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DISTRIBUTION OF JUVENILE CALIFORNIA HALIBUT (*PARALICHTHYS CALIFORNICUS*) IN BAY AND COASTAL HABITATS OF LOS ANGELES, ORANGE, AND SAN DIEGO COUNTIES IN 1992

FINAL REPORT

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EXECUTIVE SUMMARY

California halibut (*Paralichthys californicus*) is important to the ecology and fisheries of southern California. However, the population of halibut may be threatened by development of embayments used as nursery habitats. Although juvenile halibut are generally most abundant in bays, substantial numbers of transforming (settling) halibut were found along the open coast during surveys in 1988 and 1989. The highest densities of settling individuals along the open coast were in semiprotected areas, particularly in southeastern Santa Monica Bay and in Long Beach Harbor. Because of the general importance of the species and the continuing encroachment of human activities into bays, the Natural Resources Management Research Program, Southern California Edison Company (SCE), is investigating the relative importance of bay and coastal areas as halibut nursery grounds. SCE has used the services of MBC Applied Environmental Sciences to conduct these studies.

Several environmental features of protected and semiprotected habitats may be important to settling halibut, including warmer water temperature, decreased turbulence, finer sediments, and a different associated biota. It is known from laboratory tests that juvenile halibut of different sizes prefer different sediment types. However, the relationship has not been fully confirmed in the field.

The objectives of this study were to describe the distribution of newly settled and larger Age-0 California halibut in selected bay and coastal areas of southern California in 1991, and to describe the relationship of Age-0 halibut densities to sediment type and other physical parameters.

Two bays (Anaheim Bay and Agua Hedionda Lagoon) and five coastal sites (Hermosa Beach, Long Beach, Huntington Beach, San Onofre, and Carlsbad) were sampled. Three depths were sampled at each site: 0.5, 1.0, and 3.0 m in the bays and 6.0, 9.0, and 11.0 m along the coast. Stations were sampled using beam trawls with 2.5 mm mesh netting; a 1.0 m wide trawl was used in bays and a 1.6 m wide trawl on the coast. Three replicate tows were attempted at each station, each replicate consisting of a 10 min tow along an isobath. Surveys were conducted monthly at each site from June to September 1992.

A total of 217 trawl samples was collected, 160 along the coast and 57 in the bays. These obtained a total of 346 California halibut weighing 33.0 kg. Halibut density was 1.4 times higher in bays than on the coast. Among coastal sites, densities were highest at Hermosa Beach and lowest at Huntington Beach; in bays they were highest in Anaheim Bay. Standing crop was 7.7 times greater along the coast than in the bays. The highest standing crop was at Hermosa Beach and the lowest in Agua Hedionda Lagoon.

Coastal settlement of California halibut was higher in 1992 than in 1990 and 1991 but was lower than in 1989; settlement continued to be relatively high in Anaheim Bay in 1992. Settlement was highest in September in 1992 but high densities of 21-100 mm fish at Anaheim Bay and Hermosa Beach suggested that settlement may also have been high prior to the survey.

California halibut collected in this study ranged from 6 to 455 mm in length. The overall modal size class of California halibut was 60 mm; the modal size in bays was

INTRODUCTION

California halibut (*Paralichthys californicus*) is important to the ecology and fisheries of coastal southern California. However, halibut populations may be threatened by the development of embayments which are used as nursery habitats. Until recently, little was known concerning the early life history of California halibut. The high abundance of juveniles in bays has been known for some time (Haaker 1975), as has the scarcity of small juveniles (i.e., <150 mm) in open coastal areas (M. J. Allen 1982, Plummer et al. 1983), but the distribution and biology of newly settled juveniles was not known. Information on juvenile California halibut is rapidly accumulating and many recent studies have addressed settlement patterns and other aspects of the biology of Age-0 California halibut (Lavenberg et al. 1986; Kramer and Hunter 1987; L. G. Allen 1988a; Kramer and Hunter 1988; L. G. Allen et al. 1990; M. J. Allen and Herbinson 1990; Drawbridge 1990; Gadomski et al. 1990; Kicklighter 1990; Kramer 1990a,b; MBC 1990a; Moser and Watson 1990; Kramer 1991; MBC 1991a,b).

