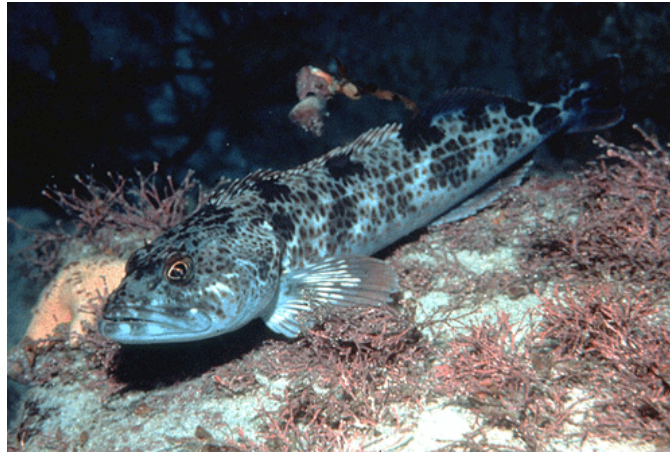


## 15 Lingcod, *Ophiodon elongatus*



Lingcod, *Ophiodon elongatus*. Photo credit: Daniel W. Gotshall.

### History of the Fishery

Lingcod, *Ophiodon elongatus*, is an important commercial and recreational species of the Pacific coast of the United States. As a nearshore species, it has been fished by inhabitants along the coastline of California for thousands of years, serving an important role in the diet along with shellfish. More recently, lingcod has been a California commercial fishery since the early 1900s. The lingcod fishery showed a general upward trend ranging from 0.5 million to 2 million pounds (225 to 900 metric tons) in landings since records began in 1916 to a rapid rise during the 1970s, with the growth of the west coast trawl fishery. Commercial landings have been variable, but was greatest between 1970 and 1990 (except for a drop in the mid 1980s), with peak landings of nearly 4 million pounds (1800 metric tons) landed in 1974. Landings decreased in the last decade due to management restrictions beginning in the 1990s, with catch levels consistently under 0.5 million pounds (225 metric tons) (Figures 15-1, 15-2). During the 2000s, annual landings averaged only 145,000 pounds (65 metric tons) with an average value of \$209,000 (Figure 15-3).

The average price per pound increased from \$0.23 in 1980 to \$1.56 in 2008 (\$0.50 to \$3.44 per kilogram), mainly due to the increased value of the live fish market that began in the mid 1990s (Figure 15-3). From 1998 to 2008, the value of lingcod sold live has comprised a growing share of total lingcod market value; in 1993 live fish represented 1 percent of total commercial lingcod landings, increasing to a range from 32 percent in 1998 to 57 percent in 2003. Prior to the mid 1980s, trawl gear was the predominate gear used to catch lingcod. Fishing strategies changed as the live fish fishery expanded and currently trawl and hook and line gear are used equally. A minor portion of lingcod are taken with gill nets.

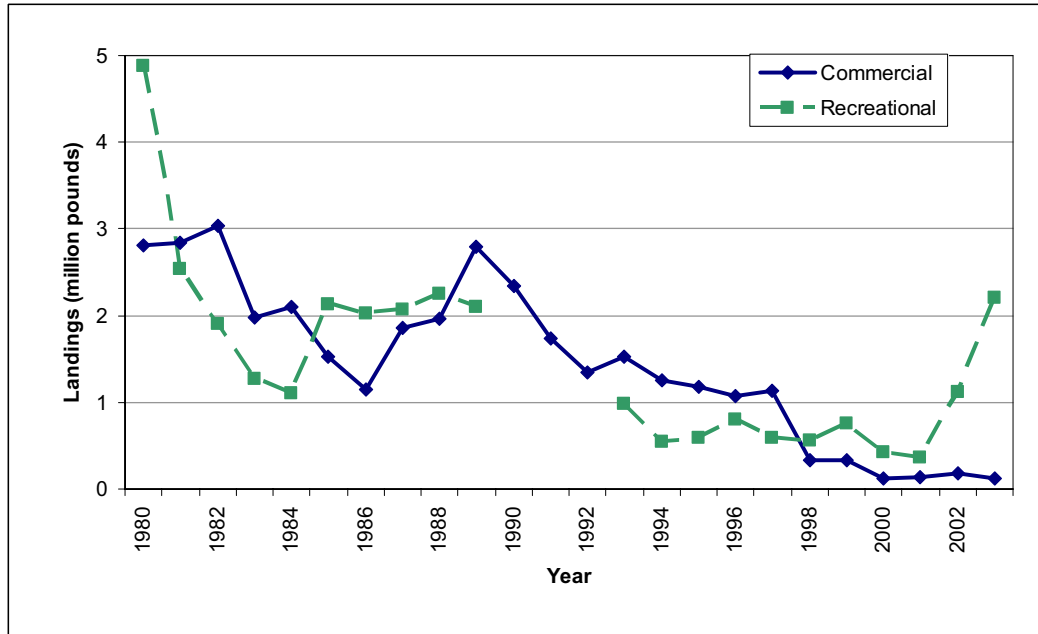


Figure 15-1. Lingcod commercial and recreational landings, 1980-2003. Data Sources: Commercial - CFIS data, all gear types combined. Recreational - MRFSS data, all fishing modes and gear types combined. Data not available for 1990-1992. CPFV data not available for central and northern California for 1993-1995.

