
Atlas 35: Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson, S. R. Charter, and E. M. Sandknop. Distributional atlas of fish larvae and eggs from Manta (surface) samples collected on CalCOFI surveys from 1977 to 2000. Published May 2002.

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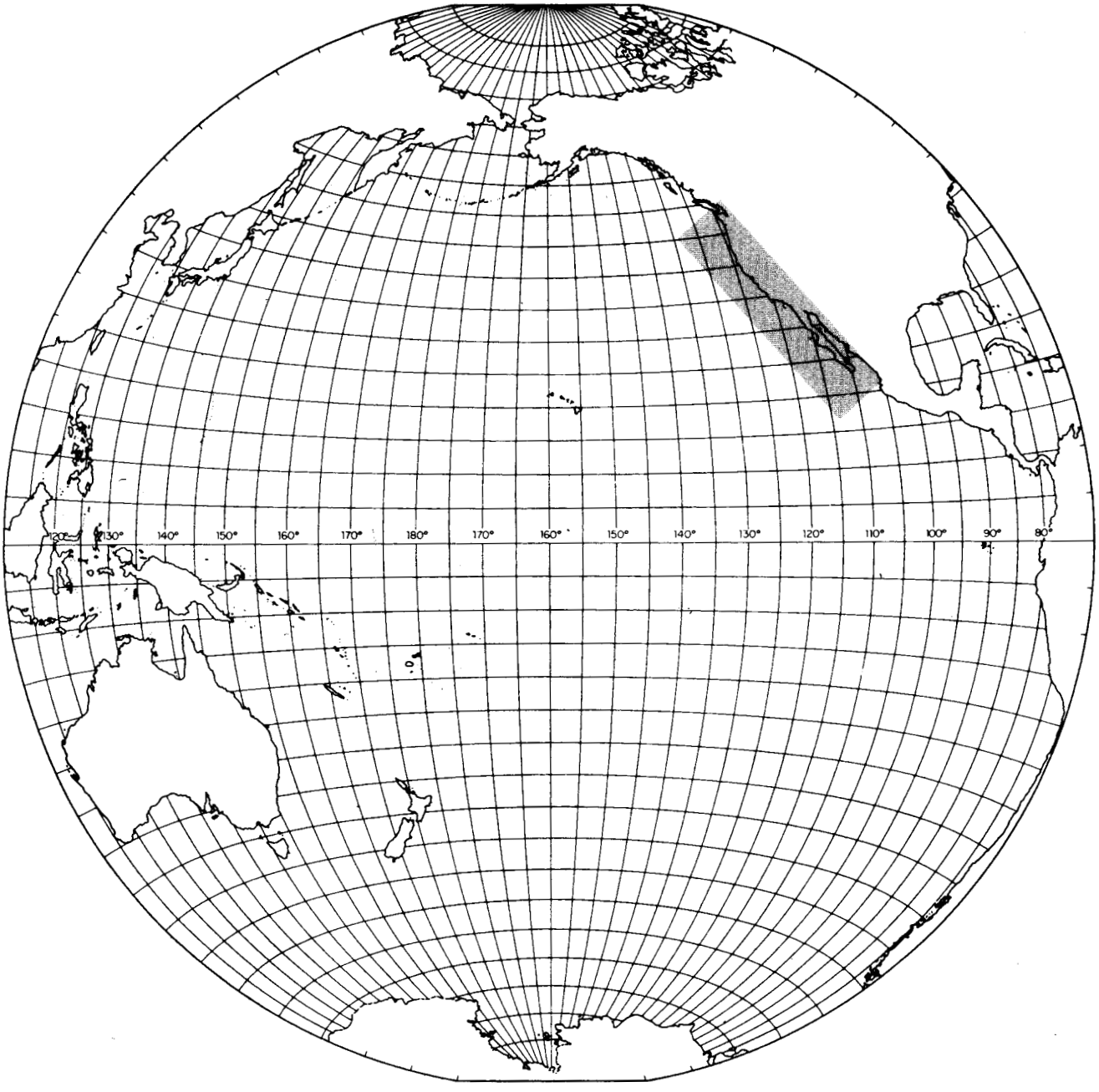
References to the data, published in annual ichthyoplankton data reports are given in the introduction to the Atlas. In addition, these data are available in PDF format on the SWFSC web site at http://swfsc.noaa.gov/publications/swcpub/qryPublications.asp, enter "ichthyoplankton" in the Subject line and "California Cooperative Oceanic Fisheries Investigations" in the Title line. Checking the ALL YEARS button will produce the entire list of available data.

The report for each year usually is published about 7-9 months after the fall cruise, and includes notes about nomenclature changes, etc. The ultimate goal is to update the old ichthyoplankton identifications to current standards; the database is updated as re-identifications for each cruise are completed.




# CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

ATLAS No. 35

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# *Atlas No. 35*

*Cooperating Agencies*:
CALIFORNIA DEPARTMENT OF FISH AND GAME
NATIONAL OCEANOGRAPHIC AND ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICE
UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

MAY, 2002

## THE CALCOFI ATLAS SERIES

This is the thirty-fifth in a series of atlases containing data on the hydrography and plankton from the region of the California Current. The field work was carried out by the California Cooperative Oceanic Fisheries Investigations[1], a program sponsored by the following agencies:

California Department of Fish and Game
National Oceanic and Atmospheric Administration, National Marine Fisheries Service
University of California, Scripps Institution of Oceanography

CalCOFI atlases[2] are issued as individual units as they become available. They provide processed physical, chemical, and biological measurements of the California Current region. Each number may contain one or more contributions. A general description of the CalCOFI program with its objectives appears in the preface of Atlas No. 2.



CalCOFI atlases in this series, through May 2000 are:

No. 1. Anonymous. 1963. CalCOFI atlas of 10-meter temperatures and salinities 1949–1959.
No. 2. Fleminger, A. 1964. Distributional atlas of calanoid copepods in the California Current region, Part I.
No. 3. Alvariño, A. 1965. Distributional atlas of Chaetognatha in the California Current region.
No. 4. Wyllie, J. G. 1966. Geostrophic flow of the California Current at the surface and at 200 meters.
No. 5. Brinton, E. 1967. Distributional atlas of Euphausiacea (Crustacea) in the California Current region , Part I.
No. 6. McGowan, J. A. 1967. Distributional atlas of pelagic molluscs in the California Current region.
No. 7. Fleminger, A. 1967. Distributional atlas of calanoid copepods in the California Current region, Part II.
No. 8. Berner, L. D. 1967. Distributional atlas of Thaliacea in the California Current region.
No. 9. Kramer, D. and E. H. Ahlstrom. 1968. Distributional atlas of fish larvae in the California Current region: northern anchovy, *Engraulis mordax* (Girard), 1951–1965.
No. 10. Isaacs, J. D., A. Fleminger, and J. K. Miller. 1969. Distributional atlas of zooplankton biomass in the California Current region: Spring and Fall, 1955–1959.
No. 11. Ahlstrom, E. H. 1969. Distributional atlas of fish larvae in the California Current region: jack mackerel, *Trachurus symmetricus*, and Pacific hake, *Merluccius productus*, 1951–1959.
No. 12. Kramer, D. 1970. Distributional atlas of fish eggs and larvae in the California Current region: Pacific sardine, *Sardinops caerulea* (Girard), 1951–1966.
No. 13. Smith, P. E. 1971. Distributional atlas of zooplankton volume in the California Current region, 1951–1966.
No. 14. Isaacs, J. D., A. Fleminger, and J. K. Miller. 1971. Distributional atlas of zooplankton biomass in the California Current region: Winter, 1955–1959.

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[1] Usually abbreviated CalCOFI, sometimes CALCOFI

[2] For citation this issue in the series should be referred to as CalCOFI Atlas No. 35. Library of Congress Catalog Card Number 67-4236.

No. 15. Wyllie, J. G. and R. J. Lynn. 1971. Distribution of temperature and salinity at 10 meters, 1960–1969 and mean temperature, salinity and oxygen at 150 meters, 1950–1968 in the California Current.

No. 16. Crowe, F. J. and R. A. Schwartzlose. 1972. Release and recovery records of drift bottles in the California Current region, 1955–1971.

No. 17. Ahlstrom, E. H. 1972. Distributional atlas of fish larvae in the California Current region: six common mesopelagic species –*Vinciguerria lucetia*, *Triphoturus mexicanus*, *Stenobrachius leucopsarus*, *Leuroglossus stilbius*, *Bathylagus wesethi*, and *Bathylagus ochotensis*, 1955–1960.

No. 18. Brinton, E. 1973. Distributional atlas of Euphausiacea (Crustacea) in the California Current region, Part II.

No. 19. Bowman, T. E. and M. W. Johnson. 1973. Distributional atlas of calanoid copepods in the California Current region, 1949 and 1950.

No. 20. Thomas, W. H. and D. L. R. Seibert. 1974. Distribution of nitrate, nitrite, phosphate, and silicate in the California Current region, 1969.
Owen, R. W., Jr. 1974. Distribution of primary production, plant pigments and Secchi depth in the California Current region, 1969.
Smith, P. E. 1974. Distribution of zooplankton volumes in the California Current region, 1969.

No. 21. Fleminger, A., J. D. Isaacs, and J. G. Wyllie. 1974. Zooplankton biomass measurements from CalCOFI cruises of July 1955 to 1959 and remarks on comparison with results from October, January, and April cruises of 1955 to 1959.

No. 22. Namias, J. 1975. Northern hemisphere seasonal sea level pressure and anomaly charts, 1947–1974.

No. 23. Ahlstrom, E. H. and H. G. Moser. 1975. Distributional atlas of fish larvae in the California current region: flatfishes, 1955–1960.

No. 24. Brinton, E. and J. G. Wyllie. 1976. Distributional atlas of euphausiid growth stages off southern California, 1953–1956.

No. 25. Eber, L. E. 1977. Contoured depth-time charts (0 to 200 m, 1950–1966) of temperature, salinity, oxygen and sigma-t at 23 CalCOFI stations in the California Current.

No. 26. Ahlstrom, E. H., H. G. Moser, and E. M. Sandknop. 1978. Distributional atlas of fish larvae in the California Current region: rockfishes, *Sebastes* spp., 1950–1975.

No. 27. Namias, J. 1979. Northern hemisphere seasonal 700 mb height and anomaly charts, 1947–1978, and associated North Pacific sea surface temperature anomalies.

No. 28. Hewitt, R. 1980. Distributional atlas of fish larvae in the California Current region: northern anchovy, *Engraulis mordax* (Girard), 1966–1979.

No. 29. Namias, J. 1981. Teleconnections of 700 mb height anomalies for the northern hemisphere.

No. 30. Lynn, R. J., K. A. Bliss, and L. E. Eber. 1982. Vertical and horizontal distributions of seasonal mean temperature, salinity, sigma-t, stability, dynamic height, oxygen, and oxygen saturation in the California Current, 1950–1978.

No. 31. Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, S. R. Charter, C. A. Meyer, E. M. Sandknop, and W. Watson. 1993. Distributional atlas of fish larvae and eggs in the California Current region: taxa with 1000 or more total larvae, 1951–1984.

No. 32. Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, S. R. Charter, C. A. Meyer, E. M. Sandknop, and W. Watson. 1994. Distributional atlas of fish larvae in the California Current region: taxa with less than 1000 total larvae, 1951–1984.

No. 33. Moser, H. G. (ed.). 1996. The early stages of fishes in the California Current region.

No. 34. Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson, S. R. Charter, and E. M. Sandknop. 2001. Distributional atlas of fish larvae and eggs in the Southern California Bight region: 1951–1998.

No. 35. Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson, S. R. Charter, and E. M. Sandknop. 2002. Distributional atlas of fish larvae and eggs from Manta (surface) samples collected on CalCOFI surveys from 1977 to 2000.

# DISTRIBUTIONAL ATLAS OF FISH LARVAE AND EGGS FROM MANTA (SURFACE) SAMPLES COLLECTED ON CALCOFI SURVEYS FROM 1977 TO 2000

**Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, W. Watson, S. R. Charter, and E. M. Sandknop**

**CalCOFI ATLAS NO. 35**

Kevin T. Hill, CalCOFI Coordinator
California Department of Fish and Game
Southwest Fisheries Science Center
8604 La Jolla Shores Drive
La Jolla, CA 92037-1508

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## Introduction

Surface waters are inhabited by the early life stages and adults of a large array of fish species. Eggs and larvae of some species occur throughout the upper water column whereas those of others are found exclusively in surface waters and have evolved special adaptations for life in that zone (Zaitsev 1970; Hempel and Weichert 1972; Moser 1981). An early survey (Ahlstrom and Stevens 1976) in the northeast Pacific (20°–48° N, seaward to 148°W), employing a neuston[4] net, provided initial information on the distribution and abundance of surface-living ichthyoplankton in this region. Gruber et al. (1982) used a neuston net of the same design to sample ichthyoplankton in a two-year study in the Southern California Bight (SCB). These early studies provided useful information; however, the volume of water filtered by the nets could not be measured, thus the catches could not be standardized. Doyle (1992a, b), used a quantitative surface sampler (Sameoto and Jaroszynski 1969) in a study of the distribution and abundance of ichthyoplankton off northern California, Oregon, and Washington. The Manta net (Brown and Cheng 1981) was used to sample surface ichthyoplankton in a number of site-intensive studies off the southern California coast (Brewer et al. 1981; Schlotterbeck and Connally 1982; Barnett et al. 1984; Moser and Pommeranz 1999).

This atlas summarizes the spatial and temporal distribution and abundance of 93 ichthyoplankton taxa or categories collected in Manta net tows on CalCOFI biological-oceanographic survey cruises from December, 1977 to October, 2000. CalCOFI Atlases 31 and 32 presented distributional

[3]Southwest Fisheries Science Center, National Marine Fisheries Service, La Jolla, California

[4]Usage of the term "neuston" for surface-living marine organisms is controversial because it was applied originally to organisms associated with the surface film in freshwater habitats (Naumann 1917). Banse (1975) reviewed in detail the evolution of the usage of this term, a related term, "pleuston", and the various subdivisions of each. Neuston is now used by most workers in referring to the uppermost (upper ~10–20 cm) layer of the sea and to the assemblage of organisms that lives in that zone, either permanently or facultatively (Zaitsev 1970; Hempel and Weikert 1972; Peres 1982; Doyle 1992b). We accept this definition and use it interchangeably with the more general term "surface" (e.g., surface waters, surface zone, surface tow, surface assemblage). The net used by Ahlstrom and Stevens (1976) consisted of a rectangular frame, modified from 1-m ring net frame, with styrofoam floats attached inside the ends. The netting was identical to that used in a standard CalCOFI 1-m ring net with 0.505 mm mesh. There was no flow meter attached to the net frame, which was partially out of the water during the tow.

summaries for all taxa taken in oblique tows on surveys that covered the greater CalCOFI sampling area (Figure 1) extending from northern California to Cabo San Lucas, Mexico during 1951–84. Since 1985, CalCOFI surveys have been conducted on a quarterly basis over a sampling grid consisting of 66 standard stations in the SCB region (Figure 2). CalCOFI Atlas 34 summarized distributions and abundances of fish eggs and larvae taken in oblique tows from 1951 to 1998 in the area defined by the present survey pattern. Surface sampling with the Manta net was initiated during the 1977-78 survey. Manta tows were taken on some (~40%) of the total net tow stations during 1977-78 because surface tows were not yet part of the standard station protocol. On subsequent surveys Manta tows were taken on most net tow stations (86–88% of the stations during surveys in 1980–85, 92% during 1986–87, and >97% during1988–2000).

