

The Columbia River Estuary: An Important Nursery for Dungeness Crabs, *Cancer magister*

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Introduction

Dungeness crab, *Cancer magister*, occur from Unalaska, Alaska, to Magdalena Bay, Mexico (Schmitt, 1921) and are one of the most important crustacean fisheries from California to Washington. Only pandalid shrimp landings are greater in terms of weight (PMFC, 1983).

Because of the commercial importance of the Dungeness crab, their reproductive biology and life history have been studied extensively. Butler (1960) found that female crabs reach sexual maturity at 2 years when they are about 100 mm in carapace width. Males mature at the same age, but with most active breeding activity beginning at 3 years or 140 mm. Copulation occurs in May-June (Cleaver, 1949), immediately after the female has molted and is soft-shelled; premating and mating behavior is lengthy (Snow and Nielsen, 1966).

Egg fertilization and extrusion occur in September-October in California (Or-

cutt, 1978), October-December in Washington (Cleaver, 1949), and September-February in British Columbia (Butler, 1956). Females carrying eggs can be found in Oregon waters from October to March (Waldron, 1958). Eggs adhere to the pleopodal hairs on the female crab's abdomen, forming a bright orange "sponge," where they remain until they hatch. Up to 2,500,000 eggs can be found in a clutch (Wickham, 1980), although the actual number which hatch is usually less (Wild, 1980). The eggs hatch in the spring, 60-130 days after extrusion, depending on temperature.

Newly hatched larvae are planktonic until becoming juveniles; larvae undergo five zoeal stages and one megalops stage, requiring 130-160 days, before metamorphosing to the first juvenile instar (Poole, 1967). Larvae can be found off the Oregon coast from January until late May (Lough, 1976) and appear to be held in the nearshore areas by strong alongshore and onshore components of the surface currents and by their own behavior (Lough, 1976). They are about 7 mm wide at the first juvenile instar (Waldron, 1958; Butler, 1961) and can be expected in Oregon coastal waters beginning in May (Waldron, 1958). Crabs grow logarithmically, and by 3.5 years of age many are large enough to enter the commercial and sport fisheries (Butler, 1961).

The California Department of Fish and Game (CDFG, 1981) has shown that the San Francisco Bay complex and

nearshore areas are important juvenile Dungeness crab nurseries. The objective of our study was to ascertain if the Columbia River estuary and its adjacent coastal areas are important crab nursery habitat.

Methods

Data were collected during four bottom trawl surveys conducted by personnel from the National Marine Fisheries Service Field Station at Hammond, Oreg., between 1973 and 1982. The four surveys were as follows:

1) Columbia River Estuarine Trawl Survey, 1973-74—Seventeen areas in the Columbia River estuary were sampled monthly from July 1973 to June 1974 with a 5 m semiballoon shrimp trawl (Fig. 1). Overall mesh size (stretched) was 38.1 mm, with a knotless 12.7 mm liner inserted in the cod end. Figure 1 depicts the areas sampled for 2-10 minutes with 5-minute tows being most numerous. Occasionally more than one tow was done at each area; some areas were not sampled during all months.

2) Waterways Experiment Station (WES) Trawl Survey, 1974-76—Five nearshore coastal sites adjacent to the mouth of the Columbia River (Fig. 2) were sampled monthly from September 1974 to April 1976. Crabs were collected with an 8 m semiballoon shrimp trawl which had mesh identical to that of the trawl used in the Columbia River Estuarine Trawl Survey. Each sampling tow was 5 minutes in duration.

3) Columbia River Estuary Data Development Program (CREDDP) Trawl Survey, 1980-81—Twenty-two Columbia River estuary sites (Fig. 3) were sampled monthly from February 1980

ABSTRACT—Carapace width frequency distribution data for Dungeness crab, *Cancer magister*, were collected during four bottom trawl surveys conducted between 1973 and 1982; two surveys were in the Columbia River estuary and two in coastal areas adjacent to the mouth of the Columbia River. The data indicate large differences in width frequency between coastal and estuarine crab populations: Coastal populations had few and estuarine populations had many 1+ (year) age crabs. Based on the indication that 1+ age crabs are found primarily in estuaries, it appears that estuaries play an important role in Dungeness crab life history.