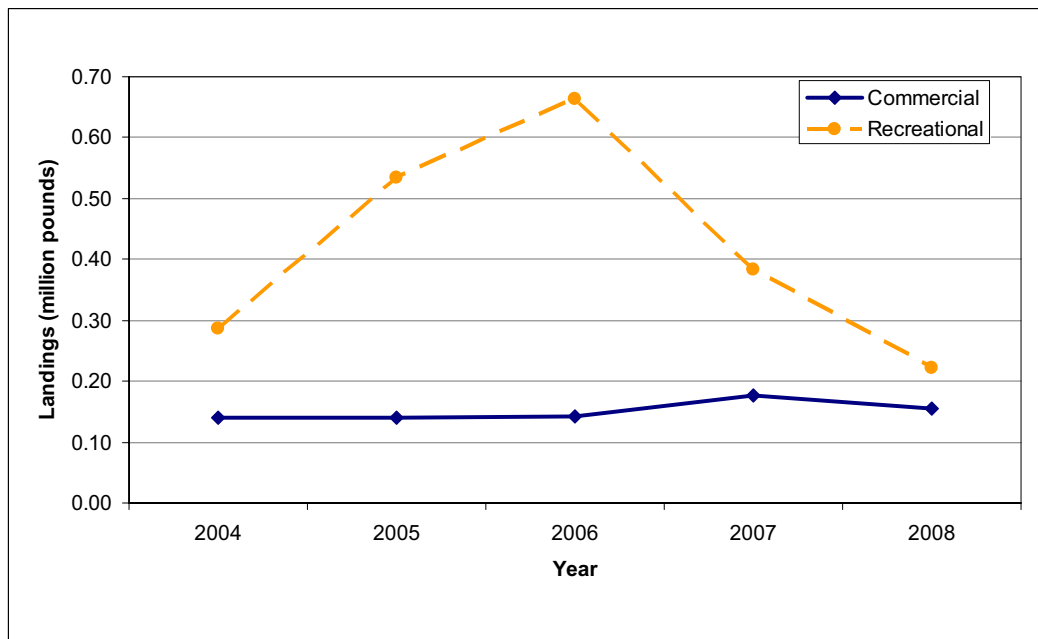


Figure 15-2. Lingcod commercial and recreational landings, 2004-2008. Data Sources: Commercial - CFIS data, all gear types combined. Recreational - CRFS data, all fishing modes and gear types combined.

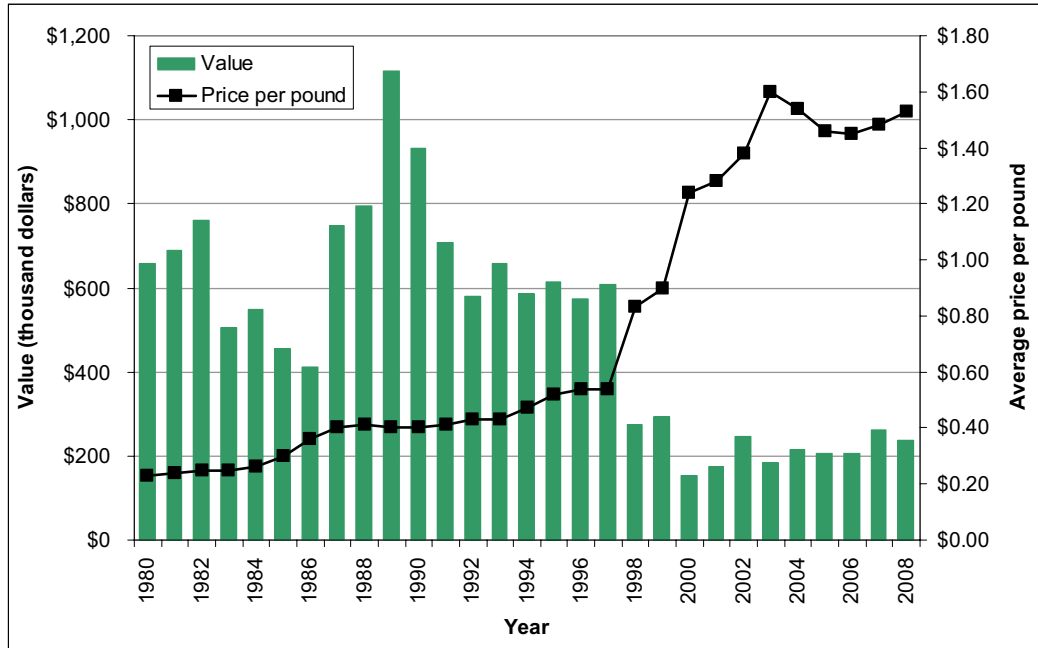


Figure 15-3. Lingcod ex-vessel value and average price per pound, 1980-2008. Data Source: CFIS data, all gear types combined.

