

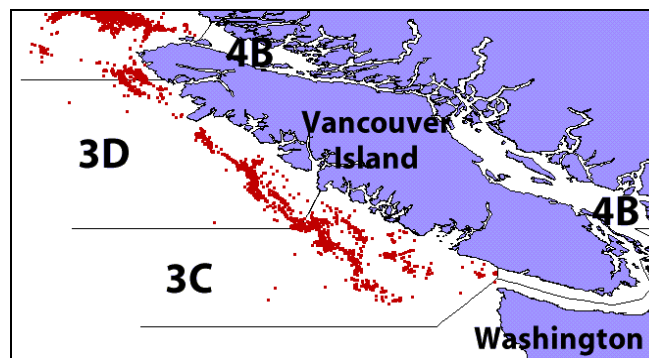
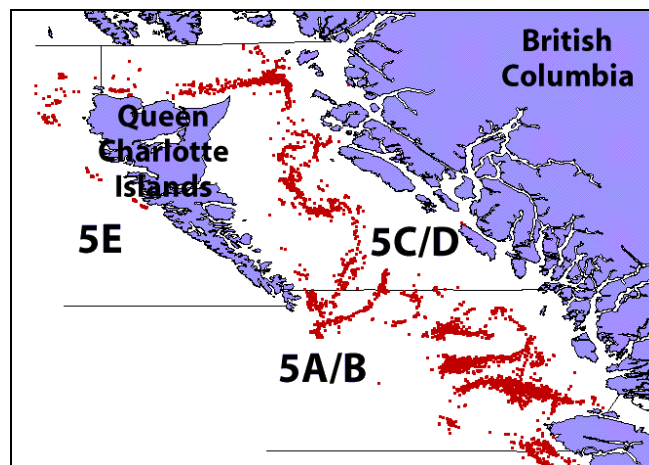
Lingcod (*Ophiodon elongatus*)

Background

Lingcod (Ophiodon elongatus) are an important component of both the commercial and recreational groundfish fishery off British Columbia, Canada. They are exploited primarily by trawl, but also by hook and line, including handline, longline, and troll. They have a long history of exploitation as a food fish, starting with First Nations as early as 5,000 years ago, and it is known that they were fished by early settlers in the inshore waters around Victoria by the mid-1800s.

Lingcod are unique to the west coast of North America. They are distributed in the nearshore waters from California to Alaska, with the centre of abundance off the coast of British Columbia. They are found on the bottom at depths of 3-400 m, with most individuals occupying rocky areas at depths of 10-100 m. In BC, *Lingcod* are found in the Strait of Georgia, off the west coast of Vancouver Island, in Queen Charlotte Sound, in Hecate Strait, and off the west coast of the Queen Charlotte Islands. Tagging studies have shown them to be largely non-migratory, and it is thought that these areas may represent distinct groups of stocks, but stock delineation has not been clearly defined for any area.

Lingcod live up to a maximum of about 14 years for males and 20 years for females, reaching a maximum size of approximately 90 cm and 120 cm, respectively. Females and males are reproductively mature at age 3-5 years (61-75 cm) and age 2 years (50 cm), respectively. Spawning takes place from December to March. Females deposit eggs in nests which males actively defend until hatching in mid-March or April. The larvae are pelagic until late May or early June when they settle to the bottom as juveniles. Juveniles may be found on flat bottom areas that are not typical habitat of older *lingcod*. They eventually settle in habitats of similar relief and substrate as older *lingcod*, but remain at shallower depths for several years. In general, the dispersion of juveniles is limited, with colonization and recruitment occurring in localized areas only. *Lingcod* begin recruiting to the commercial fishery at age 2 and are fully recruited at age 6.



Major statistical areas and Canadian trawl catch locations for *lingcod* in British Columbia, 1999.

Summary

- Abundance in the Strait of Georgia remains at levels which warrant conservation concern, and the majority of this area will remain closed to commercial fishing.
- Abundance off the west coast of Vancouver Island, in Queen Charlotte Sound, and in Hecate Strait likely remains at a moderate level. There is no evidence of any strong year classes recruiting through the 1990s. Harvest levels remain unchanged.
- *Lingcod* stock status off the west coast of the Queen Charlottes is unknown. The quota remains part of the Hecate Strait allocation.

Lingcod Biology

Lingcod are unique to the west coast of North America. They are distributed in the nearshore waters from California to Alaska, with the centre of abundance off the coast of British Columbia. They are found on the bottom at depths of 3-400 m, with most individuals occupying rocky areas at depths of 10-100 m. Tagging studies in the 1980s off the west coast of Vancouver Island and in the Strait of Georgia indicated very little movement of individuals within the first two years after release and very little mixing between inshore and offshore groups, suggesting that lingcod are a largely non-migratory species.