A data base for ichthyoplankton and station data for all Manta tows taken on 19 CalCOFI surveys from 1977 to 2000 has been established. A data report for the 1977-78 survey is published (Moser et al. 2001b) and the remaining reports are in press (Table 1).

The California Current region is one of the most oceanographically and zoogeographically complex regions in the world ocean. The CalCOFI sampling grid overlays the California Current, three coastal zoogeographic provinces (Oregonian, San Diegan, and Panamic), a coastal upwelling zone, and three oceanic water masses (Subarctic, Pacific Central, and equatorial water of the eastern tropical Pacific) (Moser 1996; Moser et al. 2001a). These water masses converge in the SCB region where complexity is heightened by a field of mesoscale eddies that extends from the inner margin of the California Current into the Bight, an undercurrent flowing poleward along the slope, a poleward flowing inshore countercurrent, and a persistent frontal zone (Ensenada Front) at the southwest corner of the Bight (Lynn and Simpson 1987; Haury et al. 1993). The inner third of the present CalCOFI survey pattern overlies the continental borderland off southern California, a region of complex topography that includes the mainland continental shelf and slope, ~13 deep-water basins, and numerous islands and banks and their shelves. The islands and banks extend coastal habitats >100 n.m. offshore and the basins provide deep-water habitats and zoogeographic refugia for a wealth of midwater species (Moser et al. 2001a).

The cyclic warming and cooling of equatorial waters, known as the El Niño/Southern Oscillation (ENSO), has produced a series of El Niños (1957–58, 1963, 1982–83, 1992–93, and 1997) and La Niñas (1954–56, 1988–89, 1998–99) in the California Current region. ENSO episodes are embedded in a low frequency oscillation in the North Pacific, the Pacific Decadal Oscillation (PDO), that is related to basin scale changes in atmospheric pressure, particularly the intensification and position of the Aleutian Low Pressure System (Mantua et al.1997; Hollowed et al. 1998; Schwing et al., in press.). The resulting 20–30 year cooling and warming cycle produced two cool ocean regimes (1900–24 and 1947–76) and two warm regimes (1925–46 and 1977–present?) during the past century. Some investigators (e.g., Minobe 2000; Schwing and Moore 2000) have suggested that the 1998–99 La Niña may have marked a shift from a warm to a cool regime in the northeast Pacific. Recently, Hare and Mantua (2000) hypothesized another regime shift in 1989. They found that the biological signals associated with this shift were much clearer than the physical climate indices and that the shift did not result in a return to pre-1977 ocean conditions. Among the apparent biological consequences of these regime shifts are basin-wide changes in primary and secondary production and in the abundance of eastern Pacific fish stocks. Production in the California Current region decreased dramatically after the regime shift of 1977 (Brodeur and Ware 1992; Roemmich and McGowan 1995a, b; Ware 1995; Hayward 1997; McGowan et al. 1998) as did groundfish and salmon stocks (Francis and Hare 1994; Mantua et al. 1997; Francis et al.1998; Hollowed et al. 1998). Major shifts occurred in the distributions of larval fishes in response to ENSO events and the PDO, as the boundaries between Subarctic and Equatorial water masses shifted latitudinally and intrusion of the Central Water Mass into the SCB region waxed and waned (Moser et. al. 1987, 2001a; Smith and Moser 1988). The time series for surface-caught fish larvae represents primarily the warm ocean regime

initiated in 1977; however, it spans the regime shifts hypothesized for 1988–89 and 1998–99 and includes El Niño events in 1982-83, 1992–93, and 1997 and La Niña events in 1988 and 1998–99. In the SCB region the long-term trend of increasing surface temperatures during the warm regime was punctuated by episodic increases and decreases during El Niño and La Niña events, respectively (Figure 3A). The trend for zooplankton volumes during this period was opposite to temperature, with short-term increases during La Niña episodes (Figure 3A). During this period the average seasonal temperature range was ~ 4.5°C, with a March minimum and a September maximum (Figure 3B). Maximum zooplankton volume preceded the temperature peak by 3–4 months with highest values in May-June (Figure 3B). Average temperatures in the borderland region of the CalCOFI survey pattern generally were slightly lower than in the offshore region, except during 1981 and 1984 when they were ~ 0.5–1.0 °C higher (Figure 3C). Average borderland surface temperatures were lower than offshore during the first five months of the year, became slightly higher during June and August, and were lower during October and November (Figure 3D). Zooplankton volumes in the borderland region were consistently slightly higher than in offshore waters during most years (Figure 3E) and during most months (Figure 3F). The seasonal peaks differed by one month between the two regions, with the maximum in May in the borderland and in June in offshore waters (Figure 3F). The information in this atlas is presented in a format that permits the reader to interpret, in general terms, the affects that high and low frequency changes in ocean conditions may have had on larval fish populations inhabiting surface waters of the SCB region from December 1977 to October 2000.

The primary time series for this atlas is composed of 4,704 net tows taken during 1977–2000 within the boundaries of the present CalCOFI survey (Tables 2 and 3). These include all standard CalCOFI survey Manta tows taken since 1985 when occupancy of the present pattern was initiated. On surveys prior to 1985 in the Southern California Bight nearshore stations did not always correspond to the exact positions of the 66 nominal stations used on surveys since 1985. In order to expedite the construction of the distribution maps, data for stations other than the nominal stations of the present pattern were assigned to the closest of the 66 nominal stations (Table 3). Maps and graphs summarizing seasonal and annual occurrence and abundance in the SCB region from 1977 to 2000 are based on the part of the time series defined by the present survey pattern. Tows prior to 1985 are a subset from the wider-ranging CalCOFI surveys (Hewitt 1988; Moser et al. 1993, 1994). An additional 1,415 tows taken north and south of the present survey area during 1977-78, 1980-81, and 1984 were used in the preparation of broad-scale maps that show the overall distribution and abundance of taxa taken in Manta tows on CalCOFI surveys.

Surface tows were made with a modified version of the Manta net originally designed by Brown and Cheng (1981). It consists of a rectangular mouth 15.5 cm deep and 86 cm wide attached to a frame that supports square lateral extensions covered with plywood and urethane foam (Figure 4). These extensions stabilize the net when it is towed and keep the top of the net at the sea surface. The net is constructed of 0.505 mm nylon mesh. The towing bridle is asymmetrical with one side longer than the other; when the net is towed this bridle arrangement forces the mouth away from the ship at a slight angle. A General Oceanics flowmeter is suspended across the center of the net mouth to measure the amount of water filtered during each tow. At each Manta tow station the tow line from the bridle is attached to the hydrographic wire and then lowered to slightly below the surface of the water before the net is deployed. The net is towed at a ship speed of 1.0–2.0 knots. In 1977-78 tow duration was 3 minutes; in subsequent survey years the towing time for each tow was 15 min. Procedures for sample handling and preservation were the same as those used for samples from oblique net tows (Kramer et al. 1972).

All taxa from the part of the CalCOFI time series used in this atlas are listed in rank order of abundance (raw larval count) summed for all occurrences (Table 4) and in rank order of total occurrences (Table 5). These tables include 188 total larval taxa (including the unidentified and disintegrated categories). Distributional summaries are presented for the larval fish taxa that had ~10 or

more total larvae and also for five other categories: total fish larvae, total fish eggs, and the eggs of northern anchovy *Engraulis mordax*, Pacific sardine *Sardinops sagax,* and Pacific saury *Cololabis saira.* These summaries were not produced for some higher taxonomic categories (genera, families, orders) that contained >10 total larvae (Table 4) because their distributions were better represented in analyses of component taxa. In one case, *Sebastolobus altivelis* and *Sebastolobus* spp. were combined in order to show the distribution and abundance of the genus.

Since 1951, fish larvae in CalCOFI samples have been identified to species or to the lowest taxon that knowledge and specimen condition permitted. The number of identifiable taxa increased with the improvement of taxonomic knowledge and competency. Historical identifications were evaluated thoroughly during the development of the CalCOFI ichthyoplankton computer data base in 1984–88 and historical advances in the identification process were standardized at approximately decadal intervals. Our ability to identify larvae in the California Current region improved greatly during 1988–95 as a result of taxonomic research that culminated in a taxonomic monograph on the ontogenetic stages of fishes of this region (Moser 1996). This resulted in a ~ 60% increase in the number of identifiable taxa beginning in 1985. These changes are documented in previous CalCOFI ichthyoplankton data reports and atlases; the following interpretive notes and caveats are pertinent to this atlas:

*Ceratoscopelus townsendi* – *Ceratoscopelus* larvae in the CalCOFI sampling region are *C. townsendi*, a species associated with the California Current; at the western margin of the California Current (approx. westward of station 200), *C. townsendi* is replaced by the tropical-subtropical cosmopolite, *C. warmingii* (Wisner 1976; Butler et al. 1997); larvae of the two species are not distinguishable.

*Cheilopogon* spp. – small damaged specimens that could not be identified to species; most, perhaps all, are *C. heterurus* or *C. pinnatibarbatus*.

*Diaphus* spp. – *Diaphus theta* is the dominant *Diaphus* species in the survey area and most, if not all, of the larvae from the SCB region are this species; the generic category is used because a small proportion of the *Diaphus* larvae captured at the outer margin of the survey pattern may represent other species whose larvae are identical to those of *D. theta.*

Disintegrated fish larvae – larvae that could not be identified because of their poor condition; separated from the "unidentified" category to monitor the general condition of the ichthyoplankton samples through the time series.

*Nannobrachium* spp. – most of the larvae in this category are small (< 5 mm), often poorly preserved specimens of this genus, recently separated from *Lampanyctus* by Zahuranec (2000) on the basis of small or absent pectoral fins in adults; two *Nannobrachium* species, *N. ritteri* (formerly *L. ritteri*) and *N. regale* (formerly *L. regalis*), occur commonly in the present CalCOFI survey pattern; larvae of these species > ~ 5 mm have been identified since 1954 and were referred to the genus *Lampanyctus* in CalCOFI Atlases 31 and 32; adults of *Nannobrachium* species are much more common than those of *Lampanyctus* in the present CalCOFI survey pattern, however, in samples from the subtropical-tropical eastern Pacific the opposite may be true.

*Parophrys vetulus*–Sakamoto (1984) changed pleuronectid generic designations for some of the species in the CalCOFI area, including *Parophrys vetulus*, which was transferred into *Pleuronectes*; although these changes were incorporated in the lists of Robins et al. (1991) and Eschmeyer (1998) we follow Nelson (1994) in retaining the older nomenclature because Sakamoto's (1984) changes were based on a phenetic study; also, the older names are used in the major identification guides to fishes of our region (Miller and Lea 1972, Eschmeyer et al. 1983, Matarese et al. 1989, and Moser 1996).

Unidentified fish larvae–larvae that were generally in good condition but could not be identified because of their small size or early stage of development.

*Vinciguerria lucetia–V. lucetia*, an eastern tropical Pacific species, is common in the present CalCOFI region whereas the central water mass species *V. poweriae* is rarely encountered; a small percentage of *V. poweriae* larvae may have been included in the *V. lucetia* category because of the difficulty in separating early larvae of the two species.

**Relative Abundance: Manta vs. Oblique**

Northern anchovy was the most abundant taxon in both the Manta and the oblique time series during 1977-2000 in the present survey area (Table 6), accounting for 64.6% of the total larvae in Manta samples and for 43.2% of the total in oblique samples. Other species that were represented in relatively large numbers in Manta samples were poorly sampled by oblique net tows. For example, Pacific saury ranked third in total count in Manta samples but only 87$^{th}$ in oblique samples. Mussel blenny *Hypsoblennius jenkinsi* ranked fourth in total count in Manta samples and 71$^{st}$ in oblique samples; its congener, *H. gilberti*, ranked 18$^{th}$ in Manta samples and 193$^{rd}$ in oblique samples. Jacksmelt *Atherinopsis californiensis* and grunion *Leuresthes tenuis* ranked 10$^{th}$ and 13$^{th}$ in Manta catches but only 162$^{nd}$ and 215$^{th}$, respectively, in oblique catches. This also was true for some commercially important species such as kelp greenling *Hexagrammos decagrammus* and cabezon *Scorpaenichthys marmoratus*, which ranked 8$^{th}$ and 11$^{th}$ in Manta samples but only 197$^{th}$ and 105$^{th}$, respectively in oblique samples. Three flyingfish categories (Family Exocoetidae) were captured in moderate numbers by Manta nets but were not taken at all in oblique tows (Table 6). Some taxa that were relatively abundant in oblique samples were rare in Manta catches. For example, the blacksmelt (Bathylagidae) species, *Leuroglossus stilbius*, *Bathylagus ochotensis*, and *B. wesethi*, have relatively deep-living larvae (Ahlstrom 1959; Moser and Smith 1993), and ranked 5$^{th}$, 8$^{th}$, and 11$^{th}$, respectively, in oblique samples but ranked 81$^{st}$, 70$^{th}$, and 112$^{th}$, in Manta samples. Other examples are the myctophids *Protomyctophum crockeri* and *Diogenichthys atlanticus*, which ranked 12$^{th}$ and 17$^{th}$, respectively, in oblique samples but ranked 84$^{th}$ and 81$^{st}$ in Manta net catches during 1977–2000. Comparison of catches from the two types of tows emphasizes the importance of taking surface tows as well as integrated tows, particularly for sampling obligate neustonic larvae of heavily impacted nearshore fishes such as cabezon, greenlings, and lingcod (*Ophiodon elongatus*).

**Larval Fish Assemblages**

A robust method of revealing assemblages of organisms is to examine their degree of co-occurrence. Recurrent group analysis (Fager 1957, 1963) defines groups of taxa that occur together frequently and thus share a common environment. Two procedures are used: first an index of affinity (program name AFFINITY) is calculated for each pair of taxa that ever occur together and then taxa are formed into groups (program name REGROUP) using a chosen minimum affinity index (0.2 in this study). The category "group member" is supplemented by the term "associate" for taxa that have significant affinity indices with one or more but not all members in one or more of the groups. Previous recurrent group analyses of the CalCOFI icthyoplankton time series (Moser et al. 1987; Moser and Smith 1993) have defined larval fish assemblages from oblique tows taken over the extended CalCOFI survey pattern from 1951–84. A recurrent group analysis of neuston and oblique ichthyoplankton samples from 17 stations within the continental borderland of the SCB during 1974–76 revealed two neustonic recurrent groups (Gruber et al. 1982). Group 1 consisted of northern anchovy, the rockfish genus *Sebastes*, and white croaker *Genyonemus lineatus*, with the blenny genus *Hypsoblennius*, the silversides family Atherinidae, and kelp greenling as associates, and Group 2 contained Pacific saury and the flyingfish family Exocoetidae (Gruber et al. 1982). Our analysis of 4,704 net tows taken during 1977–2000 within the boundaries of the present CalCOFI survey pattern, extending seaward to a maximum of ~ 376 n. mi. revealed four neustonic recurrent groups (Figure 5A; Table 7). One group, consisting of northern anchovy, *Sebastes* spp., and cabezon, had Pacific sardine as an associate and was weakly connected to another three-member group consisting of Pacific barracuda *Sphyraena argentea*, mussel blenny, and blacksmith *Chromis punctipinnis*. The latter group had the kelp and sandbass genus *Paralabrax* and chub mackerel *Scomber japonicus* as associates

(Figure 5A; Table 7). The other two groups each contained two members and lacked connections with each other or with the three-member groups. Panama lightfish *Vinciguerria lucetia* and dogtooth lampfish *Ceratoscopelus townsendi* comprised one group and the other consisted of two haemulids, sargo *Anisotremus davidsoni* and salema *Xenistius californiensis*, with garibaldi *Hypsypops rubicundus* as an associate. Only two taxa, cabezon and mussel blenny, in the neustonic recurrent groups are neuston obligates; the others have relatively shallow distributions or, in the case of multiple-species taxa (e.g., *Sebastes*), include species with shallow distributions.