Lingcod have been caught recreationally in California since the 1920s, and are now a significant portion of the recreational fishery. Since 1980, there have been two different recreational sampling programs: the Marine Recreational Fisheries Statistical Survey (MRFSS) (1980-2003) and the California Recreational Fisheries Survey (CRFS) (2004-2008). Due to changes in the sampling protocol and how the data are used to estimate landings these two surveys are not comparable. An analysis of MRFSS data (1980-2003) shows lingcod as the third-ranking species among all recreationally caught species in landed weight, averaging 5.6 percent of the total recreational catch for that time period. For 2004-2008, CRFS data rates lingcod as the fifth highest species by weight, at 4.7 percent of the total recreational catch. They are a large, sporting fish that are considered tasty. Most are taken using hook and line (sometimes inadvertently caught fishing for salmon), and some are caught by spearfishing. From 1980 to 2003, 95 percent of lingcod caught were taken by boat modes [commercial passenger fishing vessels (CPFV) and private/rental boats], and for 2004-2008, 97 percent of lingcod were taken by boat mode. Private boat landings were predominant over those from CPFVs, 72 percent to 28 percent from 1980-2003, and 56 percent to 44 percent from 2004-2008.

Since 1980, CPFV catch of lingcod (based on CPFV logbook data; Figure 15-4) has been on a downward trend that may be a result of recreational bag and minimum size limits imposed starting in 1980 (Table 15-1) and exacerbated by the severely restricted harvest guidelines implemented when lingcod was declared overfished in 2000. The CPFV catch from 2000 to 2008 has been highly variable, ranging from 10,652 fish in 2000 to 44,198 fish in 2003. For all recreational modes, both MRFSS (2000 to 2003) and CRFS recreational catch data (2004 to 2008) have also been

variable. MRFSS catch ranged from a low of 357,976 pounds (162 metric tons) in 2001 to a high of 2,202,913 pounds (1000 metric tons) in 2003 (Figure 15-1), while CRFS catch ranged from a high of 662,752 pounds (301 metric tons) in 2006 to a low of 222,920 pounds (101 metric tons) in 2008 (Figure 15-2).

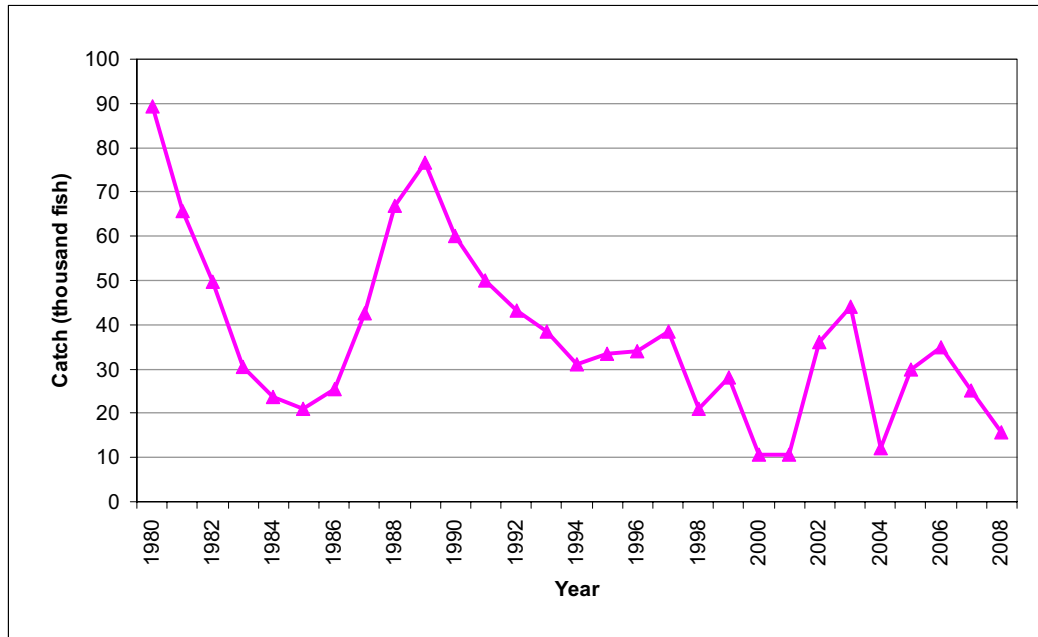


Figure 15-4. Lingcod commercial passenger fishing vessel (CPFV) catch, 1980-2008. Data source: CPFV logbook data.

Table 15-1. History of changes to California recreational lingcod bag and minimum size limits.

| Year            | Bag limit | Minimum size (inches) |
|-----------------|-----------|-----------------------|
| Prior to 1980   | 10        | --                    |
| 1980            | 5         | --                    |
| 1981            | 5         | 22                    |
| 1998            | 3         | 24                    |
| 1999            | 2         | 24                    |
| 2000            | 2         | 26                    |
| 2002            | 2         | 24                    |
| 2004            | 1*        | 30*                   |
| 2005 to present | 2         | 24                    |

\* Inseason change became effective April 1.