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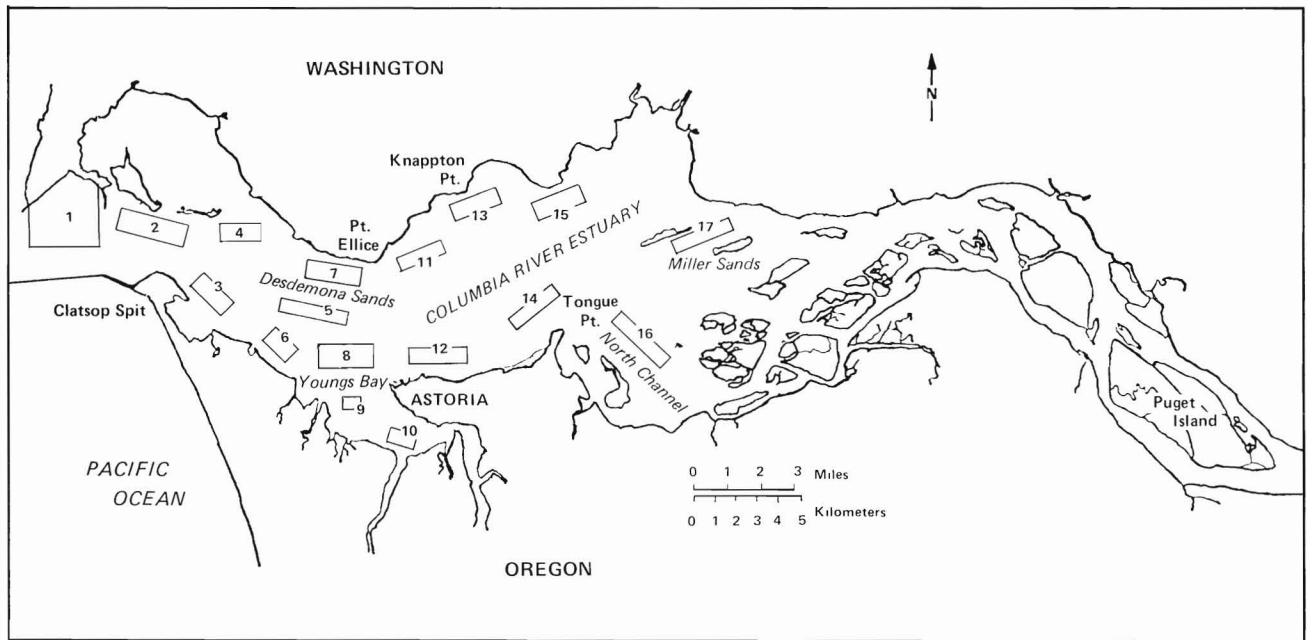


Figure 1.—Locations of the 17 areas in the Columbia River estuary sampled monthly from July 1973 to June 1974 with a 5 m trawl.