The recurrent group assemblage structure for the oblique samples from the same part of the time series was considerably more complex, consisting of two large groups representing the "northern" and "southern" complexes of Moser et al. (1987) and Moser and Smith (1993) (Figure 5B; Table 8). The eight-member southern complex group (Oblique Group 2) is a mix of species from several of the southern complex groups described by Moser et al. (1987) and has 11 southern-complex associate taxa. The six-member northern complex group (Oblique Group 1) contains two species (*E. mordax* and *Sebastes* spp.) in common with one of the neustonic groups and is strongly interconnected to a group (Oblique Group 3) composed of three northern complex midwater species (Figure 5B). Oblique Group 3 also is strongly connected to the 11-member southern complex group. Associate taxa to the three-member group are two rockfish species, Pacific sardine, and jack mackerel. The remaining two groups, each with two members, contain shorefish of the San Diegan province and lack critical affinities with the other recurrent groups and with each other (Figure 5B; Table 8).

**Length Frequencies**

Neuston nets tend to capture relatively larger larvae (both average and maximum lengths) within a given taxon, compared to oblique nets (Moser 1981; Doyle 1992b). Obligate neustonic species generally hatch from large eggs that produce relatively large larvae. This is true for demersal spawners (e.g., cabezon and other cottids, hexagrammids), pelagic spawners (e.g., sablefish), and species that attach their eggs to flotsam (e.g., sauries, flyingfishes). For facultative taxa the larger sizes may indicate movement of larger larvae to surface waters during ontogeny or may reflect diel movements. Hunter and Sanchez (1976) suggested that northern anchovy larvae swim to the surface at night, fill their gas bladders with air, and remain suspended near the surface during non-feeding hours as an energy conservation mechanism. Another possibility for the presence of larger larvae in neuston samples may be related to the fact that the upper escape plane is eliminated in a surface tow, thus limiting the avoidance options for a larva trying to escape capture.

In the CalCOFI time series, body lengths are measured for five species during the sorting and identification processes. Of these species, northern anchovy shows the largest disparity in length frequencies between Manta and oblique catches (Figure 6A). In oblique samples, the peak is at ~ 3–4 mm whereas it is at ~ 10 mm in neuston samples, the length which Hunter and Sanchez (1976) proposed for migration to the surface. In Pacific sardine, peak lengths are at ~ 5–6 mm for both surface and oblique nets; however, the length frequency curve declines abruptly in oblique samples whereas relatively large numbers of larvae are present in the neuston in length classes up to 20 mm (Figure 6B). Sardine larvae, like anchovy, are physostomous and may undergo a diel migration similar to that suggested for northern anchovy. Length distributions of the other measured species are less disparate for the two samplers. In chub mackerel (Figure 6C), the peak length in Manta catches is ~ 1 mm larger than in oblique net catches (3–4 mm vs. 4–5 mm); otherwise the length frequency curves are similar. In jack mackerel the curves are similar with slightly larger larvae in Manta catches (Figure 6D). Pacific hake samples are dominated by small size classes and average larval lengths of oblique net catches are slightly larger than those from Manta nets (Figure 6E) (Moser et al. 1997).

**Explanation of Charts and Graphs**

The distributions are summarized in a series of maps and graphs, one page per taxon. Abundance of

larvae or eggs is expressed as the number per 100 $m^3$ of water filtered or as the raw count when appropriate. Occurrence is expressed as the proportion of positive tows for larvae or eggs of a particular taxon. The upper left panel is a map of average abundance at individual CalCOFI stations on the wide-ranging surveys of 1977-78, 1980-81, and 1984. The upper right panel is a map of average abundance at stations within the boundaries of the present survey pattern from 1977 to 2000. If a taxon did not occur during 1977–84 there is no map in the upper left panel. The total raw count of larvae represented in each map is listed on the map below the range of years. The middle left panel is a graph of seasonal occurrence for the stations where the taxon occurred consistently within the survey area (see Table 9 for the range of stations used in these calculations). The middle right panel is a graph of average seasonal abundance for the stations where the taxon occurred consistently within the survey area (see Table 9). The lower left panel is a graph of annual occurrence during the principal spawning period at the stations where the taxon occurred consistently within the survey area (see Table 9 for the range of months used in these calculations). The lower right panel is a graph of average annual abundance during the principal spawning period of the taxon for the stations where its larvae were consistently found within the survey area (see Table 9). ENSO events are indicated by vertical bars (El Niño, shading; La Niña, hatching). Dashed lines indicate the period of triennial CalCOFI surveys.

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Table 1. List of ichthyoplankton data reports for Manta (surface) net samples from CalCOFI surveys for 1977 to 2000. Citations for each report are included in the Literature Cited section of this atlas.

| Survey Year | Senior Author | Publication Year |
|---|---|---|
| 1977-78 | Moser et al. | 2001 |
| 1980-81 | Ambrose et. al. | 2002a |
| 1984 | Charter et al. | 2002a |
| 1985 | Ambrose et al. | 2002b |
| 1986 | Charter et al. | 2002b |
| 1987 | Sandknop et al. | 2002a |
| 1988 | Watson et al. | 2002a |
| 1989 | Ambrose et al. | 2002c |
| 1990 | Charter et al. | 2002c |
| 1991 | Sandknop et al. | 2002b |
| 1992 | Watson et al. | 2002b |
| 1993 | Ambrose et al. | 2002d |
| 1994 | Charter et al. | 2002d |
| 1995 | Sandknop et al. | 2002c |
| 1996 | Watson et al. | 2002c |
| 1997 | Ambrose et al. | 2002e |
| 1998 | Ambrose et al. | 2002f |
| 1999 | Ambrose et al. | 2002g |
| 2000 | Watson et al. | 2002d |

Table 2. Total stations within the current CalCOFI survey pattern used in this atlas, listed by month and year.

| | Month | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Total |
| 1977 | | | | | | | | | | | | 2 | 2 |
| 1978 | 4 | 4 | 11 | 31 | 33 | 15 | 19 | 50 | | | | | 167 |
| 1980 | | | | | | | | | | | 29 | 24 | 53 |
| 1981 | 48 | 32 | 7 | 29 | 48 | | 47 | | | | | | 211 |
| 1984 | 61 | 42 | 19 | 50 | 27 | 29 | 63 | | | 47 | | | 338 |
| 1985 | | 42 | 4 | 1 | 39 | | | 55 | | | 47 | | 188 |
| 1986 | | 54 | | | 50 | | | | 51 | 2 | 50 | | 207 |
| 1987 | | | 60 | 3 | 63 | | | | 62 | | 45 | | 233 |
| 1988 | 58 | 4 | | 10 | 42 | | | 65 | | 66 | | | 245 |
| 1989 | 51 | 10 | | 63 | 12 | | 53 | 5 | | | 66 | | 260 |
| 1990 | | | 56 | 47 | | | 31 | 34 | | | 65 | | 233 |
| 1991 | 60 | 12 | 42 | | | | 36 | 29 | 13 | 50 | | | 242 |
| 1992 | 17 | 43 | | 65 | | | 66 | | 22 | 42 | | | 255 |
| 1993 | 65 | | 9 | 57 | | | | 65 | | 66 | | | 262 |
| 1994 | 44 | 22 | 38 | 27 | | | | 66 | 4 | 60 | | | 261 |
| 1995 | 65 | | | 51 | | | 66 | | | 66 | | | 248 |
| 1996 | 10 | 56 | | 60 | 2 | | | 66 | | 61 | 4 | | 259 |
| 1997 | 13 | 53 | | 61 | | | 66 | | 46 | 12 | | 9 | 260 |
| 1998 | 38 | 26 | | 66 | | | 66 | | 66 | | | | 262 |
| 1999 | 65 | | | 61 | | | | 65 | | 64 | | | 255 |
| 2000 | 66 | | | 66 | | 10 | 56 | | | 65 | | | 263 |
| Total | 665 | 400 | 246 | 748 | 316 | 54 | 569 | 500 | 264 | 601 | 306 | 35 | 4704 |

Table 3. Total stations within the current CalCOFI survey pattern used in this atlas, listed by line and station.

| | Line | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Station | 76.7 | 80.0 | 82.0 | 83.3 | 86.7 | 90.0 | 93.3 | Total |
| 27 | | | | | | | 76 | 76 |
| 28 | | | | | | 81 | 81 | 162 |
| 30 | | | | | | 81 | 81 | 162 |
| 33 | | | | | 75 | | | 75 |
| 35 | | | | | 80 | 71 | 80 | 231 |
| 37 | | | | | | 80 | | 80 |
| 40 | | | | | 80 | | 79 | 159 |
| 40.6 | | | | 79 | | | | 79 |
| 42 | | | | 80 | | | | 80 |
| 45 | | | | | 77 | 78 | 77 | 232 |
| 46.9 | | | 74 | | | | | 74 |
| 49 | 65 | | | | | | | 65 |
| 50 | | | | | 72 | | 78 | 150 |
| 51 | 74 | 79 | | 72 | | | | 225 |
| 53 | | | | | | 76 | | 76 |
| 55 | 72 | 76 | | 72 | 71 | | 77 | 368 |
| 60 | 77 | 80 | | 72 | 73 | 76 | 75 | 453 |
| 70 | 65 | 75 | | 68 | 69 | 72 | 75 | 424 |
| 80 | 64 | 72 | | 62 | 65 | 77 | 73 | 413 |
| 90 | 63 | 71 | | 63 | 66 | 74 | 73 | 410 |
| 100 | 55 | 58 | | 63 | 59 | 72 | 65 | 372 |
| 110 | | | | 50 | 49 | 61 | 60 | 220 |
| 120 | | | | | | 59 | 59 | 118 |
| Total | 535 | 511 | 74 | 681 | 836 | 958 | 1109 | 4704 |

Table 4. Ranked abundance of larval fish taxa taken in Manta net tows on CalCOFI surveys from 1977 to 2000. The total for each taxon is the summed raw count for all recorded occurrences.

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 1 | *Engraulis mordax* | 149592 | 44 | *Citharichthys sordidus* | 75 |
| 2 | *Sardinops sagax* | 27247 | 46 | *Pleuronichthys verticalis* | 71 |
| 3 | *Cololabis saira* | 7459 | 47 | *Icichthys lockingtoni* | 66 |
| 4 | *Hypsoblennius jenkinsi* | 6155 | 48 | *Neoclinus blanchardi* | 64 |
| 5 | *Scomber japonicus* | 5633 | 49 | *Oxylebius pictus* | 62 |
| 6 | *Sebastes* spp. | 5348 | 50 | *Anisotremus davidsoni* | 60 |
| 7 | Scorpaenidae | 3791 | 51 | *Nannobrachium* spp. | 52 |
| 8 | *Merluccius productus* | 3501 | 52 | Unidentified fish larvae | 49 |
| 9 | *Hexagrammos decagrammus* | 2190 | 52 | *Stomias atriventer* | 49 |
| 10 | *Chromis punctipinnis* | 2155 | 52 | Cottidae | 49 |
| 11 | *Atherinopsis californiensis* | 1996 | 55 | *Aristostomias scintillans* | 42 |
| 12 | *Scorpaenichthys marmoratus* | 1868 | 55 | *Nannobrachium ritteri* | 42 |
| 13 | *Trachurus symmetricus* | 1526 | 57 | *Sebastes aurora* | 39 |
| 14 | *Leuresthes tenuis* | 1384 | 58 | *Halichoeres semicinctus* | 38 |
| 15 | *Vinciguerria lucetia* | 1086 | 58 | *Semicossyphus pulcher* | 38 |
| 16 | *Sebastes jordani* | 683 | 60 | *Peprilus simillimus* | 37 |
| 17 | *Oxyjulis californica* | 642 | 61 | *Cyclothone* spp. | 32 |
| 18 | *Sphyraena argentea* | 620 | 61 | *Anoplopoma fimbria* | 32 |
| 19 | *Hypsoblennius gilberti* | 592 | 63 | *Atherinops affinis* | 30 |
| 20 | *Sebastes diploproa* | 560 | 63 | *Neoclinus stephensae* | 30 |
| 21 | *Ceratoscopelus townsendi* | 506 | 63 | *Coryphopterus nicholsii* | 30 |
| 22 | *Scorpaena guttata* | 463 | 66 | *Sebastes paucispinis* | 26 |
| 23 | *Xenistius californiensis* | 398 | 67 | *Macroramphosus gracilis* | 25 |
| 24 | *Paralabrax* spp. | 389 | 68 | *Fodiator acutus* | 24 |
| 25 | *Girella nigricans* | 360 | 69 | *Gigantactis* spp. | 20 |
| 26 | *Hypsoblennius* spp. | 307 | 70 | *Bathylagus ochotensis* | 19 |
| 27 | *Genyonemus lineatus* | 291 | 70 | *Pleuronichthys decurrens* | 19 |
| 28 | *Ophiodon elongatus* | 255 | 72 | *Hermosilla azurea* | 18 |
| 29 | *Stenobrachius leucopsarus* | 229 | 72 | *Neoclinus* spp. | 18 |
| 30 | *Medialuna californiensis* | 223 | 74 | *Diaphus* spp. | 17 |
| 31 | *Tetragonurus cuvieri* | 187 | 74 | *Rathbunella alleni* | 17 |
| 32 | *Pleuronichthys coenosus* | 185 | 74 | *Ophidion scrippsae* | 17 |
| 33 | *Citharichthys stigmaeus* | 158 | 77 | *Symbolophorus californiensis* | 16 |
| 34 | *Triphoturus mexicanus* | 151 | 77 | Atherinidae | 16 |
| 35 | *Seriphus politus* | 142 | 79 | *Bolinichthys longipes* | 15 |
| 36 | Disintegrated fish larvae | 123 | 80 | *Hemilepidotus spinosus* | 14 |
| 37 | *Cheilopogon heterurus* | 119 | 81 | *Synodus lucioceps* | 13 |
| 38 | *Hypsoblennius gentilis* | 116 | 81 | *Diogenichthys atlanticus* | 13 |
| 39 | *Hypsypops rubicundus* | 102 | 81 | *Leuroglossus stilbius* | 13 |
| 40 | *Cheilopogon pinnatibarbatus* | 99 | 84 | *Protomyctophum crockeri* | 12 |
| 41 | *Cheilopogon* spp. | 88 | 84 | *Citharichthys* spp. | 12 |
| 42 | *Lampadena urophaos* | 81 | 84 | *Bathophilus flemingi* | 12 |
| 43 | *Paralichthys californicus* | 76 | 87 | *Nannobrachium regale* | 11 |
| 44 | *Cyclothone signata* | 75 | 87 | *Icosteus aenigmaticus* | 11 |

