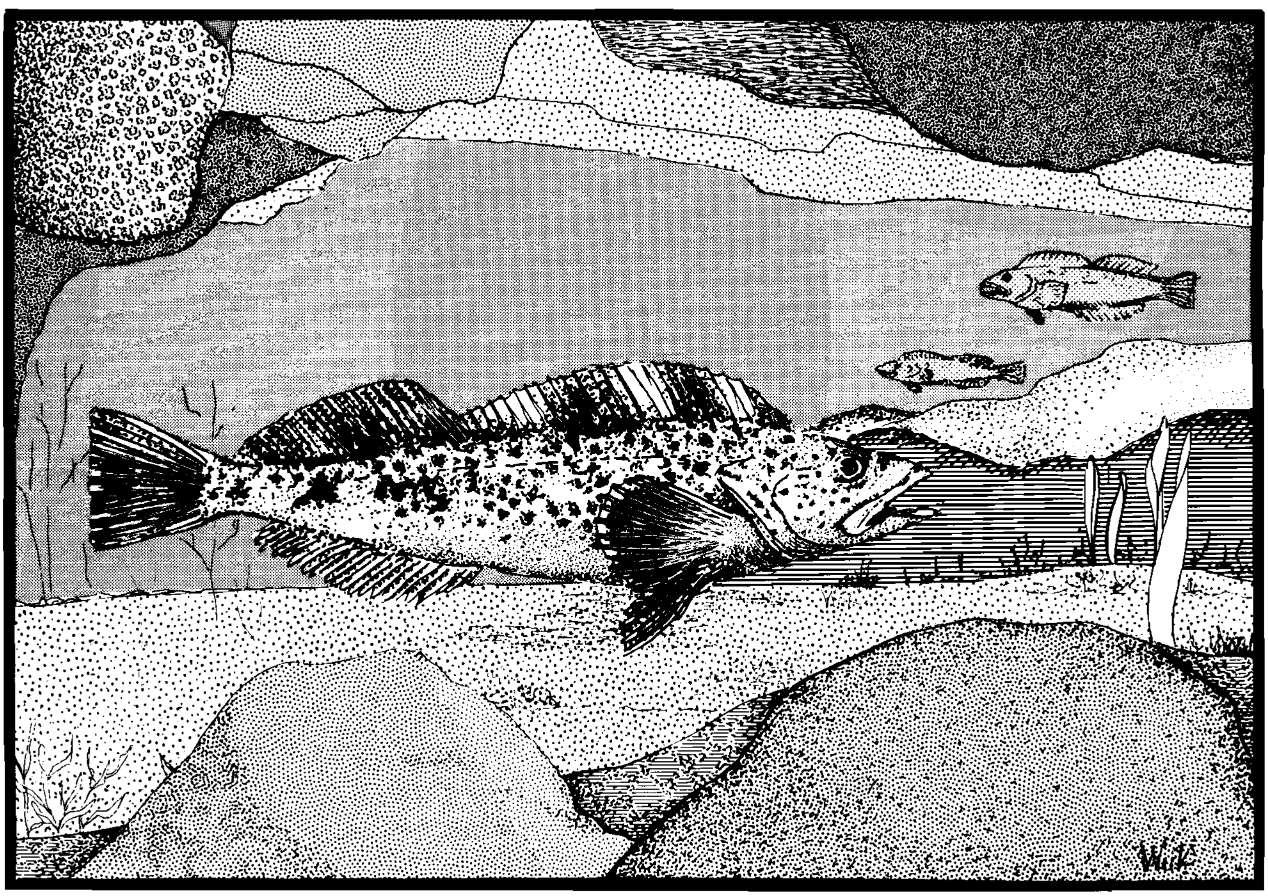
Biological Report 82(11.119)
December 1989

TR EL-82-4

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest)

LINGCOD



Coastal Ecology Group
Waterways Experiment Station
U.S. Army Corps of Engineers

Fish and Wildlife Service
U.S. Department of the Interior

Biological Report 82(11.119)
TR EL-82-4
December 1989

Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest)

LINGCOD

by

William N. Shaw
Fred Telonicher Marine Laboratory
Humboldt State University
Trinidad, CA 95570

and

Thomas J. Hassler
U.S. Fish and Wildlife Service
California Cooperative Fishery Research Unit
Humboldt State University
Arcata, CA 95521

Project Officer
David Moran
U.S. Fish and Wildlife Service
National Wetlands Research Center
1010 Gause Boulevard
Slidell, LA 70458

Performed for
Coastal Ecology Group
U.S. Army Corps of Engineers
Waterways Experiment Station
Vicksburg, MS 39180

and

U.S. Department of the Interior
Fish and Wildlife Service
Research and Development
Washington, DC 20240

DISCLAIMER

The mention of trade names does not consitute endorsement or recommendation for use by the Federal Government.

This series may be referenced as follows:

U.S. Fish and Wildlife Service. 1983-19__. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates. U.S. Fish Wildl. Serv. Biol. Rep. 82(11). U.S. Army Corps of Engineers, TR EL-82-4.

This profile may be cited as follows:

Shaw, W.N., and T.J. Hassler. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--lingcod. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.119). U.S. Army Corps of Engineers, TR EL-82-4. 10 pp.