Females and males are reproductively mature at age 3-5 years (61-75 cm) and age 2 years (45 cm), respectively. Seasonal migration to nearshore spawning sites begins in October, with the males migrating before the females. Males typically select nest sites in rock crevices or on ledges where there are strong currents. Spawning begins in December and continues into March with the peak spawning activity occurring in late January to early February. Males remain within 1 metre of an egg mass and exhibit aggressive behaviour to large predators such as kelp greenling (*Hexagrammos decagrammus*) and striped seaperch (*Embiotoca lateralis*) which typically feed on lingcod eggs and larvae. Egg mortality due to predation can be very significant, and nests that are left unguarded, or that have males removed from them, do not survive to hatching.

Larvae hatch in early March through late April, at a length of about 6-10 mm. The larvae are pelagic and are found in the upper 3 m of the water column during the day, but migrate to deeper waters at night. By about mid-May the post-larval lingcod are approximately 50-70 mm in length and have become demersal, inhabiting areas near kelp or eelgrass beds. By September, the young-of-year are found in a wider range of flat bottom areas, and by age 2, begin to inhabit similar substrates as older lingcod. Typically, larger lingcod inhabit deep banks and reefs,

while smaller (mainly immature) lingcod inhabit shallow waters and banks.

Growth during the first years of life is rapid. Up to age 2 males and females grow at similar rates, with both reaching an average length of 45 cm. After age 2, females grow faster than males, with the growth of males tapering off at about age 8, and females continuing to grow rapidly until about age 12-14. For waters off the west coast of Canada, the maximum age recorded for lingcod was 14 years for males and 20 years for females. Females reach lengths in excess of 100 cm, while males rarely exceed lengths of 90 cm.

Lingcod are voracious predators, with large, gaping mouths and long, pointed teeth. As larvae, lingcod feed on a variety of zooplankton including larval herring (*Clupea harengus*). As the young-of-year move inshore and begin a demersal life, their diet switches from zooplankton to juvenile herring. Juvenile lingcod consume a wide variety of small fish and invertebrates. Adults feed mostly on herring and Pacific hake (*Merluccius productus*), but are predators of many fish and invertebrates. Adult lingcod are also cannibalistic and feed on juvenile lingcod.

Lingcod that survive the early larval stages have few predators. Adult lingcod are vulnerable mainly to marine mammals such as sea lions and harbour seals.

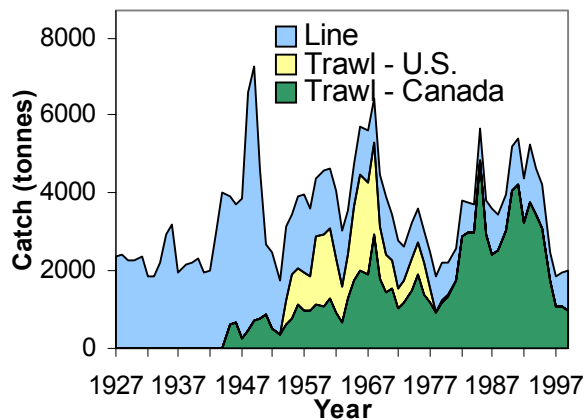
The Fishery

The commercial fishery for lingcod in Canada began around 1860. The fishery remained primarily an inshore hook and line fishery until the establishment of the trawl fishery in the 1940s. Historically both Canada and the U.S. participated in the trawl fishery in BC, with the U.S. fleet contributing 40-60% of the total trawl catch between 1954 and 1970. The U.S. fishery off BC was prohibited after the establishment of extended jurisdiction in 1977.

Prior to the 1940s, lingcod catches averaged around 2000 t/year. During the 1940s, lingcod catches increased dramatically, reaching a

historic high of 7300 t in 1949. With the advent of the trawl fishery in the 1940s, the area of exploitation was extended to include the entire BC coast. Starting in the 1950s, trawl catches rose steadily, while line catches gradually declined. Total catch peaked again in 1968 at 6400t, of which about 20% was from the line fishery. Coast wide catches declined sharply through the 1970s, but rose again soon after extended jurisdiction in 1977, reaching another record high of about 5600 t in 1985. Coastwide catches were high in the early 1990s but have declined in recent years. The introduction in 1996 of on-board vessel observers, bycatch limits for halibut, and the provision that all catches of quota species, including discards, would be counted against individual vessel quotas, substantially changed the groundfish trawl fishery in BC, and has resulted in reduced targeting on lingcod.

Canadian and US Lingcod Commercial Catch In British Columbia 1927-1999



Inshore Lingcod

The commercial lingcod fishery in the Strait of Georgia (Area 4B) was dominated by the handline/troll fishery, with minor catches by trawl and longline. In addition, lingcod was exploited by sport angling and spear fisheries. Annual commercial catches of over 2000 t occurred regularly in the 1940s, with a record catch of about 3300 t occurring in 1944. Annual catches have decreased progressively since the 1950s, and by the late 1980s, both commercial

and recreational catches in all areas of the Strait of Georgia had declined to low levels.

A variety of management measures, such as winter closures, commercial and recreational size limits, sports bag limits, and sports annual limits have been implemented over the course of the fishery, and since the early 1990's most of the Strait of Georgia has been closed to commercial fishing. However, there is no indication that these measures have resulted in any rebuilding of the Strait of Georgia stocks.

