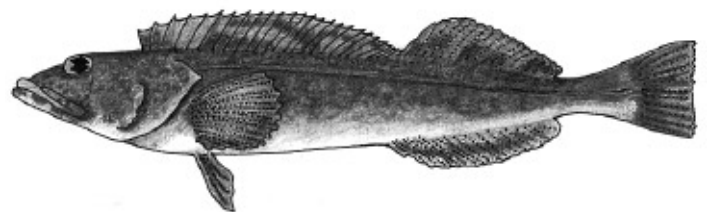
The character of lingcod fisheries has changed greatly in the past 30 years. In the 1970s, about 85 percent of the commercially landed lingcod were caught with trawls; however, hook-and-line gear now account for half of the commercial landings. In addition, the recently developed nearshore fishery that delivers live fish to markets and restaurants landed an average of more than 40,000 pounds per year in the 1990s. There has also been a shift in the lingcod fishery away from commercial and towards recreational catches. Recreational landings as a percentage of total lingcod landings increased from 20 percent in the 1970s to about 50 percent in the late 1990s. This was because recreational fishing effort in California increased by 65 percent between the time periods 1958 through 1961, and 1980 through 1986. Average annual landings in

the California recreational fishery almost doubled during that period, from 510,000 pounds per year to 890,000 pounds per year. The increase was due largely to an increase in the private boat fishery. In 1961, 61 percent of the recreational landings came from commercial passenger fishing vessels. Now, 70 percent of the recreational landings come from the private boat fishery. In both the commercial and recreational fisheries, landings occur predominately in central and northern California.

Stock assessments conducted by the Pacific Fishery Management Council (PFMC) have indicated large population declines for lingcod along its entire range. For the management areas that include California and Southern Oregon (the Eureka, Monterey, and Conception management areas), the current estimate of female spawning biomass is 13 percent of the unfished level. Consequently, fishery regulations have become more stringent, as fishery managers try to rebuild the stock.

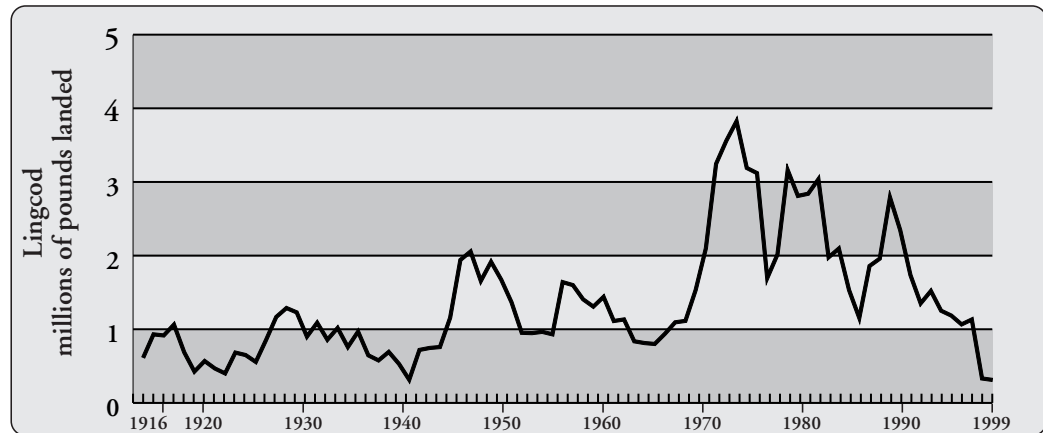
With the implementation of the PMFC's Groundfish Plan in 1983, the combined Acceptable Biological Catch (ABC) for the Eureka, Monterey, and Conception management areas was 4.8 million pounds, or more than 1.5 million pounds higher than the commercial landings. In 1995, the combined quota for these areas was reduced by about 50 percent, and a 22-inch commercial size-limit was instituted. A monthly commercial boat-limit of 20,000 pounds per month was established along with a trawl trip-limit of 100 pounds under the 22-inch size-limit. By 2000, the combined ABC for the Eureka, Monterey, and Conception International North Pacific Fisheries Commission (INPFC) areas was reduced in half again to less than 1.2 million pounds. The monthly boat limit was reduced to 1,000 pounds and the commercial size-limit was increased to 24 inches.