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 87 | *Rathbunella* spp. | 11 | 126 | *Sarda chiliensis* | 4 |
| 87 | *Cryptotrema corallinum* | 11 | 137 | *Myctophum nitidulum* | 3 |
| 91 | *Tactostoma macropus* | 10 | 137 | *Clinocottus analis* | 3 |
| 91 | *Parophrys vetulus* | 10 | 137 | *Lythrypnus dalli* | 3 |
| 93 | *Pleuronichthys ritteri* | 9 | 140 | *Taaningichthys minimus* | 2 |
| 93 | *Oneirodes* spp. | 9 | 140 | *Argyropelecus sladeni* | 2 |
| 93 | *Hippoglossina stomata* | 9 | 140 | *Artedius harringtoni* | 2 |
| 93 | *Brosmophycis marginata* | 9 | 140 | *Icelinus* spp. | 2 |
| 97 | Clupeidae | 8 | 140 | Labrisomidae | 2 |
| 97 | *Symphurus atricaudus* | 8 | 140 | *Oligocottus* spp. | 2 |
| 97 | *Typhlogobius californiensis* | 8 | 140 | *Cyclothone pseudopallida* | 2 |
| 97 | *Odontopyxis trispinosa* | 8 | 140 | *Notoscopelus resplendens* | 2 |
| 97 | *Hexagrammos lagocephalus* | 8 | 140 | *Diplophos taenia* | 2 |
| 97 | *Sebastolobus* spp. | 8 | 149 | *Stemonosudis macrura* | 1 |
| 97 | Kyphosidae | 8 | 149 | *Umbrina roncador* | 1 |
| 97 | *Atractoscion nobilis* | 8 | 149 | *Roncador stearnsii* | 1 |
| 97 | *Seriola lalandi* | 8 | 149 | *Diplospinus multistriatus* | 1 |
| 97 | *Hirundichthys marginatus* | 8 | 149 | *Coryphaena hippurus* | 1 |
| 107 | *Etrumeus teres* | 7 | 149 | *Pteraclis aesticola* | 1 |
| 107 | *Cyclothone acclinidens* | 7 | 149 | *Psenes pellucidus* | 1 |
| 107 | *Howella* spp. | 7 | 149 | Carangidae | 1 |
| 107 | *Hygophum reinhardtii* | 7 | 149 | *Scopelogadus bispinosus* | 1 |
| 107 | *Liparis mucosus* | 7 | 149 | Trachipteridae | 1 |
| 112 | *Bathylagus wesethi* | 6 | 149 | *Zaniolepis frenata* | 1 |
| 112 | *Microstomus pacificus* | 6 | 149 | *Lestidiops ringens* | 1 |
| 112 | *Sebastes levis* | 6 | 149 | *Parvilux ingens* | 1 |
| 112 | *Sternoptyx* spp. | 6 | 149 | *Nannobrachium hawaiiensis* | 1 |
| 116 | *Cheilotrema saturnum* | 5 | 149 | *Diogenichthys laternatus* | 1 |
| 116 | *Chiasmodon niger* | 5 | 149 | *Bathypterois* spp. | 1 |
| 116 | *Hirundichthys* spp. | 5 | 149 | *Scopelosaurus* spp. | 1 |
| 116 | *Trachipterus altivelis* | 5 | 149 | *Idiacanthus antrostomus* | 1 |
| 116 | *Desmodema lorum* | 5 | 149 | *Argentina sialis* | 1 |
| 116 | *Hypsopsetta guttulata* | 5 | 149 | *Melamphaes lugubris* | 1 |
| 116 | *Vinciguerria poweriae* | 5 | 149 | *Xystreurys liolepis* | 1 |
| 116 | *Leptocottus armatus* | 5 | 149 | Stomiiformes | 1 |
| 116 | *Tarletonbeania crenularis* | 5 | 149 | *Dolichopteryx longipes* | 1 |
| 116 | *Ruscarius creaseri* | 5 | 149 | *Lampanyctus bristori* | 1 |
| 126 | *Menticirrhus undulatus* | 4 | 149 | *Caulophryne pelagica* | 1 |
| 126 | Myctophidae | 4 | 149 | *Caulophryne* spp. | 1 |
| 126 | *Brama japonica* | 4 | 149 | *Antennarius avalonis* | 1 |
| 126 | Sciaenidae | 4 | 149 | *Pleuronichthys* spp. | 1 |
| 126 | *Sebastes goodei* | 4 | 149 | *Mugil cephalus* | 1 |
| 126 | *Artedius lateralis* | 4 | 149 | *Glyptocephalus zachirus* | 1 |
| 126 | *Lepidogobius lepidus* | 4 | 149 | *Sebastolobus altivelis* | 1 |
| 126 | *Chilara taylori* | 4 | 149 | *Cataetyx rubrirostris* | 1 |
| 126 | *Lyopsetta exilis* | 4 | 149 | Stichaeidae | 1 |
| 126 | Exocoetidae | 4 | 149 | Clinidae | 1 |

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 149 | Gobiidae | 1 | 149 | Cyclopteridae | 1 |
| 149 | *Liparis fucensis* | 1 | 149 | *Ruscarius meanyi* | 1 |
| 149 | *Liparis florae* | 1 | 149 | *Lepidopsetta bilineata* | 1 |

Table 5. Ranked occurrence of larval fish taxa taken in Manta net tows on CalCOFI surveys from 1977 to 2000. The total for each taxon is the sum of all recorded occurrences.

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 1 | *Cololabis saira* | 1421 | 44 | *Sebastes aurora* | 34 |
| 2 | *Engraulis mordax* | 1365 | 45 | Disintegrated fish larvae | 32 |
| 3 | *Sebastes* spp. | 720 | 46 | *Ophiodon elongatus* | 30 |
| 4 | *Sardinops sagax* | 647 | 46 | *Neoclinus blanchardi* | 30 |
| 5 | *Hypsoblennius jenkinsi* | 349 | 46 | *Seriphus politus* | 30 |
| 6 | *Scomber japonicus* | 321 | 49 | *Cheilopogon pinnatibarbatus* | 28 |
| 6 | *Scorpaenichthys marmoratus* | 321 | 50 | *Stomias atriventer* | 26 |
| 8 | *Trachurus symmetricus* | 299 | 51 | Unidentified fish larvae | 25 |
| 9 | *Vinciguerria lucetia* | 262 | 52 | *Cyclothone* spp. | 22 |
| 10 | *Sebastes diploproa* | 188 | 52 | *Coryphopterus nicholsii* | 22 |
| 11 | *Chromis punctipinnis* | 183 | 54 | *Semicossyphus pulcher* | 21 |
| 12 | *Ceratoscopelus townsendi* | 172 | 54 | *Neoclinus stephensae* | 21 |
| 13 | *Oxyjulis californica* | 168 | 56 | *Peprilus simillimus* | 20 |
| 14 | *Atherinopsis californiensis* | 161 | 57 | *Halichoeres semicinctus* | 19 |
| 15 | *Merluccius productus* | 127 | 58 | *Gigantactis* spp. | 18 |
| 16 | *Tetragonurus cuvieri* | 122 | 59 | *Pleuronichthys decurrens* | 17 |
| 17 | *Medialuna californiensis* | 111 | 59 | *Xenistius californiensis* | 17 |
| 18 | *Hypsoblennius gilberti* | 106 | 59 | *Anoplopoma fimbria* | 17 |
| 19 | *Sphyraena argentea* | 97 | 62 | *Diaphus* spp. | 16 |
| 20 | *Stenobrachius leucopsarus* | 95 | 63 | *Atherinops affinis* | 15 |
| 21 | *Leuresthes tenuis* | 90 | 63 | *Fodiator acutus* | 15 |
| 22 | *Pleuronichthys coenosus* | 89 | 63 | *Sebastes paucispinis* | 15 |
| 23 | *Triphoturus mexicanus* | 84 | 63 | *Macroramphosus gracilis* | 15 |
| 24 | *Sebastes jordani* | 80 | 67 | *Diogenichthys atlanticus* | 13 |
| 24 | *Girella nigricans* | 80 | 67 | *Symbolophorus californiensis* | 13 |
| 26 | *Paralabrax* spp. | 60 | 69 | *Protomyctophum crockeri* | 12 |
| 27 | *Citharichthys stigmaeus* | 58 | 70 | *Bathophilus flemingi* | 11 |
| 28 | *Icichthys lockingtoni* | 56 | 70 | *Hypsypops rubicundus* | 11 |
| 29 | *Cyclothone signata* | 54 | 70 | *Nannobrachium regale* | 11 |
| 29 | *Hexagrammos decagrammus* | 54 | 73 | *Anisotremus davidsoni* | 10 |
| 31 | *Citharichthys sordidus* | 50 | 74 | *Tactostoma macropus* | 9 |
| 32 | *Cheilopogon heterurus* | 49 | 74 | *Icosteus aenigmaticus* | 9 |
| 33 | *Genyonemus lineatus* | 43 | 74 | *Ophidion scrippsae* | 9 |
| 34 | *Nannobrachium ritteri* | 39 | 74 | *Hippoglossina stomata* | 9 |
| 35 | *Lampadena urophaos* | 38 | 74 | *Oneirodes* spp. | 9 |
| 35 | *Nannobrachium* spp. | 38 | 79 | *Parophrys vetulus* | 8 |
| 37 | *Pleuronichthys verticalis* | 37 | 79 | *Pleuronichthys ritteri* | 8 |
| 37 | *Hypsoblennius* spp. | 37 | 79 | *Synodus lucioceps* | 8 |
| 39 | *Cheilopogon* spp. | 36 | 79 | *Seriola lalandi* | 8 |
| 39 | *Oxylebius pictus* | 36 | 79 | *Hirundichthys marginatus* | 8 |
| 41 | *Aristostomias scintillans* | 35 | 79 | *Typhlogobius californiensis* | 8 |
| 41 | *Paralichthys californicus* | 35 | 85 | *Bathylagus ochotensis* | 7 |
| 41 | *Hypsoblennius gentilis* | 35 | 85 | *Leuroglossus stilbius* | 7 |

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 85 | *Cyclothone acclinidens* | 7 | 132 | Kyphosidae | 2 |
| 85 | *Hemilepidotus spinosus* | 7 | 132 | *Argyropelecus sladeni* | 2 |
| 85 | Cottidae | 7 | 132 | *Icelinus* spp. | 2 |
| 85 | *Hermosilla azurea* | 7 | 132 | *Lythrypnus dalli* | 2 |
| 85 | *Howella* spp. | 7 | 132 | *Oligocottus* spp. | 2 |
| 85 | *Hygophum reinhardtii* | 7 | 132 | *Vinciguerria poweriae* | 2 |
| 93 | *Sebastes levis* | 6 | 132 | *Bolinichthys longipes* | 2 |
| 93 | *Atractoscion nobilis* | 6 | 140 | *Mugil cephalus* | 1 |
| 93 | *Bathylagus wesethi* | 6 | 140 | *Parvilux ingens* | 1 |
| 93 | *Neoclinus* spp. | 6 | 140 | *Lestidiops ringens* | 1 |
| 97 | *Brosmophycis marginata* | 5 | 140 | *Stemonosudis macrura* | 1 |
| 97 | *Hypsopsetta guttulata* | 5 | 140 | *Nannobrachium hawaiiensis* | 1 |
| 97 | *Symphurus atricaudus* | 5 | 140 | Scorpaenidae | 1 |
| 97 | *Microstomus pacificus* | 5 | 140 | *Sebastolobus altivelis* | 1 |
| 97 | *Rathbunella* spp. | 5 | 140 | *Lampanyctus bristori* | 1 |
| 97 | *Desmodema lorum* | 5 | 140 | *Ruscarius meanyi* | 1 |
| 97 | *Liparis mucosus* | 5 | 140 | *Diplophos taenia* | 1 |
| 97 | *Trachipterus altivelis* | 5 | 140 | *Artedius harringtoni* | 1 |
| 97 | *Citharichthys* spp. | 5 | 140 | *Zaniolepis frenata* | 1 |
| 97 | *Chiasmodon niger* | 5 | 140 | *Taaningichthys minimus* | 1 |
| 107 | *Tarletonbeania crenularis* | 4 | 140 | *Diogenichthys laternatus* | 1 |
| 107 | *Leptocottus armatus* | 4 | 140 | *Bathypterois* spp. | 1 |
| 107 | *Hexagrammos lagocephalus* | 4 | 140 | *Scopelogadus bispinosus* | 1 |
| 107 | *Sebastes goodei* | 4 | 140 | *Idiacanthus antrostomus* | 1 |
| 107 | *Scorpaena guttata* | 4 | 140 | *Umbrina roncador* | 1 |
| 107 | *Cheilotrema saturnum* | 4 | 140 | *Cyclothone pseudopallida* | 1 |
| 107 | *Sarda chiliensis* | 4 | 140 | *Scopelosaurus* spp. | 1 |
| 107 | *Ruscarius creaseri* | 4 | 140 | Stomiiformes | 1 |
| 107 | *Lyopsetta exilis* | 4 | 140 | *Dolichopteryx longipes* | 1 |
| 107 | Sciaenidae | 4 | 140 | *Artedius lateralis* | 1 |
| 107 | *Odontopyxis trispinosa* | 4 | 140 | *Melamphaes lugubris* | 1 |
| 107 | *Lepidogobius lepidus* | 4 | 140 | *Pleuronichthys* spp. | 1 |
| 107 | *Cryptotrema corallinum* | 4 | 140 | *Etrumeus teres* | 1 |
| 107 | *Chilara taylori* | 4 | 140 | *Argentina sialis* | 1 |
| 107 | Myctophidae | 4 | 140 | *Roncador stearnsii* | 1 |
| 107 | *Hirundichthys* spp. | 4 | 140 | *Coryphaena hippurus* | 1 |
| 107 | *Sternoptyx* spp. | 4 | 140 | *Pteraclis aesticola* | 1 |
| 107 | Clupeidae | 4 | 140 | *Psenes pellucidus* | 1 |
| 107 | *Rathbunella alleni* | 4 | 140 | Carangidae | 1 |
| 126 | *Sebastolobus* spp. | 3 | 140 | Atherinidae | 1 |
| 126 | *Clinocottus analis* | 3 | 140 | Trachipteridae | 1 |
| 126 | *Myctophum nitidulum* | 3 | 140 | *Caulophryne pelagica* | 1 |
| 126 | Exocoetidae | 3 | 140 | *Diplospinus multistriatus* | 1 |
| 126 | *Brama japonica* | 3 | 140 | *Antennarius avalonis* | 1 |
| 126 | *Menticirrhus undulatus* | 3 | 140 | Cyclopteridae | 1 |
| 132 | *Notoscopelus resplendens* | 2 | 140 | *Lepidopsetta bilineata* | 1 |

| Rank | Taxon | Total | Rank | Taxon | Total |
|---|---|---|---|---|---|
| 140 | *Glyptocephalus zachirus* | 1 | 140 | Labrisomidae | 1 |
| 140 | *Xystreurys liolepis* | 1 | 140 | Gobiidae | 1 |
| 140 | *Cataetyx rubrirostris* | 1 | 140 | *Liparis fucensis* | 1 |
| 140 | Stichaeidae | 1 | 140 | *Liparis florae* | 1 |
| 140 | Clinidae | 1 | 140 | *Caulophryne* spp. | 1 |

Table 6. Total counts of fifty most abundant larval fish from CalCOFI Manta net catches, 1977-2000, compared with standardized total counts of the same taxa from concurrent oblique net catches.