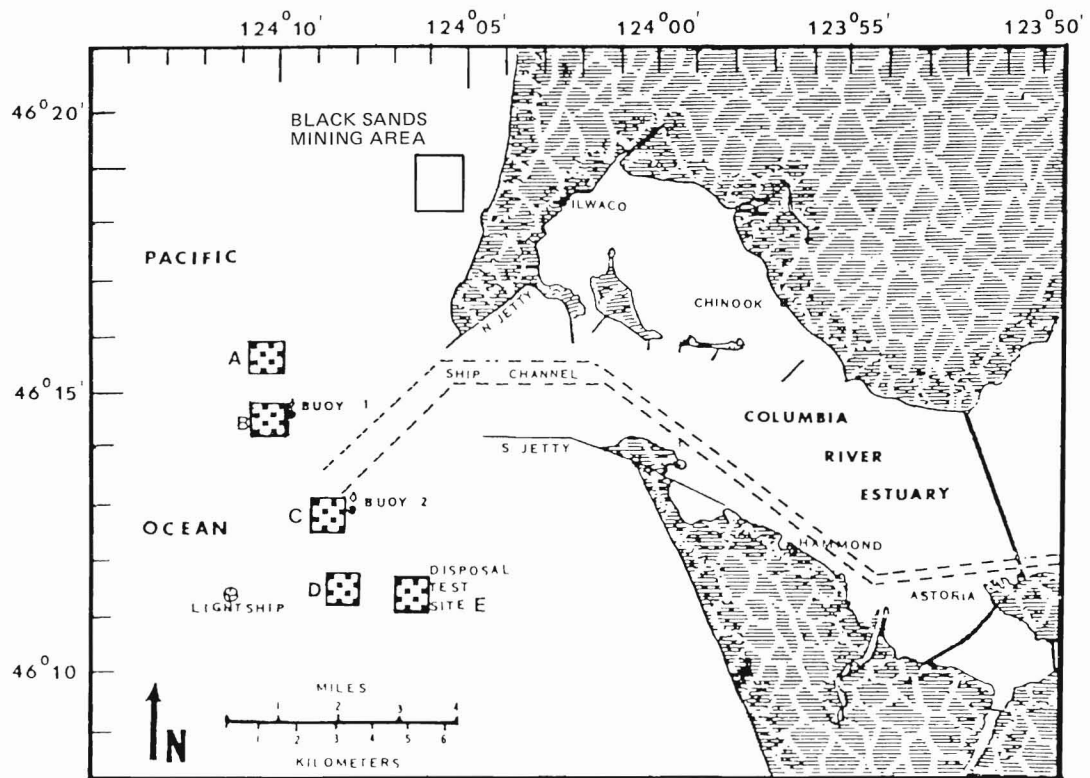


Figure 2.—Locations of five coastal 8 m trawl sites sampled monthly from September 1974 to April 1976 (A-E) and one coastal site (Black Sands Mining Area) sampled bimonthly May 1981 to May 1982.

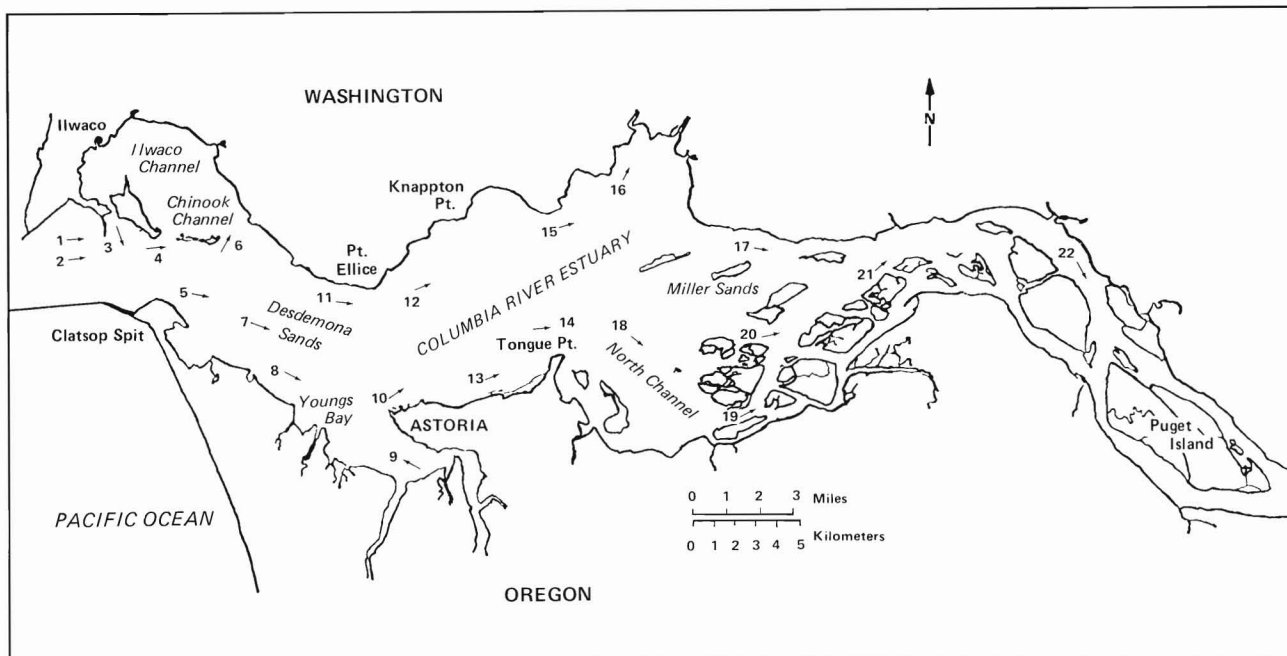


Figure 3.—Locations of 22 stations in the Columbia River estuary sampled monthly from February 1980 through July 1981 with an 8 m trawl.

through July 1981 (after October 1980, not all sites were sampled). An 8 m trawl, the same type as used in the WES Trawl Survey, was towed at each site for 5 minutes.

4) Black Sands Mining Trawl Survey, 1981-82—During this survey, one area in and adjacent to a proposed black sands (magnetite) mining area (Fig. 2) was sampled every 2 months from May 1981 through May 1982, except November 1981 when severe winter weather prevented sampling. The sampling gear and methods were identical to those used during the WES Trawl Survey and CREDDP Trawl Surveys except that a cod-end liner was not used in the trawl for all the sets.