Prior to 1980, there was a recreational catch limit of 10 lingcod per angler. This bag limit was reduced to five fish in 1980, and a 22-inch size-limit was introduced in 1981. In 1996, the bag-limit was reduced to three fish to conform to Oregon and Washington regulations, and the size-limit



Lingcod, *Ophiodon elongatus*
Credit: L. Sinclair, Miller and Lea

**Commercial Landings
1916-1999, Lingcod**
Data Source: DFG Catch
Bulletins and commercial
landing receipts.



was increased to 24 inches. In 1999, the bag-limit was reduced to two fish. In 2000, the size-limit was increased to 26 inches. Also, the lingcod fishery was closed south of Lopez Point, Monterey County during the months of January and February and from Lopez Point north to Cape Mendocino during March and April.

Status of Biological Knowledge

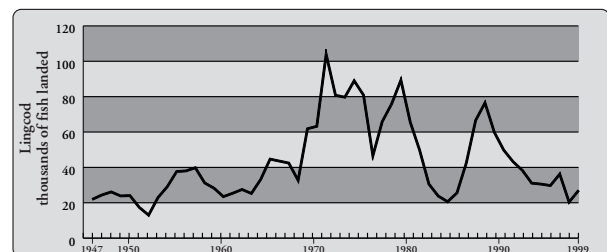
The lingcod is the largest member of the Hexagrammidae family. The scientific name *Ophiodon* is a combination of two Greek words meaning snake and tooth, a reference to the lingcod's large teeth. The name *elongatus* is of Latin origin and refers to the elongated body. Lingcod are found only off the West Coast of North America. They are distributed in nearshore waters from northern Baja California to the Shumagin Islands along the Alaskan Peninsula. Their center of abundance is off British Columbia, and they become less common toward the southern end of their range.

Lingcod lack a swimbladder and thus will rest on the bottom or actively swim in the water column. They are found over a wide range of substrates at depths from 10 to 1,300 feet, but most occur in rocky areas from 30 to 330 feet. Typically, larger lingcod occupy rocky habitats; larger animals are found on deeper banks and reefs, whereas smaller animals live in shallower waters. Adult lingcod are strongly residential, tending to remain near the reefs or rocky areas where they live. Large-scale conventional tagging studies have found that the vast majority of mature lingcod are recaptured within six miles of where they were tagged, however acoustic tagging studies have indicated frequent short-term movements. Juveniles tend to disperse and travel over a wider range than adults.

Individuals grow to a maximum length of 39 inches for males and 59 inches for females. Maximum age is thought to be 25 years. Although there is large variation in length at age, the average one-year-old fish is 13 inches long, and a two-year-old is 17 inches long. After age two, females begin to grow faster than males. The average length of a four-year-old female is 24 inches, of an eight-year-old is 32 inches, and of a 12-year-old is 35 inches. The average length of a four-year-old male is 22 inches, of an eight-year-old is 29 inches, and of a 12-year-old is 32 inches. In California, the oldest lingcod on record is a 19-year-old, 45-inch female, and the longest is a 51-inch female.

Lingcod length and age at sexual maturity vary with latitude; lingcod in the northern part of their range are larger and mature later than fish in the southern part of the distribution. As with most fishes, fecundity increases with size of fish. In the northern end of the lingcod range, females can produce 50,000 eggs at a length of 24 inches, 124,000 eggs at a length of 32 inches, and 170,000 eggs at a length of 36 inches. This level of fecundity is low compared to many other marine species in the eastern Pacific, but high for a species that guards eggs.