| Taxon | Family | Manta | | Oblique | |
|---|---|---|---|---|---|
| | | Rank | Total | Rank | Total |
| *Engraulis mordax* | Engraulidae | 1 | 149,592 | 1 | 1,182,698.5 |
| *Sardinops sagax* | Clupeidae | 2 | 27,247 | 6 | 120,223.8 |
| *Cololabis saira* | Scomberesocidae | 3 | 7,459 | 87 | 404.5 |
| *Hypsoblennius jenkinsi* | Blenniidae | 4 | 6,155 | 71 | 824.9 |
| *Scomber japonicus* | Scombridae | 5 | 5,633 | 15 | 16,564.5 |
| *Sebastes* spp. | Sebastidae | 6 | 5,348 | 4 | 128,896.8 |
| *Merluccius productus* | Merlucciidae | 7 | 3,501 | 2 | 439,873.4 |
| *Hexagrammos decagrammus* | Hexagrammidae | 8 | 2,190 | 197 | 28.0 |
| *Chromis punctipinnis* | Pomacentridae | 9 | 2,155 | 50 | 1,560.0 |
| *Atherinopsis californiensis* | Atherinidae | 10 | 1,996 | 162 | 70.0 |
| *Scorpaenichthys marmoratus* | Cottidae | 11 | 1,868 | 105 | 256.5 |
| *Trachurus symmetricus* | Carangidae | 12 | 1,526 | 10 | 21,414.7 |
| *Leuresthes tenuis* | Atherinidae | 13 | 1,384 | 215 | 19.2 |
| *Vinciguerria lucetia* | Phosichthyidae | 14 | 1,086 | 3 | 216,998.1 |
| *Sebastes jordani* | Sebastidae | 15 | 683 | 9 | 23,546.5 |
| *Oxyjulis californica* | Labridae | 16 | 642 | 33 | 3,990.3 |
| *Sphyraena argentea* | Sphyraenidae | 17 | 620 | 54 | 1,484.6 |
| *Hypsoblennius gilberti* | Blenniidae | 18 | 592 | 193 | 30.2 |
| *Sebastes diploproa* | Sebastidae | 19 | 560 | 60 | 1,121.6 |
| *Ceratoscopelus townsendi* | Myctophidae | 20 | 506 | 13 | 20,504.3 |
| *Scorpaena guttata* | Scorpaenidae | 21 | 463 | 210 | 20.5 |
| *Xenistius californiensis* | Haemulidae | 22 | 398 | 161 | 70.3 |
| *Paralabrax* spp. | Serranidae | 23 | 389 | 40 | 2,153.3 |
| *Girella nigricans* | Kyphosidae | 24 | 360 | 168 | 65.4 |
| *Hypsoblennius* spp. | Blenniidae | 25 | 307 | 61 | 1,091.1 |

| Taxon | Family | Manta | | Oblique | |
|---|---|---|---|---|---|
| | | Rank | Total | Rank | Total |
| *Genyonemus lineatus* | Sciaenidae | 26 | 291 | 18 | 14,236.6 |
| *Ophiodon elongatus* | Hexagrammidae | 27 | 255 | 160 | 75.4 |
| *Stenobrachius leucopsarus* | Myctophidae | 28 | 229 | 7 | 87,912.6 |
| *Medialuna californiensis* | Kyphosidae | 29 | 223 | 163 | 69.1 |
| *Tetragonurus cuvieri* | Tetragonuridae | 30 | 187 | 43 | 1,931.4 |
| *Pleuronichthys coenosus* | Pleuronectidae | 31 | 185 | 123 | 163.9 |
| *Citharichthys stigmaeus* | Paralichthyidae | 32 | 158 | 19 | 13,351.1 |
| *Triphoturus mexicanus* | Myctophidae | 33 | 151 | 14 | 19,847.8 |
| *Seriphus politus* | Sciaenidae | 34 | 142 | 44 | 1,900.8 |
| *Cheilopogon heterurus* | Exocoetidae | 35 | 119 | – | 0 |
| *Hypsoblennius gentilis* | Blenniidae | 36 | 116 | 150 | 93.6 |
| *Hypsypops rubicundus* | Pomacentridae | 37 | 102 | 234 | 12.1 |
| *Cheilopogon pinnatibarbatus* | Exocoetidae | 38 | 99 | – | 0 |
| *Cheilopogon* spp. | Exocoetidae | 39 | 88 | – | 0 |
| *Lampadena urophaos* | Myctophidae | 40 | 81 | 93 | 342.8 |
| *Paralichthys californicus* | Paralichthyidae | 41 | 76 | 46 | 1,781.0 |
| *Cyclothone signata* | Gonostomatidae | 42 | 75 | 16 | 15,868.2 |
| *Citharichthys sordidus* | Paralichthyidae | 43 | 75 | 21 | 11,726.9 |
| *Pleuronichthys verticalis* | Pleuronectidae | 44 | 71 | 58 | 1,296.3 |
| *Icichthys lockingtoni* | Centrolophidae | 45 | 66 | 48 | 1,589.5 |
| *Neoclinus blanchardi* | Chaenopsidae | 46 | 64 | 255 | 5.6 |
| *Oxylebius pictus* | Hexagrammidae | 47 | 62 | 108 | 233.0 |
| *Anistremus davidsoni* | Haemulidae | 48 | 60 | 190 | 33.1 |
| *Nannobrachium* spp. | Myctophidae | 49 | 52 | 24 | 9,447.3 |
| *Stomias atriventer* | Stomiidae | 50 | 49 | 55 | 1,369.0 |
| Proportion of Total for All Taxa | | | 0.978 | | 0.865 |

Table 7. Results of recurrent group analyses of larval fish in Manta and oblique net samples from CalCOFI surveys (current station pattern) during 1977-2000. Each taxon is preceded by its taxonomic code and followed by the affinity index and taxa to which it is linked.

| | | | | | |
|---|---|---|---|---|---|
| **Manta Recurrent Group 1** | | | | | |
| 31 | *Engraulis mordax* | Has | 0.462 | link to | 683 |
| | | and | 0.334 | link to | 736 |
| 683 | *Sebastes* spp. | Has | 0.339 | link to | 736 |
| 736 | *Scorpaenichthys marmoratus* | | | | |
| **Associates** | | | | | |
| 853 | *Hypsoblennius jenkinsi* | Has | 0.311 | link to | 31 |
| 19 | *Sardinops sagax* | Has | 0.362 | link to | 31 |
| **Manta Recurrent Group 2** | | | | | |
| 486 | *Sphyraena argentea* | Has | 0.316 | link to | 626 |
| | | and | 0.332 | link to | 853 |
| 626 | *Chromis punctipinnis* | Has | 0.381 | link to | 853 |
| 853 | *Hypsoblennius jenkinsi* | | | | |
| **Associates** | | | | | |
| 574 | *Scomber japonicus* | Has | 0.357 | link to | 486 |
| 431 | *Paralabrax* spp. | Has | 0.408 | link to | 486 |
| **Manta Recurrent Group 3** | | | | | |
| 93 | *Vinciguerria lucetia* | Has | 0.331 | link to | 226 |
| 226 | *Ceratoscopelus townsendi* | | | | |
| **Manta Recurrent Group 4** | | | | | |
| 601 | *Anisotremus davidsoni* | Has | 0.416 | link to | 452 |
| 452 | *Xenistius californiensis* | | | | |
| **Associates** | | | | | |
| 628 | *Hypsypops rubicundus* | Has | 0.326 | link to | 601 |

Table 8. Results of recurrent group analyses of larval fish in oblique net samples from CalCOFI surveys (current station pattern) during 1977-2000. Each taxon is preceded by its taxonomic code and followed by the affinity index and taxa to which it is linked.

| | | | | | |
|---|---|---|---|---|---|
| **Oblique Recurrent Group 1** | | | | | |
| 72 | *Leuroglossus stilbius* | Has | 0.624 | link to | 683 |
| | | and | 0.615 | link to | 901 |
| | | and | 0.333 | link to | 923 |
| | | and | 0.319 | link to | 925 |
| 31 | *Engraulis mordax* | Has | 0.579 | link to | 72 |
| | | and | 0.667 | link to | 683 |
| | | and | 0.537 | link to | 901 |
| | | and | 0.345 | link to | 923 |
| | | and | 0.365 | link to | 925 |
| 901 | *Merluccius productus* | Has | 0.356 | link to | 923 |
| | | and | 0.315 | link to | 925 |
| 683 | *Sebastes* spp. | Has | 0.546 | link to | 901 |
| | | and | 0.356 | link to | 923 |
| | | and | 0.356 | link to | 925 |
| 923 | *Citharichthys sordidus* | Has | 0.420 | link to | 925 |
| 925 | *Citharichthys stigmaeus* | | | | |
| **Associates** | | | | | |
| 68 | *Bathylagus ochotensis* | Has | 0.429 | link to | 31 |
| | | and | 0.546 | link to | 901 |
| | | and | 0.588 | link to | 72 |
| | | and | 0.470 | link to | 683 |
| 19 | *Sardinops sagax* | Has | 0.352 | link to | 31 |
| | | and | 0.313 | link to | 901 |
| | | and | 0.316 | link to | 72 |
| | | and | 0.315 | link to | 683 |
| 292 | *Stenobrachius leucopsarus* | Has | 0.546 | link to | 31 |
| | | and | 0.610 | link to | 901 |
| | | and | 0.660 | link to | 72 |
| | | and | 0.584 | link to | 683 |
| 684 | *Sebastes jordani* | Has | 0.398 | link to | 31 |
| | | and | 0.389 | link to | 901 |
| | | and | 0.385 | link to | 72 |
| | | and | 0.426 | link to | 683 |
| 686 | *Sebastes paucispinis* | Has | 0.318 | link to | 72 |
| | | and | 0.338 | link to | 901 |
| | | and | 0.317 | link to | 683 |
| 924 | *Citharichthys* spp. | Has | 0.327 | link to | 31 |
| | | and | 0.306 | link to | 683 |

**Oblique Recurrent Group 2**

| | | | | | |
|---|---|---|---|---|---|
| 71 | *Bathylagus wesethi* | Has | 0.522 | link to | 78 |
| | | and | 0.560 | link to | 93 |
| | | and | 0.511 | link to | 226 |
| | | and | 0.489 | link to | 239 |
| | | and | 0.346 | link to | 261 |
| | | and | 0.387 | link to | 288 |
| | | and | 0.500 | link to | 296 |
| 78 | *Cyclothone signata* | Has | 0.617 | link to | 93 |
| | | and | 0.611 | link to | 226 |
| | | and | 0.558 | link to | 239 |
| | | and | 0.357 | link to | 261 |
| | | and | 0.379 | link to | 288 |
| | | and | 0.489 | link to | 296 |
| 93 | *Vinciguerria lucetia* | Has | 0.627 | link to | 226 |
| | | and | 0.553 | link to | 239 |
| | | and | 0.310 | link to | 261 |
| | | and | 0.407 | link to | 288 |
| | | and | 0.454 | link to | 296 |
| 226 | *Ceratoscopelus townsendi* | Has | 0.536 | link to | 239 |
| | | and | 0.326 | link to | 261 |
| | | and | 0.345 | link to | 288 |
| | | and | 0.447 | link to | 296 |
| 239 | *Diogenichthys atlanticus* | Has | 0.366 | link to | 261 |
| | | and | 0.445 | link to | 288 |
| | | and | 0.497 | link to | 296 |
| 261 | *Nannobrachium* spp. | Has | 0.367 | link to | 288 |
| | | and | 0.697 | link to | 296 |
| 288 | *Protomyctophum crockeri* | Has | 0.413 | link to | 296 |
| 296 | *Symbolophorus californiensis* | | | | |

**Associates**

| | | | | | |
|---|---|---|---|---|---|
| 68 | *Bathylagus ochotensis* | Has | 0.317 | link to | 261 |
| | | and | 0.417 | link to | 288 |
| 72 | *Leuroglossus stilbius* | Has | 0.338 | link to | 288 |
| 76 | *Cyclothone* spp. | Has | 0.346 | link to | 93 |
| | | and | 0.341 | link to | 226 |
| | | and | 0.322 | link to | 239 |
| 94 | *Vinciguerria poweriae* | Has | 0.332 | link to | 78 |
| | | and | 0.347 | link to | 226 |
| 105 | *Argyropelecus sladeni* | Has | 0.321 | link to | 78 |
| 107 | *Sternoptyx* spp. | Has | 0.324 | link to | 78 |
| | | and | 0.317 | link to | 226 |
| 161 | *Idiacanthus antrostomus* | Has | 0.397 | link to | 71 |
| | | and | 0.365 | link to | 78 |
| | | and | 0.433 | link to | 93 |
| | | and | 0.396 | link to | 226 |
| | | and | 0.304 | link to | 296 |
| | | and | 0.344 | link to | 239 |

| | | | | | |
|---|---|---|---|---|---|
| 901 | *Merluccius productus* | Has | 0.320 | link to | 288 |
| 311 | *Lestidiops ringens* | Has | 0.336 | link to | 71 |
| | | and | 0.320 | link to | 93 |
| 252 | *Hygophum reinhardtii* | Has | 0.310 | link to | 78 |
| | | and | 0.348 | link to | 226 |
| 273 | *Myctophum nitidulum* | Has | 0.301 | link to | 93 |
| | | and | 0.332 | link to | 226 |
| 260 | *Nannobrachium ritteri* | Has | 0.354 | link to | 71 |
| | | and | 0.339 | link to | 78 |
| | | and | 0.318 | link to | 296 |
| | | and | 0.359 | link to | 239 |
| | | and | 0.306 | link to | 261 |
| | | and | 0.419 | link to | 288 |
| 283 | *Notoscopelus resplendens* | Has | 0.318 | link to | 226 |
| 292 | *Stenobrachius leucopsarus* | Has | 0.376 | link to | 288 |
| 301 | *Triphoturus mexicanus* | Has | 0.381 | link to | 71 |
| | | and | 0.333 | link to | 78 |
| | | and | 0.444 | link to | 93 |
| | | and | 0.338 | link to | 226 |
| 514 | *Trachurus symmetricus* | Has | 0.331 | link to | 71 |
| | | and | 0.322 | link to | 296 |
| | | and | 0.303 | link to | 261 |
| 546 | *Tetragonurus cuvieri* | Has | 0.314 | link to | 78 |
| | | and | 0.328 | link to | 93 |
| | | and | 0.306 | link to | 226 |

**Oblique Recurrent Group 3**

| | | | | | |
|---|---|---|---|---|---|
| 68 | *Bathylagus ochotensis* | Has | 0.339 | link to | 260 |
| | | and | 0.612 | link to | 292 |
| 260 | *Nannobrachium ritteri* | Has | 0.322 | link to | 292 |
| 292 | *Stenobrachius leucopsarus* | | | | |

**Associates**

| | | | | | |
|---|---|---|---|---|---|
| 19 | *Sardinops sagax* | Has | 0.327 | link to | 292 |
| 684 | *Sebastes jordani* | Has | 0.400 | link to | 292 |
| 686 | *Sebastes paucispinis* | Has | 0.310 | link to | 292 |
| 514 | *Trachurus symmetricus* | Has | 0.346 | link to | 260 |

**Oblique Recurrent Group 4**

| | | | | | |
|---|---|---|---|---|---|
| 431 | *Paralabrax* spp. | Has | 0.374 | link to | 486 |
| 486 | *Sphyraena argentea* | | | | |

**Oblique Recurrent Group 5**

| | | | | | |
|---|---|---|---|---|---|
| 531 | *Peprilus simillimus* | Has | 0.354 | link to | 610 |
| 610 | Sciaenidae | | | | |

Table 9. List of taxa with station and month ranges used in calculating averages for atlas graphs.