Since 1999, MRFSS and CRFS records show total recreational catch estimates exceeding commercial catch every year (Figures 15-1 and 15-2). In 2004, recreational catch accounted for 65 percent of the total coastwide lingcod catch. This shift away from the opposite pattern of greater commercial landings in the 1970s is attributable to

both the recent management restrictions imposed on the commercial fishery (see Management Considerations, below) and increased effort from the recreational sector. An analysis of historical recreational catch data indicates a 65 percent increase in recreational effort (primarily boat modes) between the years 1958 to 1961 and 1981 to 1986, although effort decreased by about 20 percent between 1981 to 1986.

Both average weights and lengths for the lingcod recreational fishery have demonstrated similar trends since 1980, except for a spike in average weights between 1997 to 2001, and a peak in 2004 (Figure 15-5). The increase in lengths beginning in 1997 may be due to the increase in the minimum size limit from 22 to 24 inches in 1996 (Table 15-1). The peak average length of 28.3 inches (72 centimeters) in 2004 is likely due to the April 1 inseason increase of the minimum length size limit to 30 inches (76.2 centimeters), returning to the 24 inch (71.1 centimeters) size limit the following year.

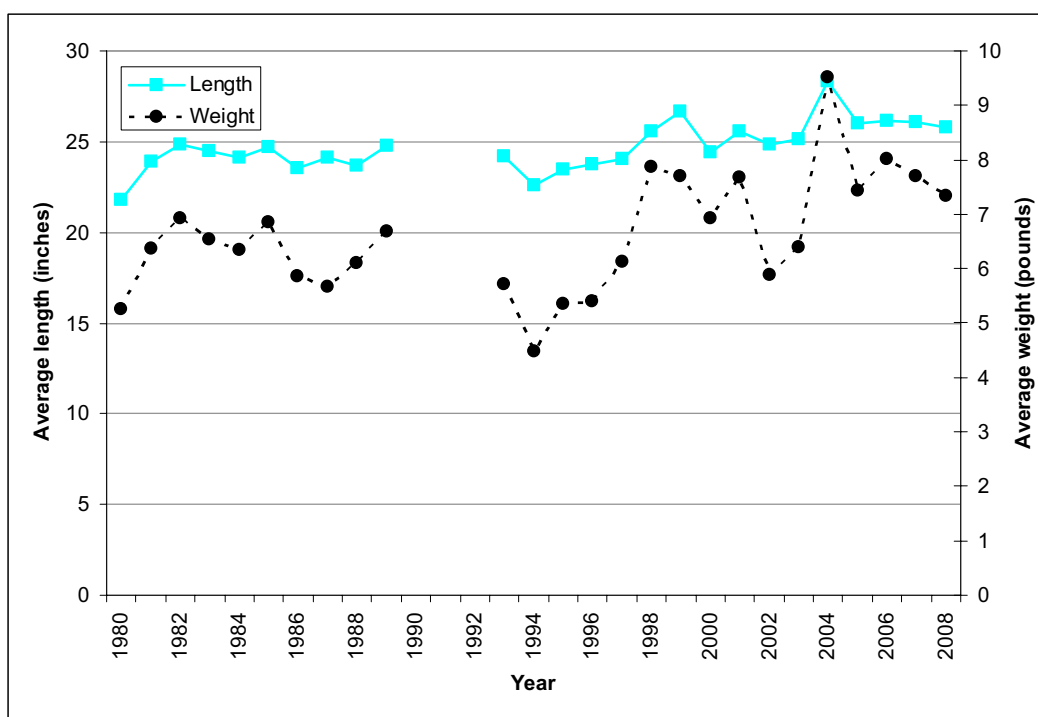


Figure 15-5. Lingcod recreational catch average yearly length and weight, 1980-2008. Data source: MRFSS (1980-2003) and CRFS (2004-2008) sampler examined data, all fishing modes and gear types combined. Data not available for 1990-1992. CPFV data not available for central and northern California for 1993-1995.

The declining catch-per-unit-effort (CPUE) in the commercial fishery since 1980 (Figure 15-6) reflects the decreasing biomass of the stock according to the 2005 stock assessment. The non trawl peak for years 1985-1989 may be attributable to the increased use of gill nets those years, with a relatively higher CPUE from this gear type.