Lavenberg et al. (1986) found yolk-sac larvae of California halibut to be most abundant in southern California in winter and spring during 1982-1984, especially off Seal Beach and Playa del Rey. In 1983-1985 L. G. Allen (1988a) found that Age-0 halibut were more abundant at a protected site in Alamitos Bay than at a semiprotected site at Belmont Shores: they were absent at an exposed site off Seal Beach. Comparing settlement in bays and along the coast, Kramer and Hunter (1987, 1988) and Kramer (1990a,b) found almost no coastal settlement of halibut off San Diego County in 1987 but widespread coastal settlement in 1988. Settling halibut were also abundant elsewhere along the coast in 1988; of 16 sites surveyed between San Augustine (Santa Barbara County) and San Mateo Point (Orange County), newly settled halibut were most abundant in southeastern Santa Monica Bay and eastern Long Beach Harbor (L. G. Allen 1988b; L. G. Allen et al. 1990).

In 1989, 1990, and 1991 the Natural Resources Management Research Program of Southern California Edison Company (SCE) funded MBC Applied Environmental Sciences to investigate settlement of California halibut along Los Angeles, Orange, and San Diego Counties (M. J. Allen and Herbinson 1990; MBC 1990a, 1991a,b). Age-0 halibut were most abundant in protected bays, moderately abundant along semiprotected coasts, and least abundant along exposed coasts. Coastal settlement was highest in 1989 and relatively low in 1990 and 1991. Highest coastal settlement occurred in southeastern Santa Monica Bay and Long Beach Harbor in 1989 and at Long Beach in 1990 and 1991. Settlement was relatively high in Anaheim Bay in all three years but decreased in each year.

Several features of protected habitats may be important to settling halibut: warmer temperatures, reduced turbulence, finer sediments, and a different biota. Some studies suggest that settlement of California halibut is independent of temperature between 13 and 25°C (L. G. Allen 1988a; M. J. Allen and Herbinson 1990; MBC 1990a). However, L. G. Allen et al. (1990) found settlement to be positively correlated with temperatures of 13 to 21°C along the coast in 1988 and MBC (1991a) found halibut settlement at 21°C in 1990 but Age-0 halibut decreased rapidly above 22° C (MBC 1991b).

The sediment grain-size regime is closely associated with turbulence and the benthic biota with the sediment regime. Thus, the three features are closely related, with grain size being the most amenable to measurement. In laboratory tests, Drawbridge (1990) found that juvenile California halibut of different sizes preferred different substrate, with newly settled halibut preferring fine sediment, and large halibut preferring sandy sediments. Highest densities of newly settled halibut in the field in 1990 were on sediments of 25% silt/clay (MBC 1991a) but in 1991 a single sample of 55% silt/clay had the highest density (MBC 1991b).

Southeastern Santa Monica Bay and Long Beach Harbor have been identified as coastal nursery sites (M. J. Allen and Herbinson 1990; MBC 1990a; L. G. Allen et al. 1990), but little is known regarding other possible coastal nursery sites along the coast. Kramer (1990a) found survival and some growth of recently settled individuals at Torrey Pines (San Diego County) in 1988, but MBC (1991a) found no settlement there in 1990.

also 60 mm but modal sizes were 10 and 70 mm on the coast. The 60 mm mode represents Age-0 fish.

Newly settled (<21 mm) and Age-0 halibut differed from larger halibut in having a modal density at 15% silt/clay; halibut greater than 100 mm occurred on sandy sediments with 5% silt/clay. However, newly settled halibut were generally found over a similar range of values for other parameters as larger individuals. In contrast, in 1991 newly settled halibut were found primarily on sediments of 55% silt clay. As in 1990 the highest densities of newly settled and Age-0 California halibut occurred in habitats with higher temperatures and oxygen concentrations than did halibut larger than 100 mm.

Although temperatures are generally warmer in the bays than on the coast during the summer, continual temperature records in Anaheim Bay suggest that halibut may experience considerable variation in temperature in bays (16-23°C during the summer); most temperature variation follows a biweekly cycle rather than a diel cycle. It is not known whether halibut experience this full range of variation or select locations which allow them to live at a more constant temperature.

Water temperatures were warmer along the coast in June and July than in most previous surveys but were warmer in August and September. It has suggested that higher halibut settlement occurs in years with cooler water temperatures. The combination of warm water temperatures and low coastal settlement in 1990 and 1991 appear to substantiate this observation. Higher settlement in 1992 may be related to the cooler months of June and July than to the warm temperatures of the months when settlement did occur.

The higher densities of the 10-, 60-, and 70-mm modes in this survey suggests that more 200-mm halibut should be expected along the coast in 1992 than in 1990 or 1992.