| Taxon | Stations | Months |
|---|---|---|
| *Anisotremus davidsoni* | 27–33 | 6–8 |
| *Anoplopoma fimbria* | 42–90 | 1–5 |
| *Aristostomias scintillans* | 53–120 | 1–12 |
| *Atherinops affinis* | 27–51 | 3–11 |
| *Atherinopsis californiensis* | 27–55 | 11–7 |
| *Atractoscion nobilis* | 27–55 | 4–8 |
| *Bathophilus flemingi* | 80–120 | 1–12 |
| *Bathylagus ochotensis* | 50–100 | 1–5 |
| *Bolinichthys longipes* | 90–120 | 9–11 |
| *Ceratoscopelus townsendi* | 53–120 | 1–12 |
| *Cheilopogon heterurus* | 27–80 | 6–10 |
| *Cheilopogon pinnatibarbatus* | 27–53 | 5–11 |
| *Chromis punctipinnis* | 27–60 | 7–10 |
| *Citharichthys sordidus* | 28–90 | 1–12 |
| *Citharichthys stigmaeus* | 30–100 | 1–12 |
| *Cololabis saira* | 27–120 | 1–12 |
| *Cololabis saira* eggs | 27–120 | 1–12 |
| *Coryphopterus nicholsii* | 33–70 | 1–9 |
| *Cryptotrema corallinum* [a] | 42–51 | 3–7 |
| *Cyclothone signata* | 60–120 | 1–11 |
| *Diaphus* spp. | 60–120 | 4–10 |
| *Diogenichthys atlanticus* | 45–120 | 1–12 |
| *Engraulis mordax* | 27–120 | 1–12 |
| *Engraulis mordax* eggs | 27–120 | 1–12 |
| *Etrumeus teres* | 27–51 | 4–10 |
| *Fodiator acutus* | 27–60 | 7–10 |
| *Genyonemus lineatus* | 27–55 | 10–3 |
| *Gigantactis* spp. | 70–120 | 7–1 |
| *Girella nigricans* | 27–60 | 4–11 |
| *Halichoeres semicinctus* | 27–70 | 4–10 |
| *Hemilepidotus spinosus* [b] | 46.9–60 | 1–3 |
| *Hermosilla azurea* | 27–40 | 7–8 |
| *Hexagrammos decagrammus* | 33–60 | 1–4 |
| *Hexagrammos lagocephalus* [c] | 33–55 | 1–3 |
| *Hypsoblennius gentilis* | 27–51 | 4–12 |
| *Hypsoblennius gilberti* | 27–60 | 4–10 |
| *Hypsoblennius jenkinsi* | 27–55 | 4–11 |
| *Hypsypops rubicundus* | 27–53 | 6–9 |
| *Icichthys lockingtoni* | 51–110 | 1–12 |
| *Icosteus aenigmaticus* | 55–80 | 1–5 |
| *Lampadena urophaos* | 80–120 | 7–11 |
| *Leuresthes tenuis* | 27–51 | 4–8 |
| *Leuroglossus stilbius* | 33–100 | 1–4 |
| *Macroramphosus gracilis* | 28–70 | 1–12 |
| *Medialuna californiensis* | 27–100 | 5–11 |
| *Merluccius productus* | 28–110 | 10–4 |
| *Microstomus pacificus* | 50–90 | 3–8 |
| *Nannobrachium regale* | 55–120 | 1–10 |
| *Nannobrachium ritteri* | 40–120 | 1–12 |
| *Neoclinus blanchardi* | 27–55 | 1–12 |
| *Neoclinus stephensae* | 27–55 | 1–12 |
| *Ophidion scrippsae* | 27–60 | 3–8 |
| *Ophiodon elongatus* | 27–55 | 1–4 |
| *Oxyjulis californica* | 27–70 | 4–10 |
| *Oxylebius pictus* | 28–90 | 10–7 |
| *Paralabrax* spp. | 27–60 | 6–10 |
| *Paralichthys californicus* | 27–60 | 1–10 |
| *Parophrys vetulus* | 30–60 | 1–5 |
| *Peprilus simillimus* | 27–70 | 3–11 |
| *Pleuronichthys coenosus* | 27–60 | 1–12 |
| *Pleuronichthys decurrens* | 30–70 | 10–5 |
| *Pleuronichthys verticalis* | 27–60 | 1–10 |
| *Protomyctophum crockeri* | 51–120 | 1–7 |
| *Rathbunella alleni* | 33–51 | 2–5 |
| *Sarda chiliensis* | 27–42 | 4–8 |
| *Sardinops sagax* | 27–120 | 1–12 |
| *Sardinops sagax* eggs | 27–120 | 1–12 |
| *Scomber japonicus* | 27–100 | 3–10 |
| *Scorpaena guttata* | 27–45 | 7–8 |
| *Scorpaenichthys marmoratus* [d] | 27–70 | 10–5 |
| *Sebastes aurora* | 30–80 | 1–8 |
| *Sebastes diploproa* | 27–100 | 1–12 |
| *Sebastes jordani* | 27–60 | 1–5 |
| *Sebastes levis* | 27–60 | 1–5 |
| *Sebastes paucispinis* | 28–60 | 1–5 |
| *Sebastes* spp. | 27–80 | 1–12 |
| *Sebastolobus* spp. | 55–60 | 3–7 |
| *Semicossyphus pulcher* | 40–60 | 4–10 |
| *Seriola lalandi* | 27–60 | 8–10 |
| *Seriphus politus* | 27–51 | 2–8 |
| *Sphyraena argentea* | 27–55 | 4–10 |
| *Stenobrachius leucopsarus* | 27–120 | 12–5 |
| *Stomias atriventer* | 45–120 | 1–12 |
| *Symbolophorus californiensis* | 55–120 | 1–7 |
| *Synodus lucioceps* | 27–60 | 7–1 |
| *Tactostoma macropus* | 50–120 | 1–10 |
| *Tetragonurus cuvieri* | 35–120 | 1–12 |
| Total eggs | 27–120 | 1–12 |
| Total larvae | 27–120 | 1–12 |
| *Trachurus symmetricus* | 27–110 | 2–10 |
| *Triphoturus mexicanus* | 28–120 | 3–10 |
| *Vinciguerria lucetia* | 55–120 | 1–12 |
| *Xenistius californiensis* | 27–51 | 6–10 |

[a] lines 80–83
[b] lines 77–82
[c] lines 77–80
[d] lines 77–87

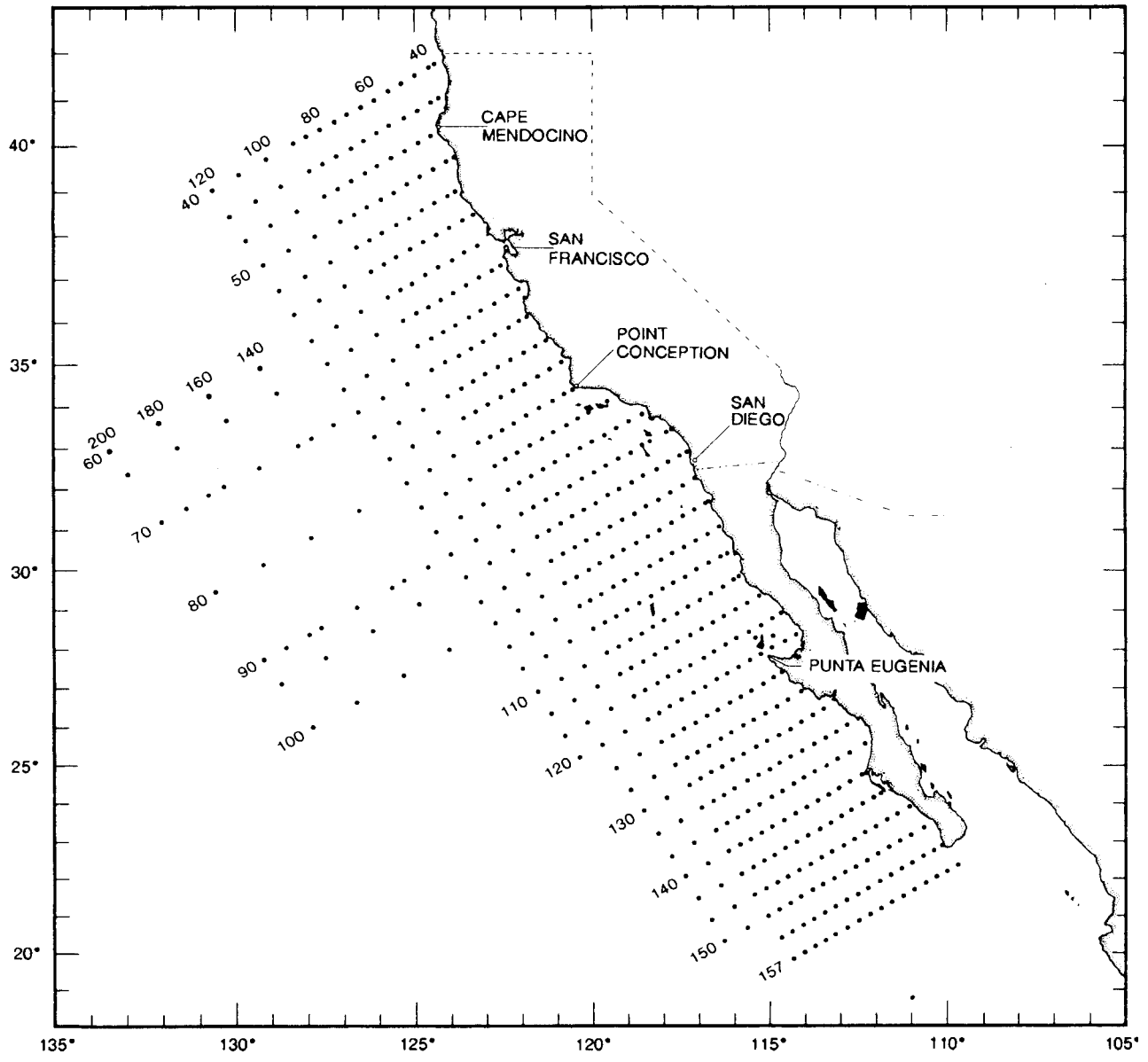



Figure 1. The basic CalCOFI station pattern occupied, in part, by cruises during 1951-1984.

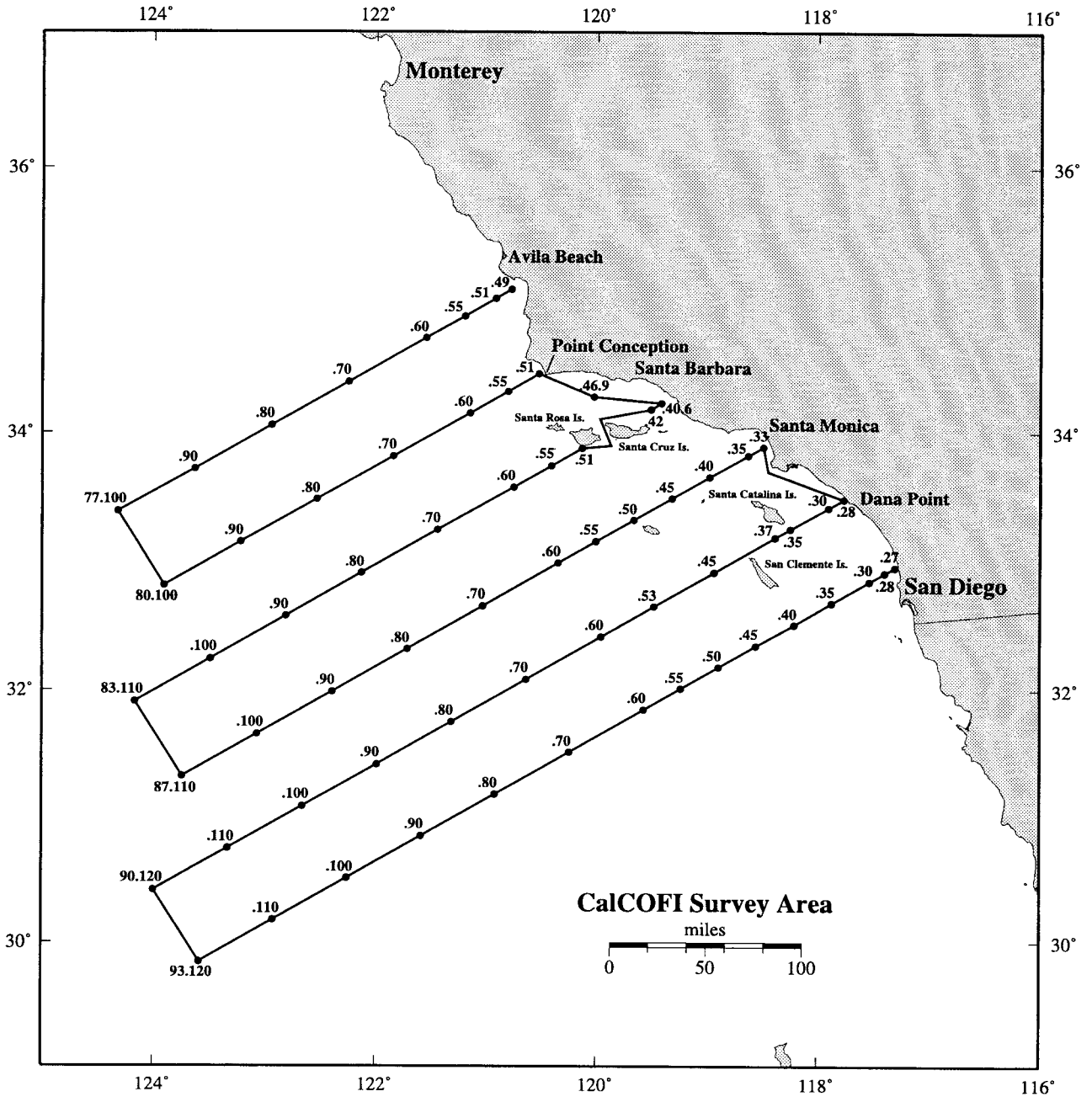



Figure 2. Basic station plan for CalCOFI survey cruises from 1985 to the present.

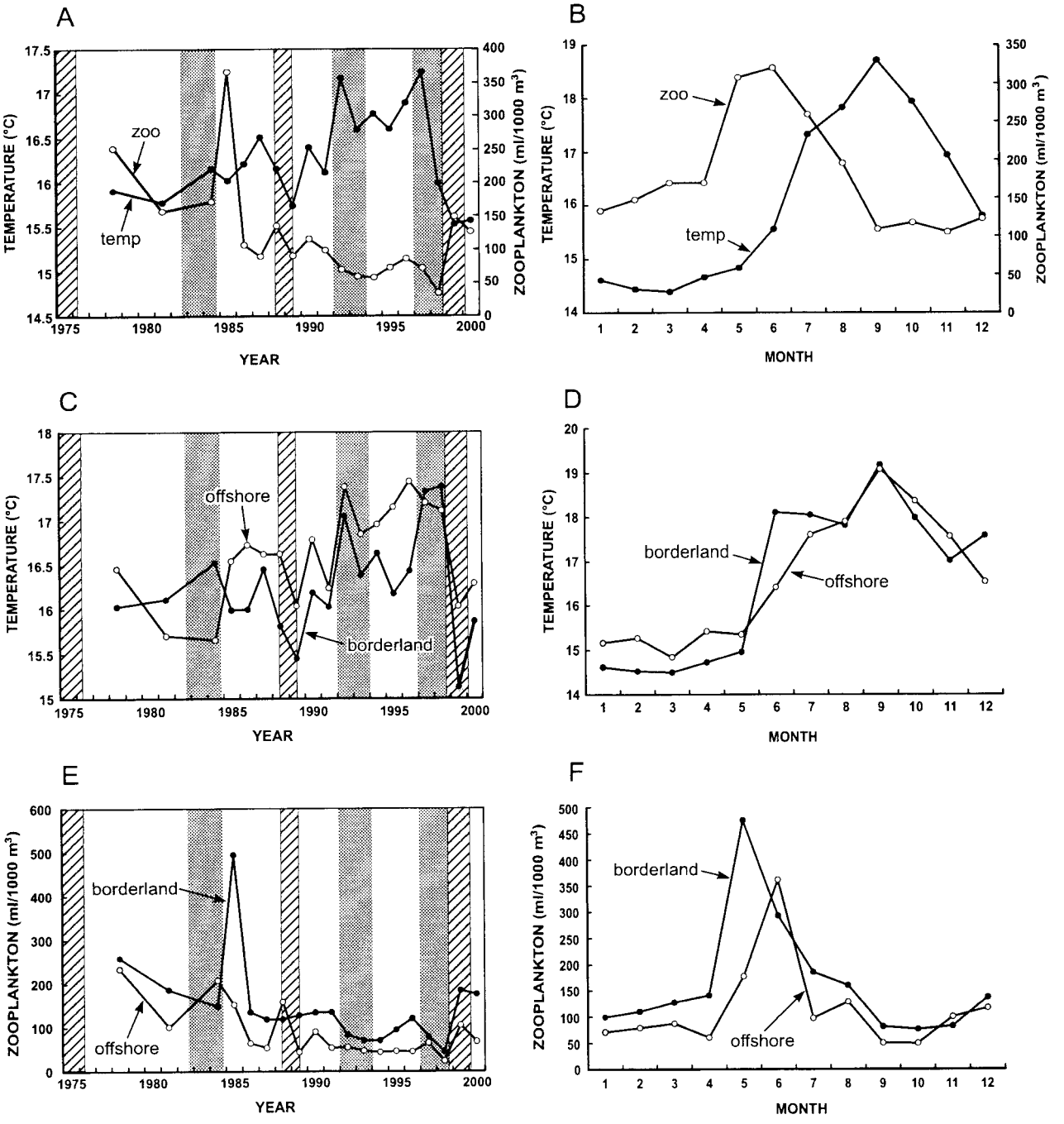



Figure 3. Average seasonal and annual temperatures and zooplankton volumes for CalCOFI stations used in this study. A) Annual temperatures (dots) and zooplankton volumes (circles) during 1978-2000; B) Monthly temperatures (dots) and zooplankton volumes (circles); C) Annual temperatures, borderland vs. offshore regions; D) Monthly temperatures, borderland vs. offshore regions; E) Annual zooplankton volumes, borderland vs. offshore regions; F) Monthly zooplankton volumes, borderland vs. offshore regions. ENSO events are indicated by vertical bars (El Niño, shading; La Niña, hatching.)