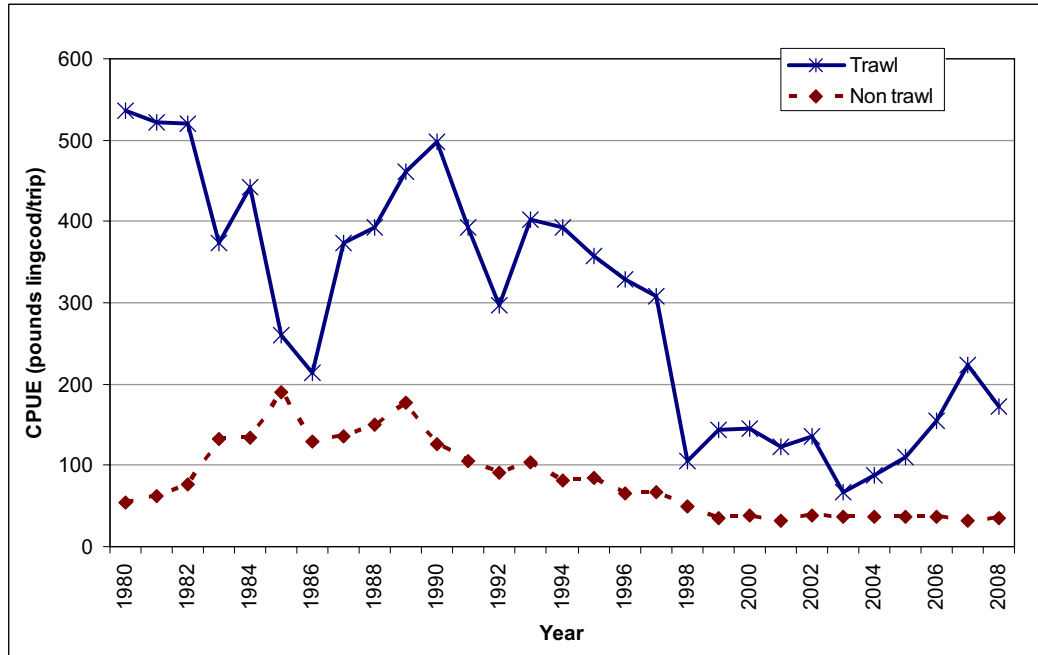


Figure 15-6. Lingcod commercial catch-per-unit-effort (CPUE), 1980-2008, for trawl and non trawl gear types. Data source: CFIS data.

The sharp CPUE increases in both the recreational fishery as a whole and the CPFV fishery in 2002 and 2003 (Figures 15-7 and 15-8) are due to much higher numbers of fish landed, as fishing effort remained about the same as previous years. In 2002 and 2003, CPFVs landed an estimated 58,784 and 35,269 fish, respectively, compared to 12,141 fish in 2001. Similarly, in 2002 and 2003, private boats landed 88,062 and 254,741 fish, compared to 26,719 fish in 2001. These increases may partly be explained by higher numbers of fish available, beginning in 1999, when the stock began to rebound, according to the latest stock assessment. The decline in CPUE in 2004 may be due to a decrease in the bag limit and significant increase in minimum size limit that year, although CPUE has remained low after those regulatory changes were rescinded in 2005 (Table 15-1).

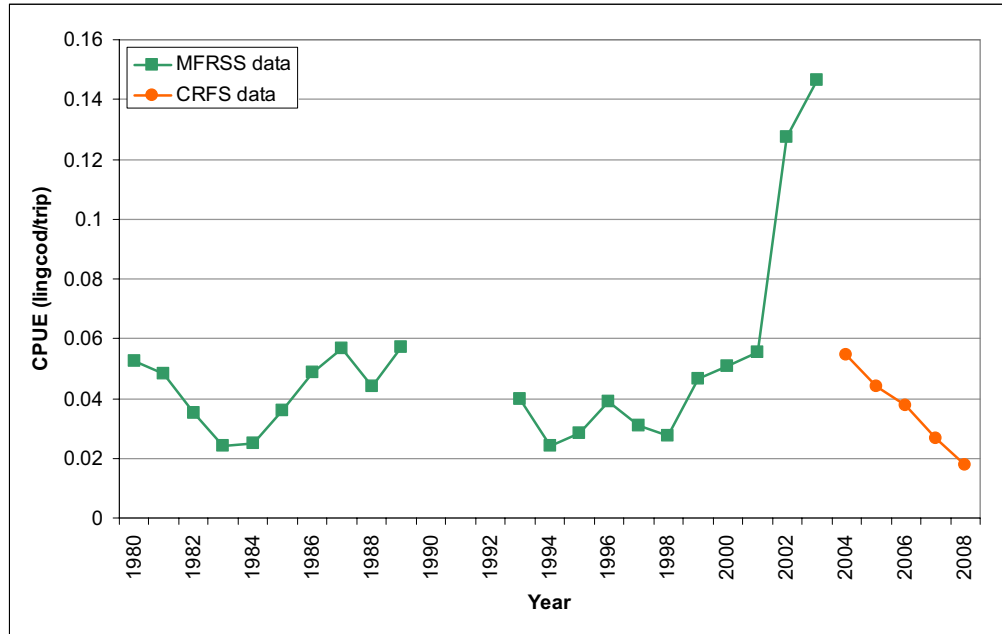


Figure 15-7. Lingcod recreational catch-per-unit-effort (CPUE), 1980-2008. Data sources: MRFSS (1980-2003) and CRFS data (2004-2008), all fishing modes and gear types combined. Data not available from 1990-1992. CPFV data not available for northern and central California for 1993-1995.