Lingcod exhibit an interesting spawning behavior, which includes a spawning migration into nearshore habitats for



Recreational Catch 1947-1999, Lingcod

CPFV = commercial passenger fishing vessel (party boat); Recreational catch as reported by CPFV logbooks, logbooks not reported prior to 1947.

the deposition of eggs in gelatinous masses, termed nests, on rocky substrates. Males establish territory as early as a month before females lay eggs, and remain on guard at the nest until eggs are hatched. Preferred nest sites are rocky areas in shallow water where there are strong currents. Males move on to spawning grounds first, followed by large females, who spawn earlier than smaller females. After a female chooses a male and a spawning site, she swims over the site and deposits a layer of several eggs. The male then swims over the site and fertilizes the eggs. This process is repeated until spawning is completed, after which the female immediately leaves the spawning grounds. The eggs become firmly cemented to each other within the gelatinous mass in 24 to 48 hours. A relatively strong current is necessary to oxygenate the egg mass and prevent death of the embryos.

After spawning, males guard the nests from predation until the eggs hatch. On occasion, males have been found guarding two nests if they were close together, and sometimes if the male is removed, a new male will assume the guardian role. The nest guarding behavior of lingcod make them susceptible to targeted fishing during the spawning period. Males guarding nests are territorial and will aggressively strike at bait or lures that come close to the nest. Targeted fishing during the spawning season can thus directly increase lingcod mortality by increasing catch rates. It can also indirectly increase mortality by dislodging animals from the nest, resulting in increased egg mortality. Fish predators such as kelp greenling, striped seaperch, and small sculpins will eat lingcod eggs if a guardian male is removed from the nest. Invertebrates such as sea urchin, sunflower star, and snails also feed on lingcod eggs, but are not chased away by males guarding the nest. The eggs generally hatch about seven weeks after they are laid, but incubation can last from five to 11 weeks. Hatching may continue for 24 to 48 hours, after which the guardian male leaves.

Egg hatching is generally synchronous, with most eggs hatching within two to seven days of each other. Newly hatched larvae are 0.25-0.4 inches in length, and grow about 0.06 inches per day. The larvae are pelagic for about three months from early March to early June and settle to the bottom when they are about three inches long. Newly settled juveniles reside in shallow bays and on nearshore sand and mud bottoms from the beach to 333 feet in depth. Juveniles occur over a wide range of habitats including mud, sand, gravel, and eelgrass, but by age two occupy similar habitats as adults.

During the pelagic juvenile stage there is a gradual transition from a diet of small copepods to one of larger copepods, crab larvae, amphipods, euphausiids, and herring larvae. As small benthic juveniles, lingcod feed on herring, flatfishes, shiner perch, and other fishes. Even

young lingcod have a very large mouth for their body size, allowing them to feed on prey much larger than other fish of their age and size. For large juvenile and adult lingcod, fish is the dominant prey, accounting for about 80 percent (by volume) of the stomach contents. In California waters, juvenile rockfishes are the most important prey.

Most predation on lingcod occurs during the egg stage, and predation becomes less common with age. On rare occasions, pelagic juvenile lingcod (1.5 to 2.6 inches) are found in the stomachs of chinook salmon. Other predators of juvenile fish, such as seabirds and marine mammals also prey on juvenile lingcod. Small benthic lingcod are probably eaten by adult lingcod and marine mammals, but have few other predators. Because of their large size, large juvenile and adult lingcod escape all but the occasional predator.

Status of the Population

Lingcod harvest has been higher than generally accepted population replacement rates for the last twenty years. Recent lingcod stock assessments have concluded that the lingcod stock is seriously depleted, and that California populations appear to be less than 25 percent of their pre-1970s level. By federal law, this level of stock depletion requires a management plan that rebuilds lingcod populations. The rebuilding plan is intended to restore the lingcod stock within 10 years. The substantial reduction in ABC after 1997 and resulting reduced fishery harvest was triggered by that rebuilding plan. Low levels of ABC and harvest will continue until lingcod populations show signs of rebounding. California lingcod appear to be highly productive, however, and there is good potential for rapid population increases given appropriate decreases in fishing effort.

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