All Dungeness crabs captured during the four surveys were measured anterior to the 10th anteriolateral spines and weighed. When more than 50 crabs were captured in a single tow, a representative subsample of 50 was measured and weighed; the remainder were counted and then weighed as a group.

In this article, carapace width frequency data are reported. Information regarding total catches and sex ratios for the WES Trawl Survey can be found in

Durkin and Lipovsky (1977). Crab information from the other surveys can be obtained from the senior author.

Results and Discussion

Carapace width frequency distributions of captured Dungeness crabs are shown in Figures 4-7. There is wide variation in the width frequency distributions between coastal (Fig. 5, 7) and estuarine (Fig. 4, 6) crab populations. The estuarine population had an abundance of crabs between 50 and 100 mm in width, whereas the coastal crab population had larger and smaller specimens but very few in this size range. Defining age as beginning with metamorphosis from megalops larvae, and using age-width information of Butler (1961) and Armstrong et al.¹, the 50-100 mm sized

crabs were primarily in the 1+ (year) age class.

Dungeness crab recruitment can be highly variable from year to year (Gotshall, 1978; California Department of Fish and Game, 1981); it is possible that the data from 2 years of coastal sampling represent extremely poor years for recruitment of the 1+ age class. We feel this is unlikely since 1977-78 commercial landings, when the 1975 1+ age class would have entered the fishery, were better than average (PMFC, 1983). Two separate ocean surveys providing the same carapace width frequency distributions imply that the absence of 1+ age crab in coastal waters adjacent to the Columbia River is a natural event.

The California Department of Fish and Game (CDFG, 1981) observed that many 0+ age crabs (young-of-the-year) move into the San Francisco Bay complex as a result of prevailing currents and subsequently (after about a year) move back to coastal waters. In the Columbia River, all age groups use the estuary, with the 1+ age class being extremely abundant. At about 2 years of age (100 mm), many crabs apparently migrate to coastal areas, although a few

¹Armstrong, D. A., B. G. Stevens, and J. C. Hoeman. 1981. Distribution and abundance of Dungeness crab and the Crangon shrimp and dredging-related mortality of invertebrates and fish in Grays Harbor, Washington. Unpubl. manuscr., 348 p. School of Fisheries, University of Washington, Seattle, WA 98195. (Prepared for the Washington Department of Fisheries and the U.S. Army Corps of Engineers, Seattle District, under contract DACW67-80-C-0086.)

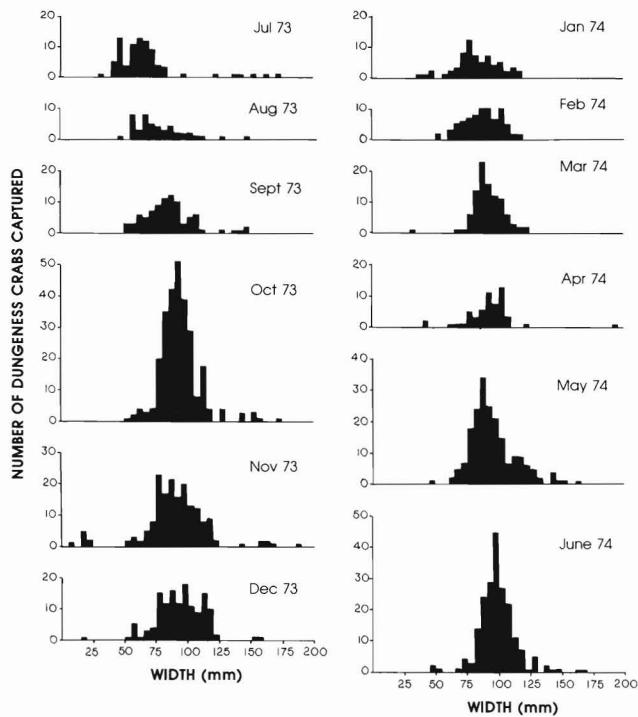


Figure 4.—Width frequency distributions of Dungeness crabs, *Cancer magister*, captured by a 5 m trawl at 17 areas in the Columbia River estuary from July 1973 through June 1974.