PREFACE

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

Information Transfer Specialist
U.S. Fish and Wildlife Service
National Wetlands Research Center
NASA-Slidell Computer Complex
1010 Gause Boulevard
Slidell, LA 70458

or

U.S. Army Engineer Waterways Experiment Station
Attention: WESER-C
Post Office Box 631
Vicksburg, MS 39180

CONVERSION TABLE

Metric to U.S. Customary

Multiply	***By***	***To Obtain***
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers	0.5396	nautical miles
square meters (m^2)	10.76	square feet
square kilometers (km^2)	0.3861	square miles
hectares (ha)	2.471	acres
liters (l)	0.2642	gallons
cubic meters (m^3)	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (° C)	1.8 (° C) + 32	Fahrenheit degrees

U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft^2)	0.0929	square meters
square miles (mi^2)	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft^3)	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces	28.35	grams
pounds (lb)	0.4536	kilograms
pounds	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (° F)	0.5556 (° F - 32)	Celsius degrees

CONTENTS

	Page
PREFACE	iii
CONVERSION TABLE	iv
ACKNOWLEDGMENTS	vi
NOMENCLATURE/TAXONOMY/RANGE	1
MORPHOLOGY/IDENTIFICATION AIDS	1
REASON FOR INCLUSION IN SERIES	3
LIFE HISTORY	3
Spawning	3
Larval Stage	3
Juvenile Stages	4
Adult Stage	4
GROWTH AND SIZE AT AGE	4
THE FISHERY	4
AQUACULTURE	6
ECOLOGICAL ROLE	6
ENVIRONMENTAL REQUIREMENTS	7
Depth	7
Habitat	7
Migration	7
REFERENCES	9

ACKNOWLEDGMENTS

We gratefully acknowledge the reviews by Peter Adams of the National Marine Fisheries Service and Robert Lee of the California Department of Fish and Game.

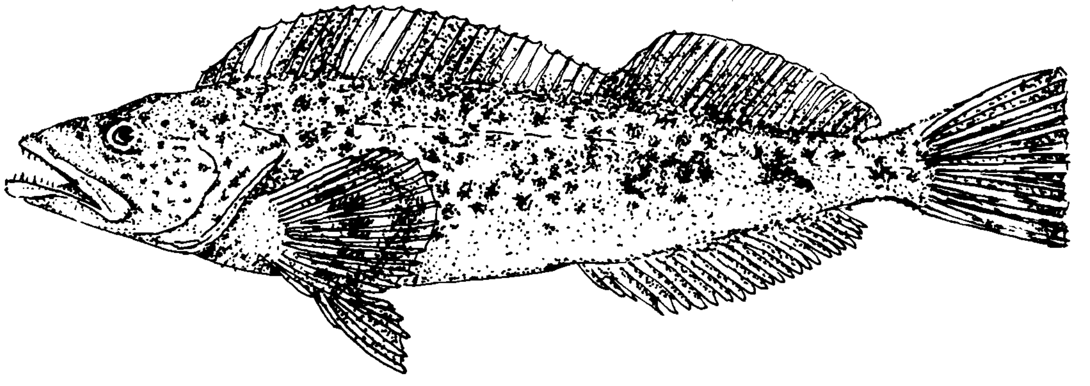


Figure 1. Lingcod.

LINGCOD

NOMENCLATURE/TAXONOMY/RANGE

Scientific name ...... *Ophiodon elongatus*

Preferred common name .... lingcod (Figure 1)
Other common names ..... cultus cod, blue cod, bluefish, green cod, buffalo cod, bocalao, greenling, white cod (Roedel 1948)
Class .... Osteichthyes
Order .... Scorpaeniformes
Family .... Hexagrammidae

Geographic range: Pta. San Carlos, Baja California, to Kodiak Island, Alaska (Miller and Lea 1972; Figure 2).

MORPHOLOGY/IDENTIFICATION AIDS

Lingcod are elongated fish tapering toward the caudal peduncle. They are recognizable by a long single moderately notched dorsal fin, large mouth, large teeth, thoracic pelvic fins, and small cycloid scales that cover the body and head (Hart 1973).

Dorsal fin rays XXIV-XXVII, 21-24, spinous part slightly incised; anal III, 21-24, spines in adults buried in flesh; pectorals much expanded; pelvics I, 5; vertebrae 55-57 (Hart 1973). (Note: Miller and Lea (1972) reported dorsal fin rays XXV-XXVIII, 19-24 and vertebrae 56-58.) Color varies from gray-brown to green and bluish, with darker spotting and mottling on upper parts (Miller and Lea 1972). Juveniles may retain fluorescent grid marks for 3 months (Phillips and Barraclough 1977). Total length to 152 cm. Body depth about 1/4.5 (standard length (SL)); head large, conical, depressed, its length about 1/3 SL (Hart 1973). Mouth terminal, large with great gape, directed slightly upward. Maxillary extended beyond posterior part of eye with lower jaw projecting. Teeth large, canine. Eye oval, rather small, length about 1/6 (length of head). Gill membranes briefly united anteriorly, free from isthmus. Anal papilla in male.