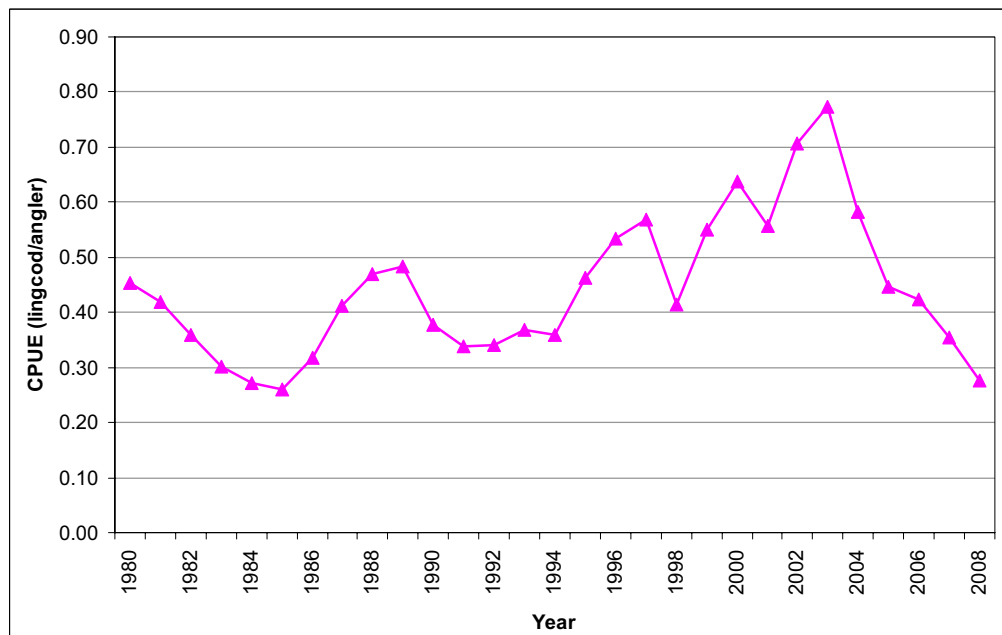


Figure 15-8. Lingcod commercial passenger fishing vessel (CPFV) catch-per-unit-effort (CPUE), 1980-2008. Data source: CPFV logbook data.

## Status of Biological Knowledge

Lingcod is a nearshore, demersal species inhabiting Pacific waters from northern Baja California, Mexico to Kodiak Island, Alaska. The areas of greatest abundance are off British Columbia and Washington, with numbers tapering off sharply south of Santa Barbara, California. They are the largest members of the Hexagrammidae (greenlings) family, although recent molecular work indicates they belong in the Cottidae (sculpins) family, being especially close to cabezon. Lingcod are the lone members of the genus *Ophiodon*, which is derived from the Greek words for snake and tooth, referring to its large teeth. The species name *elongatus* is from Latin and refers to its long body. Coloration can range from a mottled dark brown to grey, blue or green. A dorsal fin runs the length of the back, notched into two sections, and the anal fin runs from mid-belly to the tail.

Spawning season is during the fall, from November to early March in California. This is preceded by a spawning migration to nearshore areas when males seek out territories where soccer ball sized egg masses, called nests (or clutches), are deposited. The nests are found on hard substrates in rocky areas, where there is sufficient current to oxygenate the eggs. Additional factors important to lingcod embryo development and hatching are salinity, temperature and light. Mature females spend little time at the spawning grounds; after laying eggs, they leave the nest site and show a lack of nest site fidelity between seasons. Males show high nest site fidelity between seasons, and often will fertilize multiple nests within and between seasons. The polygamous behavior by both sexes serves to maximize genetic diversity.

After spawning, males will strongly defend the nests from predation, including aggressively striking at baits and lures. Males will also remain at nests in the presence of spear fishers. This behavior leaves lingcod populations especially vulnerable at this time, as mortality of nest guarding males leads to not only loss of reproductive potential of the fish, but likely mortality of the undefended egg mass (although unguarded nests may be taken over by new males). Predators of lingcod eggs include other fishes such as rockfish, kelp greenling and cabezon, and by invertebrates such as echinoderms, urchins and gastropods. After 5-11 weeks of incubation, lingcod eggs typically hatch in March or April at a size of about 0.33 inches (0.8 centimeters). Larvae move to the water column for three months, attaining a size of about 3 inches (8 centimeters) feeding on copepods, amphipods and euphausiids. They then settle into nearshore estuarine areas, eelgrass and kelp beds, and subtidal zones with sand and mud substrates. Benthic juvenile prey items include fishes such as flatfishes, herring and crustaceans. As they grow larger they move to deeper areas in rocky reef and kelp bed habitats where adults reside, usually ranging from 30-330 feet (10-100 meters). Laboratory and tagging studies show juvenile lingcod seek more structurally complex environments as they grow, as the costs of lack of protection in open areas (and increasing conspicuousness with size) increase compared to the benefits of growth while foraging. Juveniles are susceptible as prey for marine mammals, seabirds and other lingcod, while adult lingcod generally escape most predation due to their large size. Adult lingcod are ambush predators, using their large mouths and sharp teeth.

They lie in wait for prey, primarily fish but also invertebrates such as crab, squid or octopus.