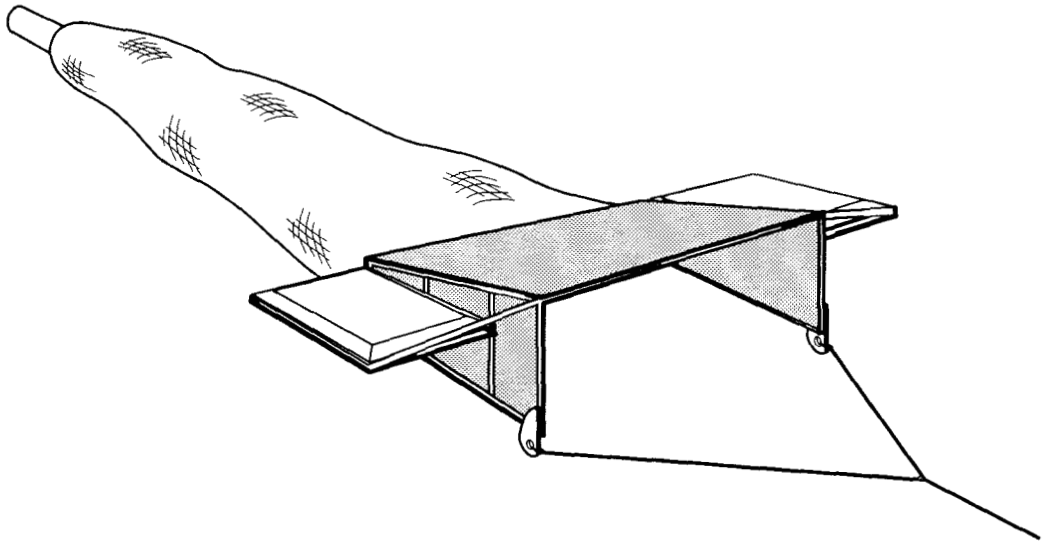


Figure 4. Diagram of the Manta net used on CalCOFI surveys, modified from the original Manta net developed by Brown and Cheng (1981).

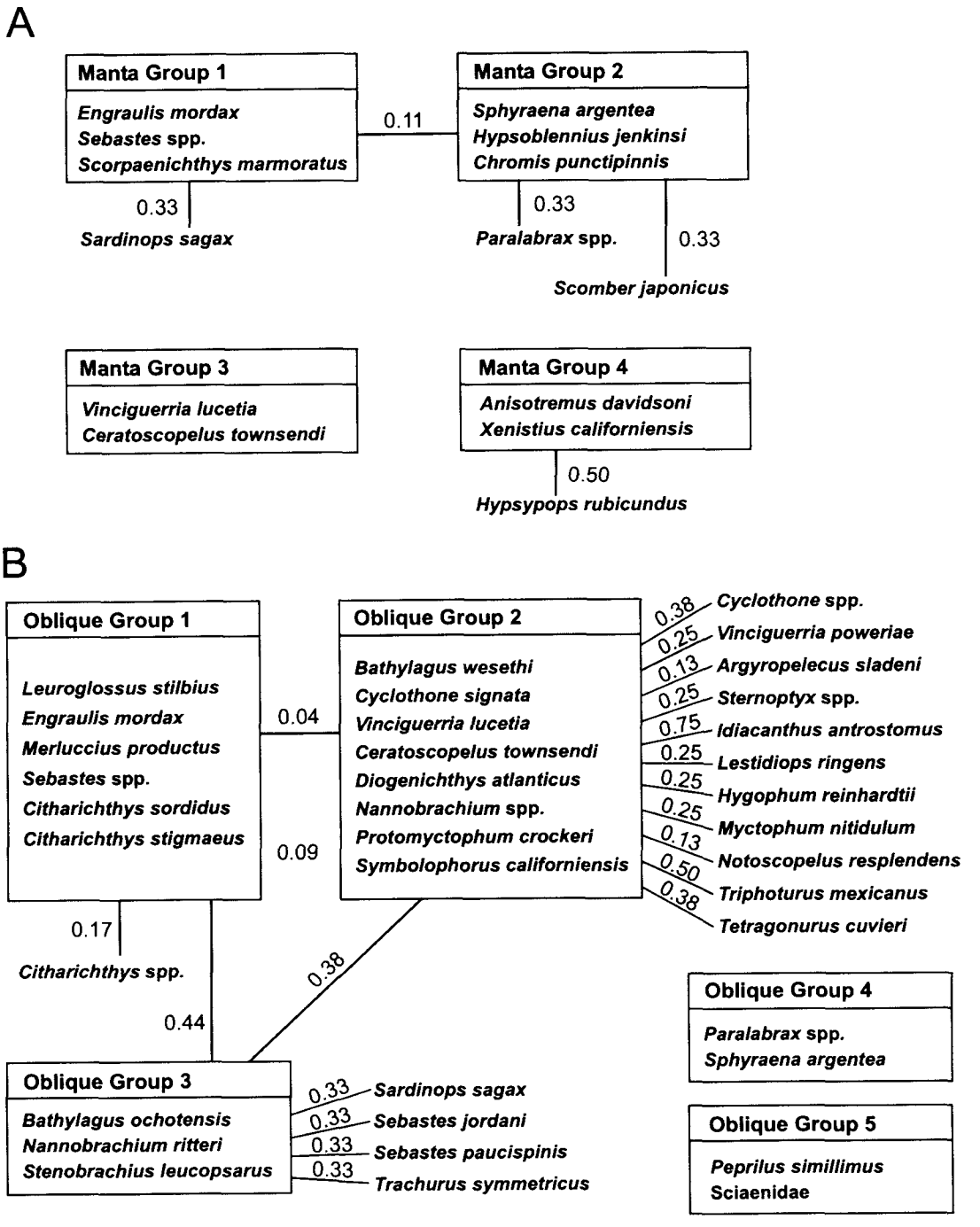



Figure 5. Recurrent groups of fish larvae from Manta net (A) and oblique net (B) samples taken on CalCOFI survey cruises during 1978-2000 in the SCB region. Fractions near lines connecting groups with other groups or with associate taxa indicate the number of significant pairs (affinity indices $\geq 0.3$) divided by the number of possible pairs.

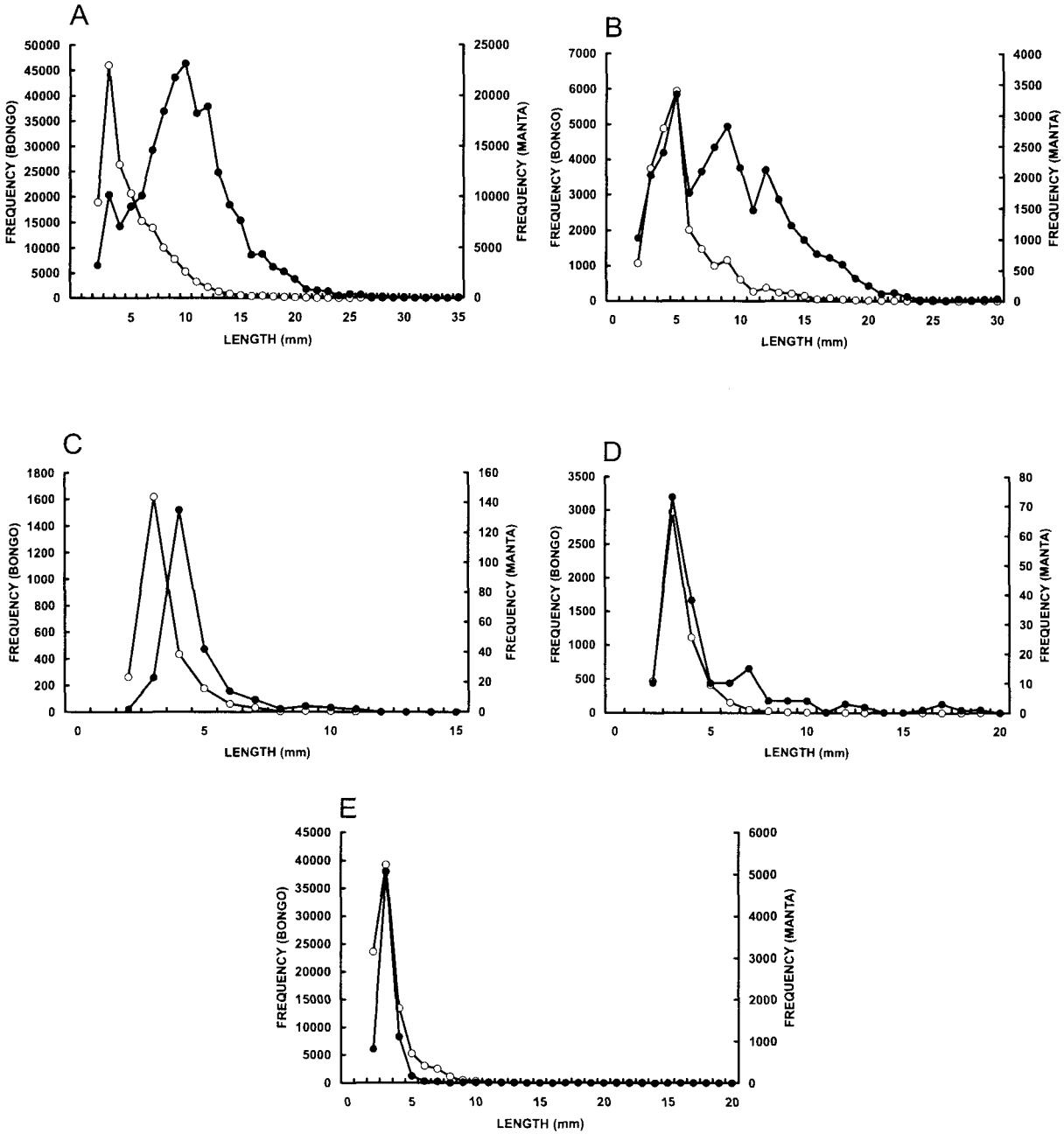


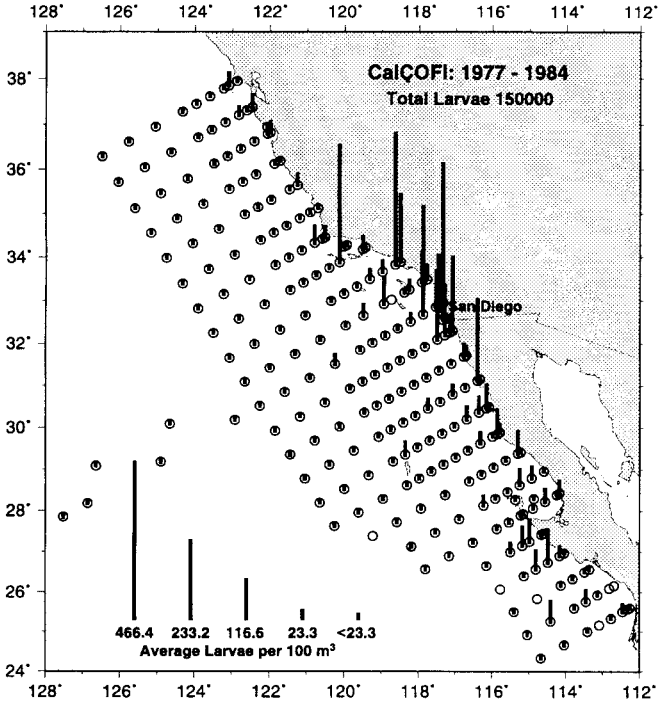

Figure 6. Length frequency distributions for larvae of five fish species taken in Manta (dots) and oblique (circles) net tows on CalCOFI surveys during 1978-2000 in the SCB region: A) northern anchovy *Engraulis mordax*; B) Pacific sardine *Sardinops sagax*; C) chub mackerel *Scomber japonicus*; D) jack mackerel *Trachurus symmetricus*; E) Pacific hake *Merluccius productus*.