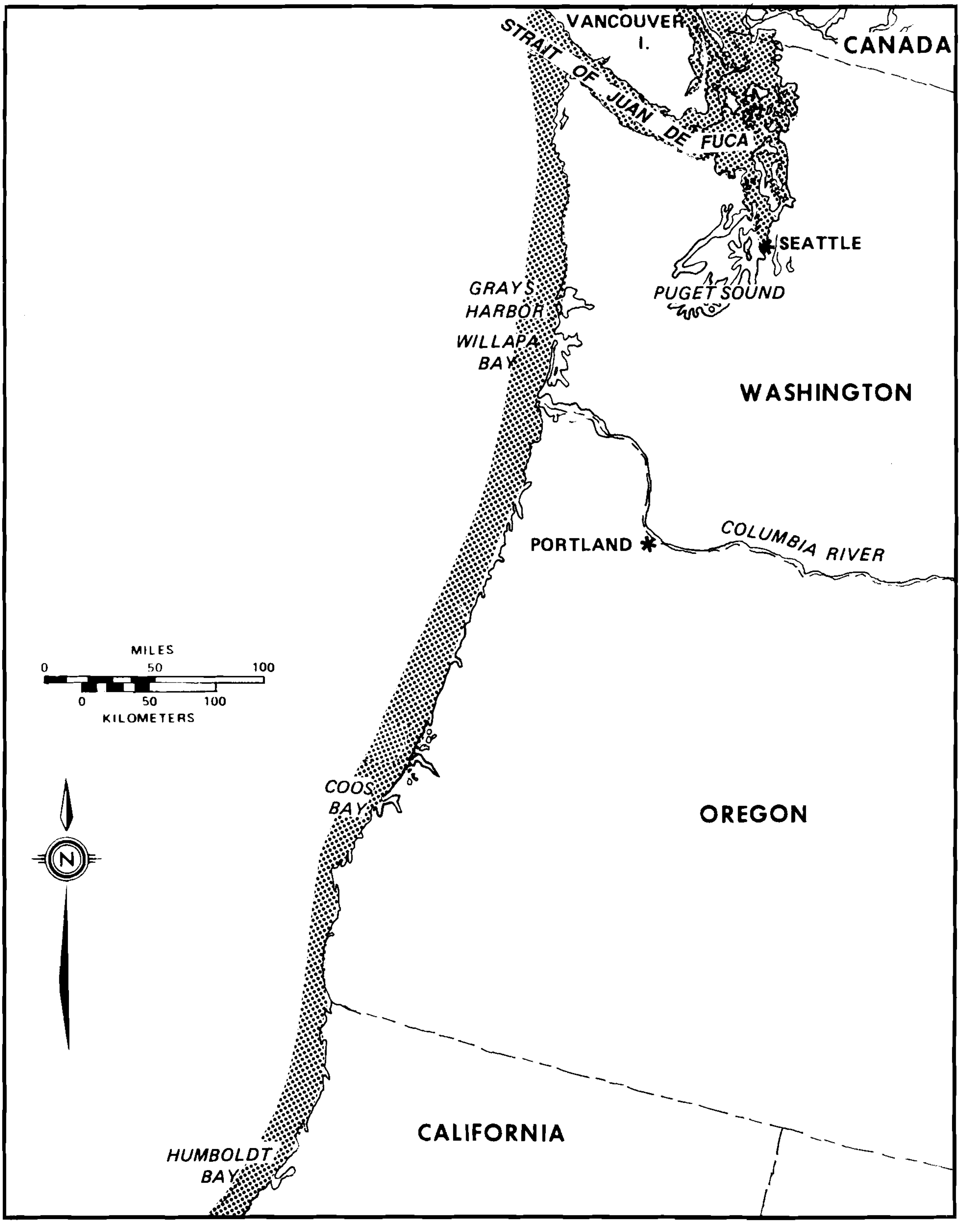


Figure 2. Distribution of lingcod in the Pacific Northwest.

REASONS FOR INCLUSION IN SERIES

The lingcod is an important sport and commercial fish, highly esteemed in the fresh seafood market. It occupies a special coastal niche generally in rocky locations and sand bottoms where there is considerable current (Wilby 1937). Any disruption of the coastal habitat by humans could seriously affect this important fishery. Consequently, careful consideration must be given to any proposed coastal manipulation.

LIFE HISTORY

Spawning

Biological information about lingcod was summarized by Wilby (1937), Miller and Geibel (1973), and Bargmann (1982). The spawning season extends from about mid-December to mid-March, although most of the fish have laid their eggs before the end of January. Prior to spawning time, males move into the nesting area to establish territories (Bargmann 1982). Females are rarely seen on the spawning grounds, and are assumed to move into the area long enough to deposit their eggs and leave (Adams 1986). Females deposit their eggs in crevices between large rocks or slightly under a boulder or rocky shelf from 3 to 10 m below the lowest tide level and where there are strong currents (Wilby 1937). A transparent, yellowish, highly viscous secretion is extruded with the eggs which, upon contact with salt water, forms a strong adhesive for the attachment of eggs to the rocky surface. Each time the female lays a layer of eggs, the male fertilizes them with short successive jets of milt. When spawning is completed, the female leaves the area and the male remains to guard the eggs.

Lingcod eggs are about 2.8 mm in diameter when first extruded but swell to about 3.5 mm shortly after contact with water (Forrester 1969). A female 76 cm long and weighing 4.5 kg had about 60,000 eggs, and another that was 92 cm long and weighed 11.1 kg produced about 518,000 eggs (Wilby 1937). Hart (1967) reported that a 100-cm female carried about 290,000 eggs. An egg mass, after being laid, can be up to 5 liters in volume (Giorgi and Congleton 1984). The exact incubation time is not known (Wilby 1937) but has been estimated to be 6-8 weeks (Jewell 1968).