Commercial catches in the remaining open areas of the Strait have been negligible (<1 t/year) since 1995. Annual retained sports catch was about 30 t in 1999.

Offshore Lingcod

Lingcod off the west coast of Vancouver Island (Areas 3C & 3D) are exploited primarily by the trawl fishery, but also by the hook and line and sport fisheries. Total catch in Area 3C has varied between 500 – 2000 t in most years. A record catch of about 3600 t occurred in 1985. Total catch in Area 3D has ranged from about 100 – 1400 t, with the highest catches occurring in 1994. Catches in 1999 were 246 t in Area 3C and 111 t in Area 3D.

Winter closures and commercial size limits (58 cm) have been in place since the 1940s. Winter closures were extended to cover the entire spawning/nesting season in 1987-88. The commercial size limit was increased to 65 cm in 1996 in both areas. The first quota for lingcod was introduced in Area 3C in 1987 and was set at 1400t. The quota was raised as high as 2100 t in 1988-1995, but was reduced to 1540 t in 1996 and 1400 t in 1997. The quota was further reduced to 950 t in 1998 and has remained at that level. A quota of 600 t was applied to Area 3D in 1993 and was reduced to 400t in 1997.

Lingcod stocks in Queen Charlotte Sound (Areas 5A & 5B) are primarily exploited by the trawl fishery, although lingcod is a minor component of the total trawl fishery. There are also small catches by the hook and line fishery. Total catch

peaked at around 2300 in 1968 and again in 1990. Catches have declined steadily since 1990 and were around 600 t in 1999; however, these declines were concurrent with quota restrictions. A commercial size limit of 58 cm originally applied to this area, but was increased to 65 cm in 1996. Winter closures for the duration of the spawning/nesting season have been in place in portions of Area 5A since 1987. A quota of 1650 t was applied in 1993 and was lowered to 1100 t in 1998.

Lingcod in Hecate Strait (Areas 5C & 5D) and off the west coast of the Queen Charlotte Islands (Area 5E) are a minor component of both the trawl and hook and line fishery. However, hook and line landings have accounted for an increasing proportion of the total catch, and in recent years, the directed line fishery for lingcod has also increased. Both trawl and line catch in Hecate Strait reached historic highs in 1991-1995, with total catch peaking at around 850 t. Lingcod catches off the west coast of the Queen Charlotte Islands peaked at about 150 t in 1994, of which only 12 t was caught by the trawl fishery. Catches have averaged around 100 t since 1995. A commercial size limit of 58 cm originally applied to this area, but was increased to 65 cm in 1996. A quota of 1000 t was implemented in 1993, initially applying only to Areas 5C/D but extended to include Area 5E in 1997.

Resource Status

Inshore Lingcod

Since the closure of the commercial fishery in the Strait of Georgia (Area 4B), the only source of data for abundance indicators is the recreational fishery. An abundance index based on creel survey data shows that recreational catch rates have risen in recent years. However, the restrictions on recreational salmon fishing which have been implemented over the same time period may have limited the ability of this index to detect abundance trends. In addition, the ecosystem has changed since 1989 and rebuilding during the 1990s may not have been

possible. Therefore, while abundance may have increased in recent years, it likely remains at levels which warrant conservation concern.

Offshore Lingcod

For the west coast of Vancouver Island (Areas 3C & 3D), the commercial CPUE index (25% Qualified trawl CPUE) does not indicate any large, persistent changes in lingcod abundance. For Area 3C, age composition data indicates no strong, persistent year classes through the 1990s. In addition, ecosystem data for the west coast of Vancouver Island since 1989 has been associated with average to below average year classes of many groundfish species, and therefore strong year classes of lingcod are not expected during this time period.

For Queen Charlotte Sound (Areas 5A and 5B), the commercial CPUE index (25% Qualified trawl CPUE) has been declining since the late 1980s, but has remained fairly constant since 1992. Age data suggests that the 1993 year class was of at least moderate strength.

For Hecate Strait (Areas 5C and 5D), the commercial CPUE index (25% Qualified trawl CPUE) exhibits no trend, and there is no evidence that this stock is being overexploited. However, historic trawl effort may be too low to provide a reliable index, and the biological data available for this area is insufficient to provide any indication of relative year class strength.

For the west coast of the Queen Charlotte Islands (Area 5E), stock status is unknown, as trawl catch remains at levels too low to provide a CPUE index, and the rapidly expanding line fishery in this area can provide little information.

Outlook

Inshore Lingcod

Both commercial and recreational harvest recommendations remain the same as in previous years for the Strait of Georgia (Area 4B), with the majority of this area closed to commercial fishing.

Offshore Lingcod

Both commercial and recreational harvest recommendations remain the same as in previous years for all offshore areas.

Yield options were ≤ 1000 t for Area 3C, 400-800 t for Area 3D, ≤ 1100 t for Area 5A/B, and ≤ 1000 t for Areas 5C/D and 5E combined. A conservative approach is recommended due to the apparent lack of any strong year classes recruiting during the 1990s, and the possible unreliability of the CPUE index in recent years.

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