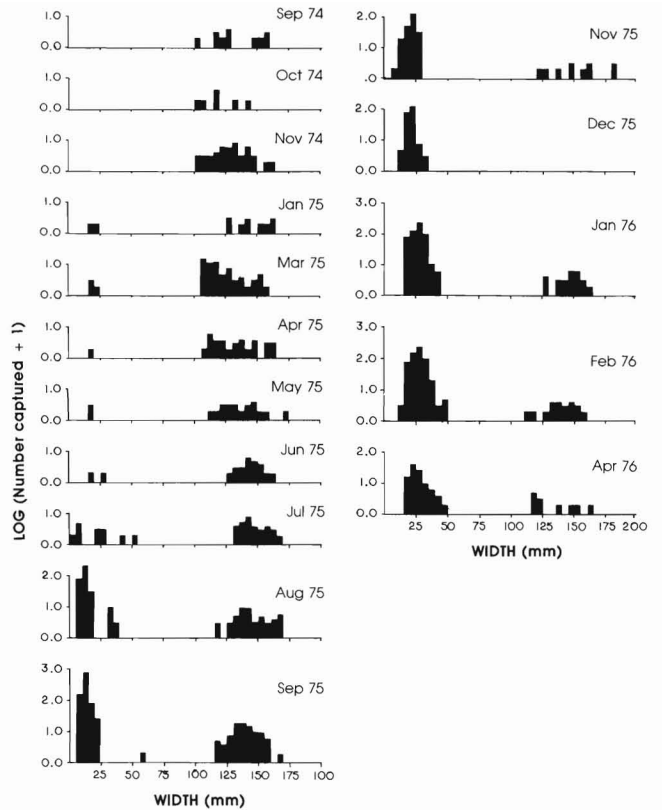


Figure 5.—Width frequency distributions of Dungeness crabs, *Cancer magister*, captured by an 8 m trawl at five coastal sites adjacent to the Columbia River estuary, September 1974 through April 1976.

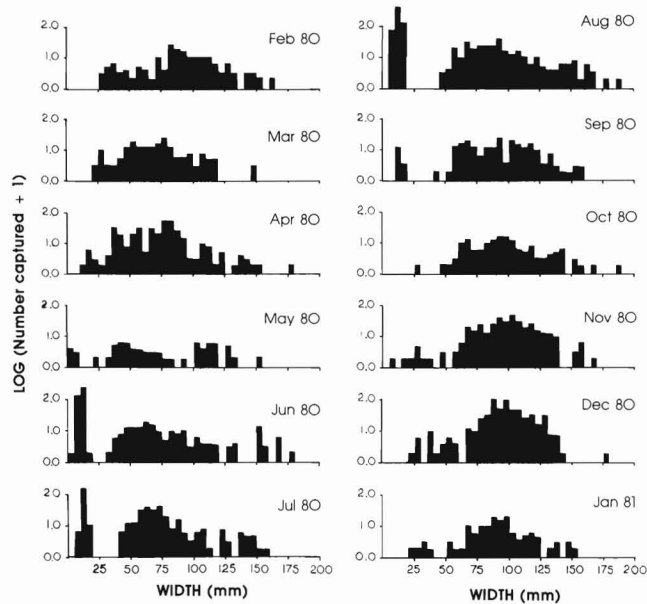


Figure 6.—Width frequency distributions of Dungeness crabs, *Cancer magister*, captured by an 8 m trawl at 22 stations in the Columbia River estuary from February 1980 through January 1981.

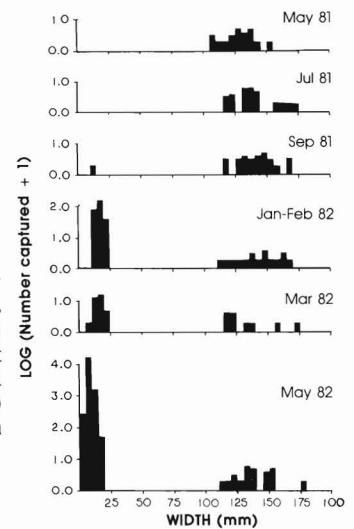


Figure 7.—Width frequency distributions of Dungeness crabs, *Cancer magister*, captured by an 8 m trawl at one coastal site (a proposed magnetite mining area) from May 1981 through May 1982.

remain.

Our data are limited because the coastal surveys were not conducted simultaneously with the estuarine sampling. Also, the coastal surveys only sampled depths from 12.2 to 36.6 m in the vicinity of the mouth of the Columbia River estuary.

Data in this article indicate that the Columbia River estuary is an important nursery area for juvenile crabs, particularly the 1+ age class. Grays Harbor, Wash., (69 km north) has also been shown to be an important nursery area for Dungeness crabs¹, but little information is available concerning other Pacific Northwest estuaries. Crab surveys are needed in other estuaries and in adjacent coastal waters to identify to what extent estuaries are used by juvenile crabs, and if estuarine habitat may be a limiting factor in Dungeness crab abundance.

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