Larval Stage

Larvae are about 7-11.5 mm long at hatching (Figure 3). The yolk sac is absorbed about 10

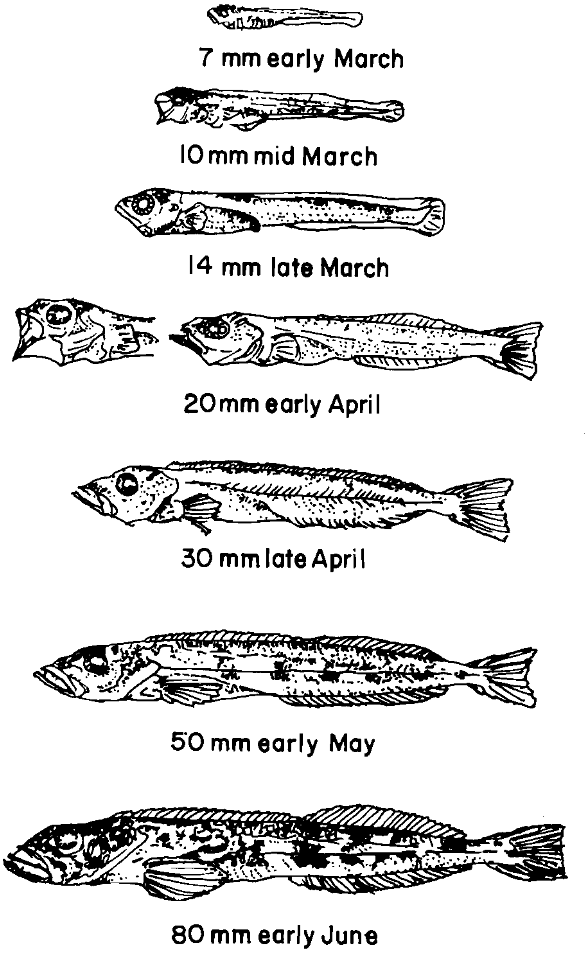


Figure 3. Development of lingcod from their first appearance in the surface plankton to their disappearance from inshore surface waters off British Columbia (from Phillips and Barraclough 1977).

days after hatching. The larvae can be identified by the small yolk sac, bright yellow oil globule near the liver, large blue eyes, elongated body, large mouth, and bright green gallbladder (Wilby 1937; Forrester 1969). Larvae are extremely active and move rapidly along the bottom. They feed on small copepods and copepod eggs; as they grow, their diet expands to include larger copepods, fish larvae, and larvaceans which are a type of pelagic tunicate (Grosse 1982).

Juvenile Stages

Juvenile stages have been extensively studied by Phillips and Barraclough (1977) for the area around Vancouver Island, Canada. While in these open waters, they grow about 1 mm per day. Around 70-80 mm long, the juveniles congregate in inshore locations. Small juveniles shift their feeding from zooplankton, mainly copepods, to juvenile herring. Captive juveniles held in aquariums keep their fluorescent grid marks for 3 months. The captive fish grow rapidly when fed live or frozen juvenile fish (Phillips and Barraclough 1977). In the Strait of Georgia, the total length (TL) of juvenile lingcod are 1-3 cm by April and 17-35 cm by December; the average is 27 cm by the end of the first year of life (March) and 47 cm at the end of the second year.

Adult Stage

Males mature at a smaller size and younger age than females. Wilby (1937) observed that the smallest mature male was 52 cm TL and the smallest female 77 cm. Phillips (1959) observed that both male and female lingcod start to mature at 58 cm TL and that practically all were mature at 65 cm. Forrester (1969) stated that the smallest mature male was 46 cm TL (age II) and female 70 cm (age V). Adult lingcod can be sexed externally: males have a distinct papilla just forward of the anus.

The life span is shorter in male lingcod than in females. Males live to an average of 12 years and females 15 years (Forrester 1969) or males 14 years and females 16 years (Phillips 1959).

GROWTH AND SIZE AT AGE

Fin rays, scales, vertebrae, and tag and recovery data have been used to estimate the age and growth of lingcod. Phillips (1959) reported that the use of scales and otoliths to estimate age was unsuccessful but that vertebrae showed promise. Chatwin (1954, 1956) used vertebrae to estimate age; Beamish and Chilton (1977) used fin rays successfully but wrote that the use of scales to age fish older than age V was difficult. Chatwin (1956) found that age determinations from vertebrae yielded growth curves similar to those of tagged lingcod.

The average length attained at different ages (estimated from vertebrae) for male and female lingcod from British Columbia waters is shown in Figure 4 (Chatwin 1954, 1956).

At age III, differential growth between sexes in some populations becomes more marked; females are about 58 cm long and males slightly smaller (Forrester 1969). Miller and Geibel (1973) aged California fish using otoliths. They found that a 3-year-old lingcod of either sex averaged around 50 cm TL, but thereafter male and female growth patterns diverged widely (Figure 5).

THE FISHERY

Lingcod are consistently caught along the Pacific coast. From 1948 to 1967, the total average annual catch was 4,775 t: 579 t from California, 1,778 t from Washington, and 2,063 t from Canada (Miller and Geibel 1973). Total catch from the United States was 4,046 t (valued at $2.3 million) in 1984, and 3,672 t (valued at $2.2 million) in 1985. In both years, the catch off Washington was the largest--2,038 t in 1984 and 1,931 t in 1985 (Korson 1986). The commercial landings of lingcod off Washington from 1970 to 1985 ranged from a