Growth of lingcod is rapid, reaching 12 inches (30 centimeters) in length the first year. Males reach sexual maturity at 2 years and 18 inches in length (45 centimeters), and females at 3-5 years and 24-36 inches in length (61-75 centimeters). Both sexes grow at the same rate until age 2, when females start to grow faster than males. Maximum age is about 20 years for females at 48 inches (120 centimeters) and 14 years for males at 36 inches (90 centimeters). Fecundity for females ranges from about 40,000 to 500,000 eggs, depending on the size of the fish. Considered a hardy species, lingcod lack a swimbladder and do not suffer decompression injuries when discarded after catch. Discard mortality is primarily due to handling, especially during the time between catch and release, so mortality calculations must account for shipboard handling procedures. Lingcod are generally sedentary, with tagging studies showing that lingcod movement patterns reflect high site fidelity, with established residences from which foraging trips are made. The exception would be during spawning season, when there is migration to spawning grounds at more inshore areas.

### **Status of the Population**

The first lingcod stock assessment provided to the Pacific Fishery Management Council (PFMC) was in 1986. Subsequent assessments for northern and southern areas of its range in 1997 and 1999, respectively, determined stock status at less than 10 percent of unfished size. As a result, the PFMC declared lingcod an overfished stock in 1999. A stock is considered overfished when the stock size is 40 percent or less of the unfished stock size. Since 2000, lingcod stock assessments have considered the coastwide stock as a whole, consisting of a northern (U.S./Canada border to Cape Blanco, OR) and southern (Cape Blanco, OR to U.S./Mexico border) stock. The most recent stock assessment from 2005 estimated the coastwide spawning biomass at 64 percent of unfished level, with the northern stock at 87 percent and the southern stock at 24 percent. Since lingcod are managed coastwide, the PFMC proclaimed the lingcod stock to be fully rebuilt four years ahead of the target rebuilding year of 2009. The recent relatively healthy stock estimates for the northern stock are due to large year classes in 1999 and 2000. However, uncertainty remains over the status of the southern stock due to the sparseness of fishery catch at age data. Also, management actions concerning both minimum size and commercial trip limits have limited the utility of fishery data regarding stock recruitment and as indices of abundance.

### **Management Considerations**

With the adoption of the Pacific Coast Groundfish Fishery Management Plan by the PFMC in 1982, lingcod became a federally managed groundfish species. Since then it has been managed under the joint jurisdiction of the state and the federal government. Prior to 1982, this species was managed by the California Department of

Fish and Game (Department) through regulations adopted by the state legislature and the California Fish and Game Commission.

The 2005 stock assessment, as mentioned above, resulted in the coastwide stock being declared fully rebuilt. However, since concern remained over the status of the southern portion of the stock, California still manages the southern stock conservatively to promote its rebuilding through strict management measures.

To achieve the greatly reduced harvest levels needed to accomplish management targets and to rebuild the stock on schedule, numerous fishing restrictions were implemented on the commercial and recreational fisheries. Both sectors are subject to a spawning closure. Beginning in 1995, commercial trawl trip limits were imposed; these have become more restrictive as yearly harvest targets have decreased and the need arose to protect yelloweye rockfish, another overfished species. Monthly trip limits of 20,000 pounds (9 metric tons) in 1995 dropped to less than 1000 pounds (454 kilograms) per two month period beginning in 2003, and more recently to less than an average of 300 pounds (136 kilograms) per two month period in 2009. A commercial minimum size limit of 22 inches (56 centimeters) was instituted in 1995, and increased to 24 inches (61 centimeters) in 1998—where it remains.

The recreational bag and size limits have changed repeatedly since 1980 in an effort to maintain catches below recreational allocations (Table 15-1). To protect lingcod populations during the spawning season, seasonal closures were implemented in 2000 for the months of November and December, as well as early months of the year, for areas south of Cape Mendocino (Humboldt County). This pattern of closures has continued since, with various months closed in different years (at a minimum December has been closed statewide since 2005, and January and February closed south of Point Conception).

Recent work using mitochondrial DNA has shown that while there are enough migrants among west coast lingcod populations to effectively homogenize the stock genetically, there are too few migrants to impact fishery management, leaving the populations effectively isolated and subject to localized overfishing. Thus, effects of overfishing can have serious consequences for local populations, as long range larval transport will not be able to rebuild depleted areas. This supports a regional management approach, as exemplified by the use of recreational management areas in California, begun in 2000.

Future research on lingcod is needed regarding age structure and recruitment, especially for the southern stock. The historical data for the southern stock is much sparser compared to that of the northern stock, contributing to the greater uncertainty over its status. Fishery-independent surveys over time and geographic area for both regions are necessary to inform future assessments and management decisions.