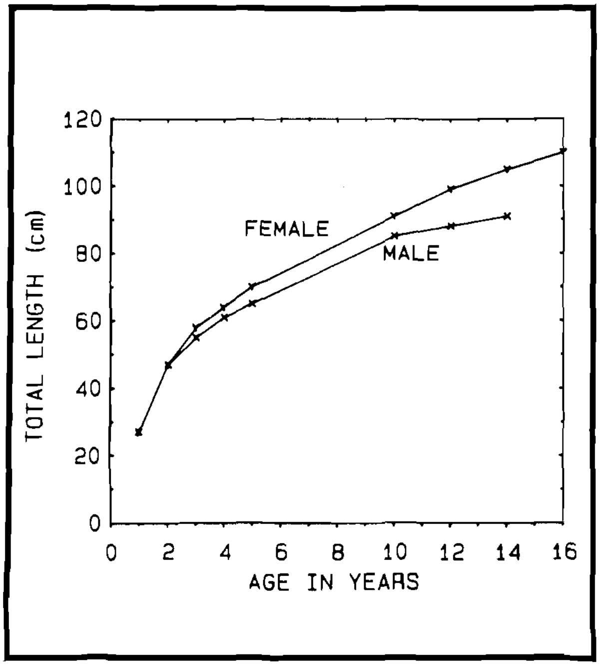


Figure 4. Average length attained at different ages by male and female lingcod from British Columbia (Chatwin 1954, 1956).

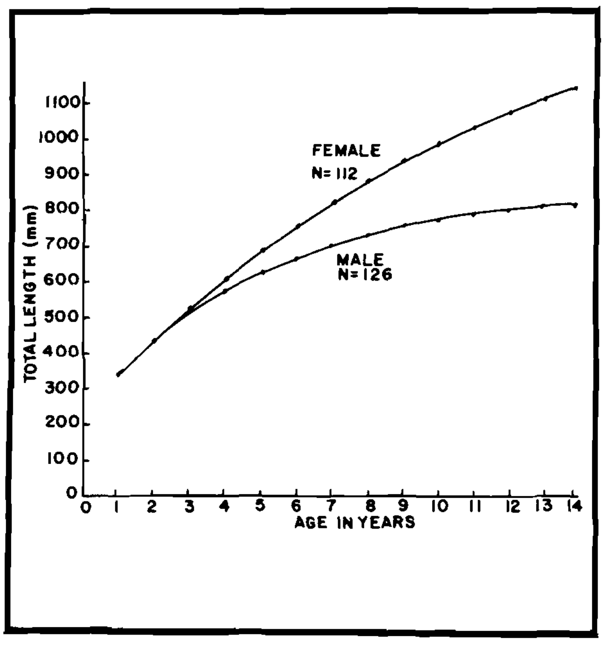


Figure 5. Van Bertalanffy growth regressions for California male and female lingcod (from Miller and Geibel 1973).

low of 771 t in 1972 to 2,086 t in 1984 (Ward and Hoines 1985). Before 1970, the highest landing of lingcod from Washington was 3,719 t in 1944 (Ward et al. 1970).

Five types of commercial fishing gear are used to catch lingcod--bottomfish trolling gear, handline jig, otter trawl, set net, and set line. The dominant commercial fishing gear in Puget Sound is bottomfish troll which harvests about 72% of the total lingcod caught. About 16% of the lingcod catch is taken in the otter trawl, the second most important gear used in the sound (Bargmann 1982). About 50% of the commercial harvest in Puget Sound is taken in 3 months--March (16%), April (21%), and May (12%). The sex ratio of lingcod captured by different gears is shown in Table 1.

The Japanese developed live-bait fishing done with vessels that had live-wells for the storage of the catch. Herring was used for bait and the lingcod were caught by jigging. The fish remained in the live-well until the capacity was reached. The lingcod were later transferred to a live-box at a base camp for later shipment to market (Wilby 1937).

Two major methods are used in the sport fishery--hook and line and spear (Bargmann 1982). Lingcod are caught from piers, the shoreline, party boats, and skiffs and are speared by skin divers (Miller and Geibel 1973).

Table 1. Sex ratio of lingcod captured with different gear, 1978-80 (Bargmann 1982).

Gear	Percent male
Spear	81
Sport angling	78
Bottomfish troll	74
Hand line jig	71
Otter trawl	34
Set net	17

In Puget Sound, between 20,000 and 30,000 fish are caught annually with hook and line (Bargmann 1982). In California, the statewide catch of lingcod from party boats has ranged from 103,965 fish caught in 1972 to 42,449 caught in 1968 (Oliphant 1979). Catches from skiffs are greatest from February to May, a period that corresponds with increased post spawning feeding in shallow waters (Miller and Geibel 1973). In Puget Sound, spearfishing is an effective method of harvesting lingcod, with the greatest catch occurring in the winter and early spring when the weather is calm and lingcod are abundant inshore. The catch is predominantly males (96%) (Bargmann 1982).

To regulate the sport catch there is a three-fish bag limit in Washington and Oregon and a five-fish bag limit in California. There is also a 559 mm (22 inch) minimum size limit in California (Adams 1986).

AQUACULTURE

Few attempts have been made to rear lingcod. No successful method of raising juveniles from hatchlings has been developed, but culturists have attempted to rear native juveniles in floating cages (Grosse 1982). The fish were caught with a modified 16-foot shrimp trawl, transferred to cages, and fed frozen herring chunks and Oregon Moist Pellets. At the end of the 52 day experiment, 62% had survived with most mortalities attributed to cannibalism. The fish did not consume the Oregon Moist Pellets.

ECOLOGICAL ROLE

Lingcod feed on a variety of organisms. Juvenile lingcod feed on crustaceans such as shrimp-like *Neomysis macrops* and the common prawn *Pandalus danae* (Wilby 1937), and small fish such as herring *Clupea* sp. and Pacific sand lance *Amodytes hexapterus* (Grosse 1982). Adult lingcod apparently are generalist carnivores consuming a variety of fish, cephalopods, gastropods, and crustaceans (Phillips 1959; Quast 1968; Miller and Geibel 1973). Fishes, mainly juvenile rockfish *Sebastes* spp., were the most common food. Of the cephalopods, half were squid *Loligo opalescens* and half were octopus *Octopus bimaculatus*. Gastropods eaten were *Calliostoma*, *Tegula*, and *Nassarius*. Crustaceans included *Cancer* crab and the shrimp *Spirontocaris* (Miller and Geibel 1973).

Since lingcod move diurnally, their food varies considerably during different times of the day. At night they are in shallow water and feed on sand lance and flatfish; as ambient light intensifies, they move to deeper water and feed on herring and spiny dogfish *Squalus acanthias* (Wilby 1937).

Feeding behavior of lingcod has been observed in an aquarium (Wilby 1937). The fish remained on the bottom most of the time with its body at an angle of about 15 to 20 degrees with the bottom. The eyes moved from time to time as a small fish swam overhead. Then, with a rapid movement, the lingcod darted upward and seized the prey by the tail.

Lingcod are cannibals when given the opportunity. Examination of the stomachs of eight nest guarding males revealed the presence of small numbers of lingcod eggs (Rohwer 1978). Studies by Grosse (1982) of cage-reared lingcod showed that over 75% of the fish were lost because of cannibalism.

Humans are the main predators of lingcod. Most declines in abundance have been due to fishing. A 10% exploitation rate can reduce the original stock by more than 50% (Ricker 1963).

Lingcod are hosts to a number of parasites. Arai (1969) listed nine digenean Trematoda--*Lecithaster gibbosus* (especially abundant in juvenile lingcod), *Paraemiuris merus*, *Rhipidocotyle elongata*, *Stephanostomum tristephanum*, *Tubulovesicula lindbergi*; Cestoda--*Naybelinia surmenicola*, *Phyllobothrium* sp.; Nematoda--*Anisakis* sp., and *Porrocaecum* sp. The nematode, *Cucullanus elongatus* is probably the main natural parasite of the lingcod caught off Vancouver Island, B.C. (Berland 1983). Of 42 lingcod examined, 12 harbored this parasite. Kabata (1969) noted that the copepod

Chondracanthus narium was a parasite in the nasal cavity of lingcod. Fraser (1919) and Kabata (1973) also observed the copepod *Lepeophtheirus breviventais* in the buccal cavity of lingcod. Parasitic tricodinid ciliates were collected by Bell (1962) off the gills of lingcod, and Turner et al. (1969) found the isopod *Livonica vulgares* parasitizing the lingcod's branchial chamber. Shiimo (1965) collected the copepod, *Lepeophtheirus trifidus* from the body surface of lingcod.

Mortality of lingcod may result from the penetration by the spines of the marine diatom *Chaetoceros convolutus* into the gill tissue. Bell (1961), who exposed healthy 18-inch lingcod to the diatom, reported that one fish died and setae were found imbedded in the gill tissue.

Lingcod are susceptible to oil pollution. Lingcod populations in rocky habitats are likely to suffer significant damage from spilled oil or other petrochemical products (Ilg et al. 1979).

A number of heavy metals have been found in lingcod. LeBlanc and Jackson (1973) found 0.3 mg/kg of arsenic in the body muscle of one fish from the west coast of Canada; Fimreite et al. (1971) found 0.08-0.27 ppm mercury in the lateral muscle of lingcod from Port Alberni, Nanaimo, and Horseshore Bay, B.C., Canada, and Childs and Gaffke (1973) found 0.06-0.73 ppm of mercury in lingcod collected along the Oregon coast.

Residues of DDT have been found in lingcod. Shaw (1972) found 0.22 ppm in liver and 0.04 ppm in flesh samples from fish collected at Monterey, California.

ENVIRONMENTAL REQUIREMENTS

Little has been published about the environmental requirements of lingcod. Parsons et al. (1970) speculated that lingcod larvae feed primarily on zooplankton in the size range of 250-512 micrometers and that their survival is greatly influenced by variations in the quantity of the smaller microzooplankton. Thus, the pelagic larvae of lingcod could be highly susceptible to annual fluctuations in the environment, e.g., salinity, temperature, etc., since their survival may depend on the type and abundance of the food supply.

Depth

The vertical distribution of lingcod is from the surface to at least 420 m (Hart 1973) while the bulk of the population is in waters less than 100 m deep (Alverson et al. 1964). Generally, juveniles are found nearshore in shallow water among the seaweeds and eel grass *Zostera marina*, and over sandy bottom, while adults are found in deeper water.

Habitat

Lingcod occupy areas where there is water movement and food is abundant. They live in rocky locations with considerable current but avoid muddy bottoms and stagnant water, except that some have been observed over sandy and mud bottoms.

Wilby (1937) listed two environments where lingcod are most plentiful:

(1) The more or less precipitous slopes of submerged banks from 10-70 m below the surface, where there is a rich growth of seaweeds, kelp, eel grass, and hydroids forming a vast feeding ground for many species of small fish.

(2) In channels where strong currents flow over and around reefs and carry quantities of plankton and plankton-feeding fish that concentrate in the tide-rips and whirlpools.