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## Further Reading

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| Lingcod commercial landings and value, 1980-2008. |                       |             |                  |      |                       |           |                  |
|---------------------------------------------------|-----------------------|-------------|------------------|------|-----------------------|-----------|------------------|
| Year                                              | Pounds<br>(thousands) | Value       | Average<br>price | Year | Pounds<br>(thousands) | Value     | Average<br>price |
| 1980                                              | 2,811                 | \$658,177   | \$0.23           | 1995 | 1,185                 | \$614,933 | \$0.52           |
| 1981                                              | 2,840                 | \$689,042   | \$0.24           | 1996 | 1,066                 | \$574,245 | \$0.54           |
| 1982                                              | 3,038                 | \$761,568   | \$0.25           | 1997 | 1,132                 | \$607,682 | \$0.54           |
| 1983                                              | 1,977                 | \$503,918   | \$0.25           | 1998 | 331                   | \$273,627 | \$0.83           |
| 1984                                              | 2,095                 | \$550,118   | \$0.26           | 1999 | 326                   | \$293,026 | \$0.90           |
| 1985                                              | 1,531                 | \$456,195   | \$0.30           | 2000 | 123                   | \$151,714 | \$1.24           |
| 1986                                              | 1,154                 | \$411,486   | \$0.36           | 2001 | 137                   | \$175,456 | \$1.28           |
| 1987                                              | 1,859                 | \$747,178   | \$0.40           | 2002 | 179                   | \$246,966 | \$1.38           |
| 1988                                              | 1,960                 | \$794,786   | \$0.41           | 2003 | 116                   | \$184,466 | \$1.60           |
| 1989                                              | 2,791                 | \$1,116,462 | \$0.40           | 2004 | 140                   | \$215,224 | \$1.54           |

| Lingcod commercial landings and value, 1980-2008. |                       |           |                  |      |                       |           |                  |
|---------------------------------------------------|-----------------------|-----------|------------------|------|-----------------------|-----------|------------------|
| Year                                              | Pounds<br>(thousands) | Value     | Average<br>price | Year | Pounds<br>(thousands) | Value     | Average<br>price |
| 1990                                              | 2,346                 | \$933,045 | \$0.40           | 2005 | 141                   | \$205,402 | \$1.46           |
| 1991                                              | 1,736                 | \$706,379 | \$0.41           | 2006 | 142                   | \$204,873 | \$1.45           |
| 1992                                              | 1,352                 | \$578,537 | \$0.43           | 2007 | 176                   | \$260,724 | \$1.48           |
| 1993                                              | 1,520                 | \$658,856 | \$0.43           | 2008 | 154                   | \$237,181 | \$1.56           |
| 1994                                              | 1,251                 | \$585,956 | \$0.47           |      |                       |           |                  |

Data Source: CFIS data, all gear types combined.

| Lingcod recreational catch, 1980-2003. |                   |      |                   |      |                   |
|----------------------------------------|-------------------|------|-------------------|------|-------------------|
| Year                                   | Number of<br>fish | Year | Number of<br>fish | Year | Number of<br>fish |
| 1980                                   | 626,945           | 1988 | 315,314           | 1996 | 122,112           |
| 1981                                   | 347,431           | 1989 | 291,979           | 1997 | 89,509            |
| 1982                                   | 243,986           | 1990 | ---               | 1998 | 73,507            |
| 1983                                   | 168,410           | 1991 | ---               | 1999 | 102,994           |
| 1984                                   | 158,046           | 1992 | ---               | 2000 | 52,421            |
| 1985                                   | 237,083           | 1993 | 159,635           | 2001 | 41,544            |
| 1986                                   | 265,880           | 1994 | 96,643            | 2002 | 148,739           |
| 1987                                   | 287,314           | 1995 | 108,854           | 2003 | 297,309           |

Data source: MRFSS data, all fishing modes and gear types combined. Data not available from 1990-1992. CPFV data not available for central and northern California for 1993-1995.

| Lingcod recreational catch, 2004-2008. |                   |
|----------------------------------------|-------------------|
| Year                                   | Number of<br>fish |
| 2004                                   | 30,909            |
| 2005                                   | 72,085            |
| 2006                                   | 82,881            |
| 2007                                   | 49,912            |
| 2008                                   | 30,477            |

Data source: CRFS data, all fishing modes and gear types combined.

| Lingcod CPFV catch, 1980-2008. |                |      |                |      |                |
|--------------------------------|----------------|------|----------------|------|----------------|
| Year                           | Number of fish | Year | Number of fish | Year | Number of fish |
| 1980                           | 89,349         | 1990 | 60,047         | 2000 | 10,689         |
| 1981                           | 65,604         | 1991 | 50,111         | 2001 | 10,652         |
| 1982                           | 49,775         | 1992 | 43,260         | 2002 | 35,981         |
| 1983                           | 30,543         | 1993 | 38,324         | 2003 | 44,198         |
| 1984                           | 23,797         | 1994 | 31,112         | 2004 | 12,001         |
| 1985                           | 20,911         | 1995 | 33,355         | 2005 | 29,871         |
| 1986                           | 25,588         | 1996 | 34,005         | 2006 | 34,805         |
| 1987                           | 42,518         | 1997 | 38,441         | 2007 | 25,269         |
| 1988                           | 66,778         | 1998 | 20,873         | 2008 | 15,616         |
| 1989                           | 76,749         | 1999 | 28,246         |      |                |

Data source: CPFV logbook data.