Benthic spawning by lingcod makes the species vulnerable to disturbance of the substrate by oil spills or by activities such as dredge-and-fill operations.

Migration

The movement of mature lingcod were examined when 3,145 fish were tagged and liberated off Vancouver Island, B.C. (Phillips

1959). Of 419 tagged fish recovered, only 9% moved more than 8 km from the location of release. The movement of immature fish, <56 cm long, was somewhat more widespread; they were recovered as far as 16 km from the area of release. Mature fish apparently establish a restricted home range. A tagged male lingcod recovered after 12 years and 2 months was caught in about the same location where it was tagged. This observation supports the general finding that lingcod are rather sedentary.

REFERENCES

Adams, P. 1986. Status of lingcod (*Ophiodon elongatus*) stocks off the coast of Washington, Oregon and California. Pages 7-1 to 7-50 *in* Status of the Pacific Coast groundfish fishery through 1986 and recommended acceptable biological catches for 1987. Pacific Fishery Management Council, Portland, Oregon.

Alverson, D.L., A.T. Pruter, and L.L. Ronholdt. 1964. A study of demersal fishes and fisheries of the northeastern Pacific Ocean. H.R. MacMillan Lectures in Fisheries. Univ. British Columbia Inst. Fish. 190 pp.

Arai, H.P. 1969. Preliminary report on the parasites of certain marine fishes of British Columbia. J. Fish Res. Board Can. 26(9):2319-2337.

Bargmann, G.G. 1982. The biology and fisheries for lingcod (*Ophiodon elongatus*) in Puget Sound. Wash. Dep. Fish. Tech. Rep. 66. 69 pp.

Beamish, R.J., and D. Chilton. 1977. Age determination of lingcod (*Ophiodon elongatus*) using dorsal fin rays and scales. J. Fish. Res. Board Can. 34(9):1305-1313.

Bell, G.R. 1961. Penetration of spines from a marine diatom into the gill tissue of lingcod (*Ophiodon elongatus*). Nature (Lond.) 192(4799):279-280.

Bell, G.R. 1962. Notes: Tricodinids from the gills of a new host, the lingcod *Ophiodon elongatus*. J. Fish. Res. Board Can. 19(3):515-516.

Berland, B. 1983. Redescription of *Cucullanus elongatus* Smedley, 1933 (Nematoda: Seuratoidea) from the lingcod *Ophiodon elongatus* Girard, 1854 from the Pacific Coast of Canada. Can. J. Zool. 61(2):385-395.

Chatwin, B.M. 1954. Growth of young lingcod. Fish. Res. Board. Can., Prog. Rep. Pac. Coast Sta. 99:14-17.

Chatwin, B.M. 1956. Age and growth of lingcod (*Ophiodon elongatus*). Fish. Res. Board Can., Prog. Rep. Pacific Coast Sta. 105:22-26.

Childs, E.A., and J.N. Gaffke. 1973. Mercury content of Oregon groundfish. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 71(3):713-717.

Fimreite, N., W.N. Holsworth, J.A. Keith, P.A. Pearce, and I.M. Gruchy. 1971. Mercury in fish and fish-eating birds near sites of industrial contamination in Canada. Can. Field-Nat. 85(3):211-220.

Forrester, C.R. 1969. Life history information on some groundfish species. Fish Res. Board Can. Tech. Rep. Series No. 105. 17 pp.

Fraser, C.M. 1919. Copepods parasitic on fish from the Vancouver Island Region. Trans. R. Soc. Can. Ser. 3, 13(5):45-67.

Giorgi, A.E., and J.L. Congleton. 1984. Effects of current velocity on development and survival of lingcod, *Ophiodon elongatus*, embryos. Environ. Biol. Fishes 10(1-2):15-27.

Grosse, D.J. 1982. An experiment in the artificial rearing of lingcod (*Ophiodon elongatus* Girard) for purposes of enhancement. Wash. Dep. Fish. Tech. Rep. No. 70. 92 pp.

Hart, J.L. 1967. Fecundity and length-weight relationship in lingcod. J. Fish. Res. Board Can. 24(11):2485-2489.

Hart, J.L. 1973. Pacific fishes of Canada. Fish. Res. Board Can. Bull. 180. 740 pp.

Ilg, J., J.M. Walton, and R.M. Buckley. 1979. An annotated bibliography of the lingcod, *Ophiodon elongatus*. State of Wash. Dep. Fish. Tech. Rep. 51. 25 pp.

Jewell, E.D. 1968. Scuba diving observations on lingcod spawning at a Seattle breakwater. Wash. Dep. Fish. Fish. Res. Paper 3:27-34.

Kabata, F. 1969. *Chondracanthus narium* sp. n. (Copepoda:Chondracanthidae), a parasite of nasal cavities of *Ophiodon elongatus* (Pisces: Teleostei) in British Columbia. J. Fish Res. Board Can. 26(11):3043-3047.

Kabata, F. 1973. The species of *Lepeophtheirus* (Copepoda: Caligidae) from fishes in British Columbia. J. Fish. Res. Board Can. 30(6):729-751.

Korson, C.S. 1986. Economic status of the Washington, Oregon, and California groundfish fishery in 1985. NOAA Tech. Memo. NMFS, NOAA-TM-NMFS, SWR-014. 29 pp.

LeBlanc, P.J., and A.L. Jackson. 1973. Arsenic in marine fish and invertebrates. Mar. Pollut. Bull. 4(6):88-90.

Miller, D.J., and J.J. Geibel. 1973. Summary of blue rockfish and lingcod life histories: a reef ecology study; and giant kelp, *Macrocystis pyrifera*, experiments in Monterey Bay, California. Calif. Dep. Fish Game Fish Bull. 158:131 pp.

Miller, D.J., and R.N. Lea. 1972. Guide to the coastal and marine fishes of California. Calif. Dep. Fish Game Fish Bull. 157:249 pp.

Oliphant, M.S. 1979. California marine fish landings for 1976. Calif. Dep. Fish Game Fish Bull. 170:56 pp.

Parsons, T.R., R.J. LeBrasseur, and W.E. Barraclough. 1970. Levels of production in the pelagic environment of the Strait of Georgia, British Columbia: a review. J. Fish. Res. Board Can. 27:1251-1264.

Phillips, A.C., and W.E. Barraclough. 1977. On the early life history of the lingcod (*Ophiodon elongatus*). Fish. Res. Board Can. Tech. Rep. 756. 35 pp.

Phillips, J.B. 1959. A review of the lingcod, *Ophiodon elongatus*. Calif. Fish Game 45(1):19-27.

Quast, J.C. 1968. Observations of the food of the kelp-bed fishes. Calif. Dep. Fish Game Fish Bull. 139:109-142.

Ricker, W.E. 1963. Big effects from small causes: two examples from fish population dynamics. J. Fish. Res. Board Can. 20(2):257-264.

Roedel, P.H. 1948. Common ocean fishes of the California coast. Calif. Dep. Fish Game Fish Bull. 68:150 pp.

Rohwer, S. 1978. Parent cannibalism of offspring and egg raiding as a courtship strategy. Am. Nat. 112(984):429-440.

Shaw, S.B. 1972. DDT residues in eight California marine fishes. Calif. Fish Game 58(1):22-26.

Shiimo, S.M. 1965. Parasitic copepods of the Eastern Pacific fishes. Rep. Fac. Fish. Prefect. Univ. Mie 5(2):441-454.

Turner, C.H., E. Ebert, and R.R. Given. 1969. Man-made reef ecology. Calif. Dep. Fish Game Fish Bull. 146:221 pp.

Ward, D.R., R. Robinson, G. Nye, and D. Reed. 1970. 1970 Fisheries Statistical Report. Department of Fisheries, State of Washington. 83 pp.

Ward, W.D., and L.J. Hoines. 1985. 1985 Fisheries Statistical Report. Department of Fisheries, State of Washington. 101 pp.

Wilby, G.V. 1937. The lingcod, *Ophiodon elongatus* Girard. Fish. Res. Board Can. Bull. 54. 24 pp.

50272-101

REPORT DOCUMENTATION PAGE	1. REPORT NO. Biological Report 82(11.119)*	2.	3. Recipient's Accession No.
4. Title and Subtitle Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Northwest)--Lingcod			5. Report Date December 1989
			6.
7. Author(s) William N. Shaw and Thomas J. Hassler			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Humboldt State University Department of Fisheries Fred Telonicher Marine Lab. Trinidad, CA 95570	U.S. Fish and Wildlife Service Calif. Coop. Fishery Research Unit Humboldt State University Arcata, CA 95521		10. Project/Task/Work Unit No.
			11. Contract(C) or Grant(G) No. (C) (G)
12. Sponsoring Organization Name and Address U.S. Department of the Interior Fish and Wildlife Service Research and Development Washington, DC 20240	U.S. Army Corps of Engineers Waterways Experiment Station P.O. Box 631 Vicksburg, MS 39180		13. Type of Report & Period Covered
			14.

15. Supplementary Notes
*U.S. Army Corps of Engineers Report No. TR EL-82-4

16. Abstract (Limit: 200 words)

Species Profiles are literature summaries of the taxonomy, morphology, distribution, life history, and environmental requirements of coastal aquatic species. They are prepared to assist in environmental impact assessments. Lingcod, especially during the spawning season, could suffer from oil spills. The lingcod, *Ophiodon elongatus*, spawns during winter in rocky areas where currents are strong. Lingcod spawn over rocky substrates and the eggs are benthic. Fecundity increases with body weight, e.g., one lingcod weighing 4.5 kg had about 60,000 eggs and one weighing 14.5 kg had about 518,000 eggs. Larvae are extremely active: at first, they feed on small copepods and copepod eggs; later they shift to larger invertebrates and fish larvae. Juvenile lingcod feed on crustaceans and small fish whereas adult lingcod apparently are generalist carnivores (feeding principally on fish). Females become larger and live longer than males. Lingcod contribute to large sport and commercial fisheries. Commercial fishermen use trolling gear, handling jigs, set nets, and set lines, and otter trawls. Sport fishermen use spears or hook and line. Mariculture of lingcod is unlikely in the near future, since no one has succeeded in rearing them from egg to market size.

17. Document Analysis a. Descriptors

Fishes	Commercial and sport fisheries	Habitat
Fisheries	Aquaculture	Migration
Life history	Feeding	
Maturity	Parasites	

b. Identifiers/Open-Ended Terms

Lingcod
Ophiodon elongatus

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Unlimited release	Unclassified	10
	20. Security Class (This Page) Unclassified	22. Price

(See ANSI-Z39.18)

OPTIONAL FORM 272 (4-77)
(Formerly NTIS-35)
Department of Commerce

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

U.S. DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

TAKE PRIDE
in America

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
National Wetlands Research Center
NASA-Slidell Computer Complex
1010 Gause Boulevard
Slidell, LA 70458