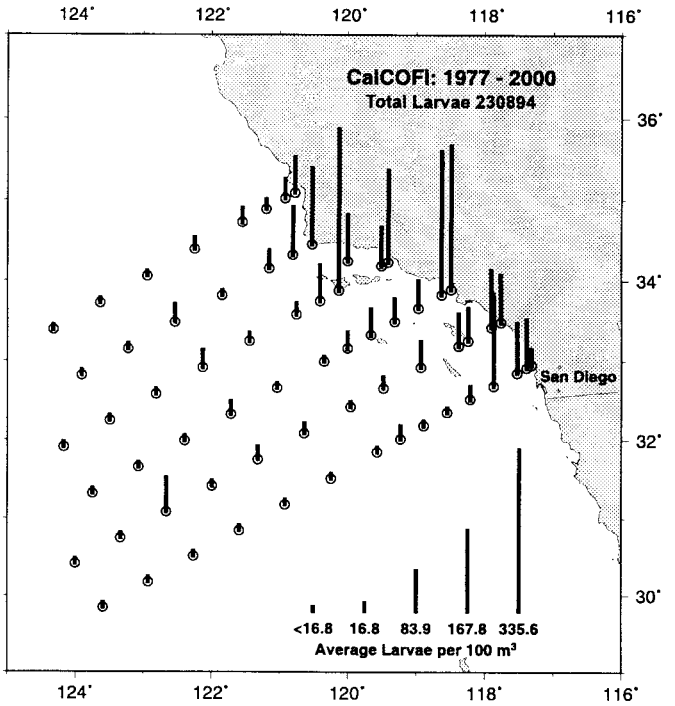
## List of Taxa

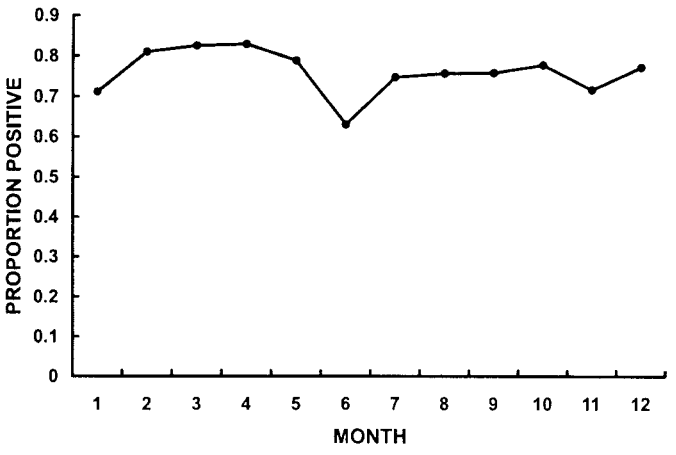
# CHARTS AND GRAPHS

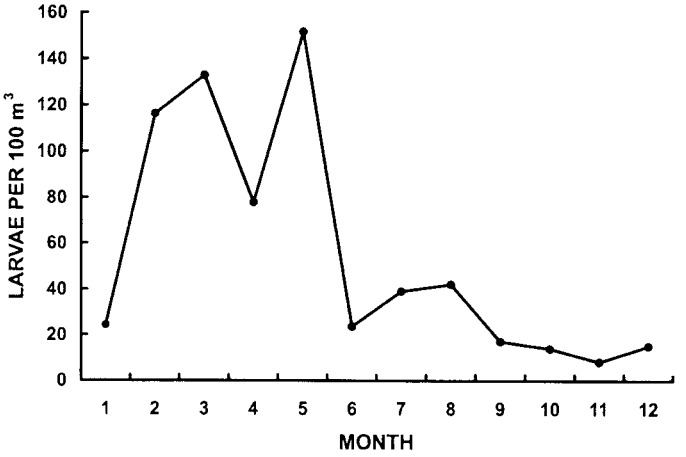
## TOTAL FISH LARVAE

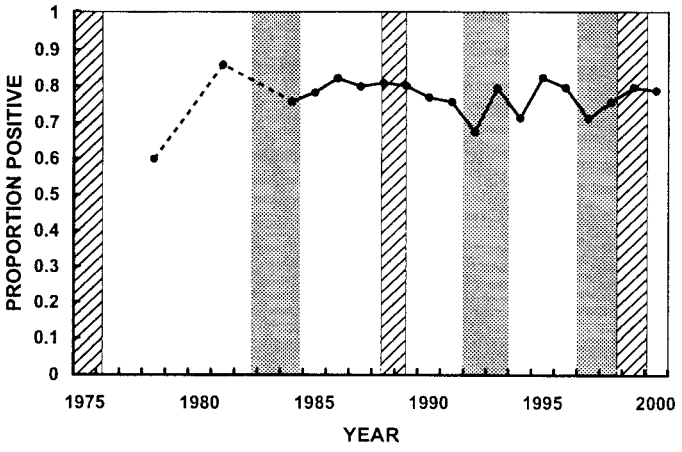
TOTAL FISH LARVAE

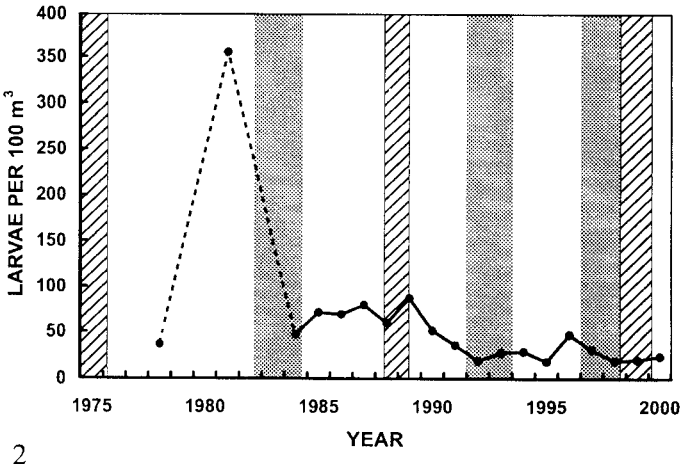


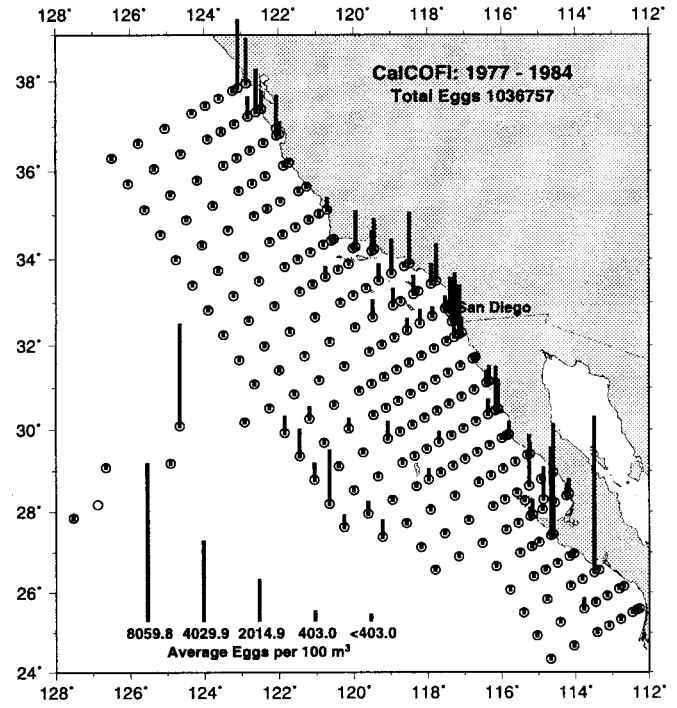



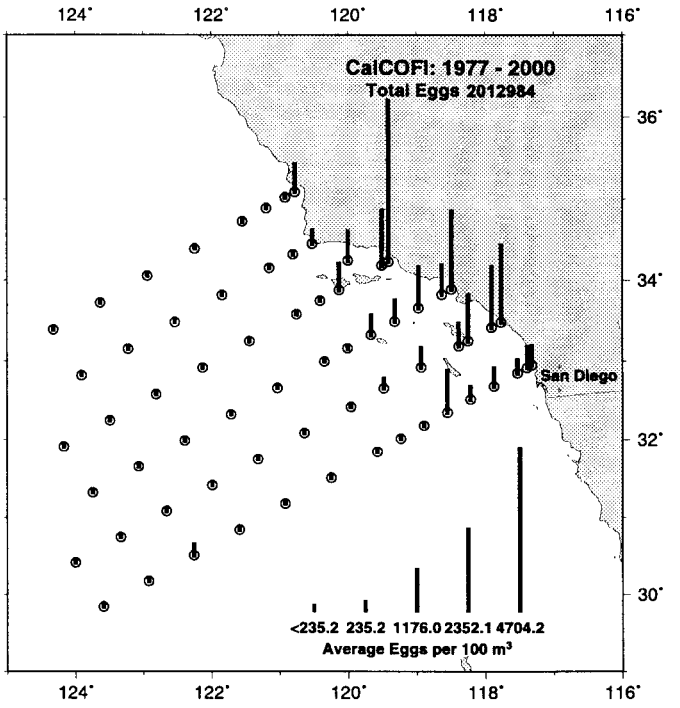



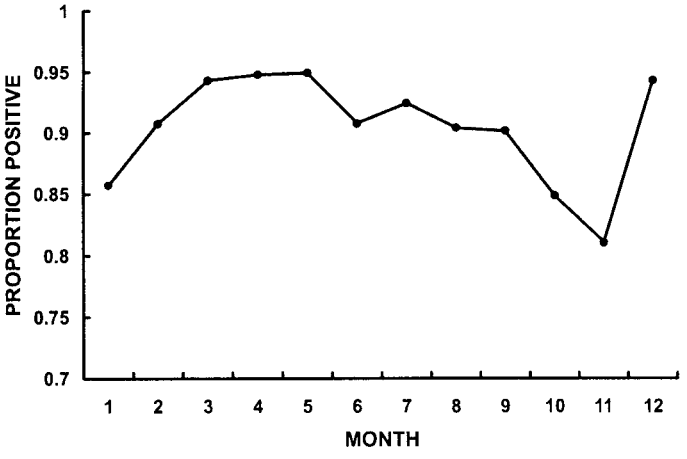



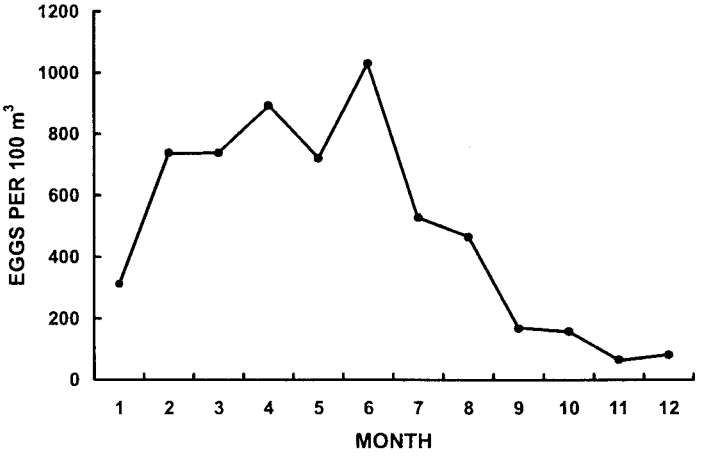
TOTAL FISH EGGS

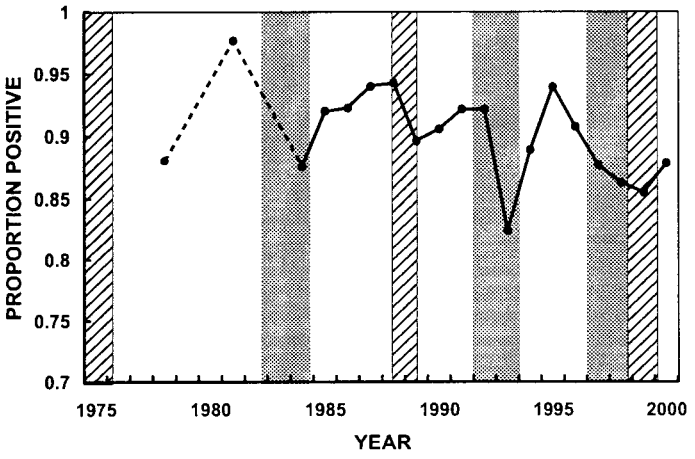


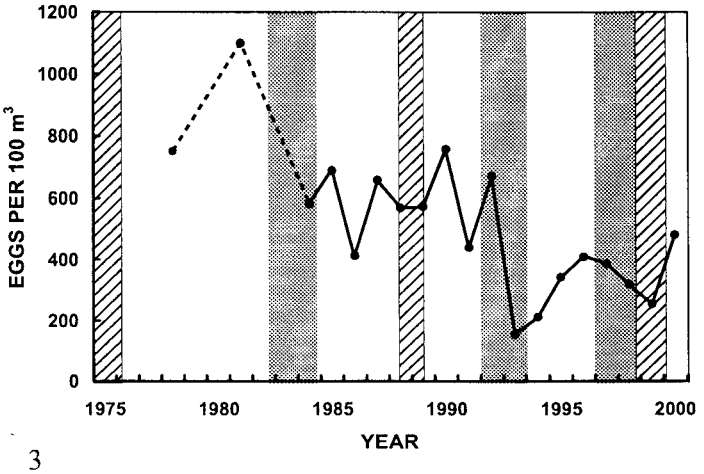

**TOTAL FISH EGGS**

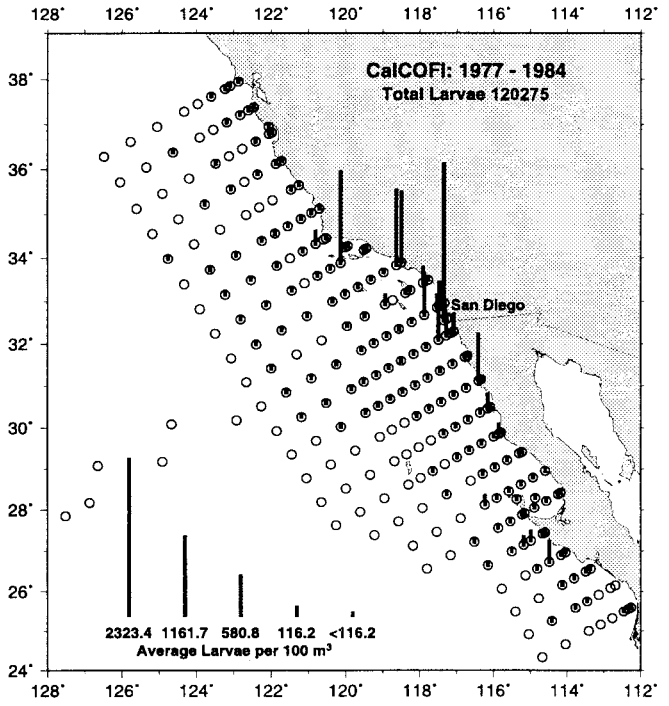


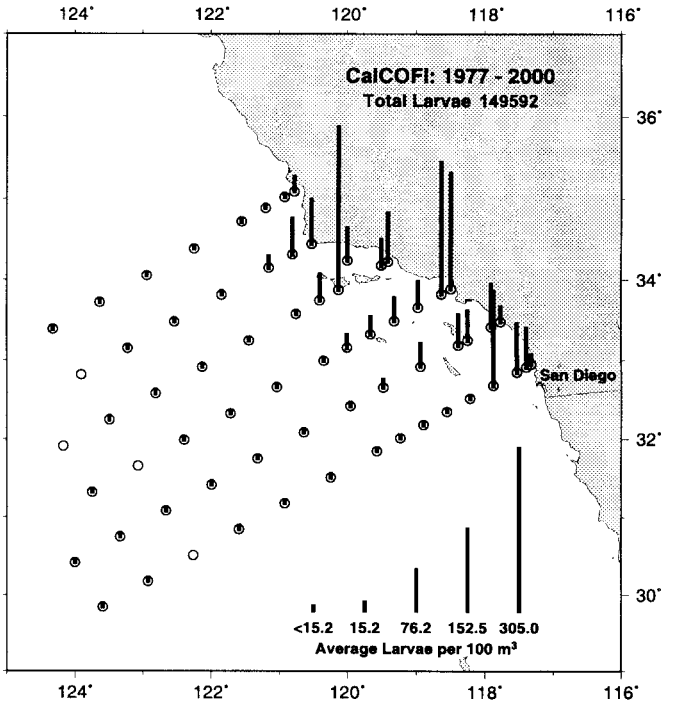



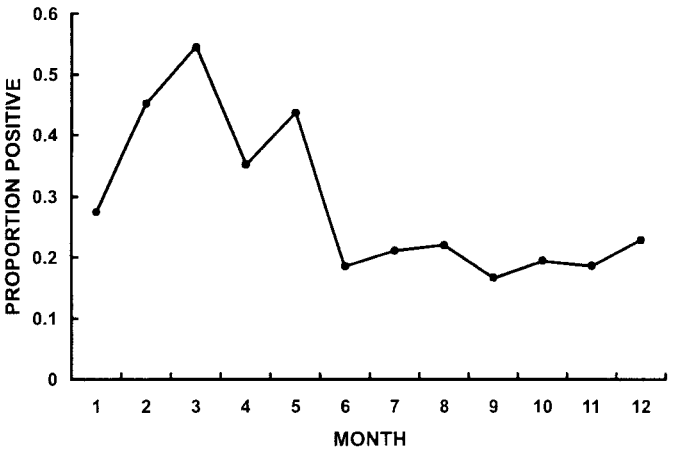



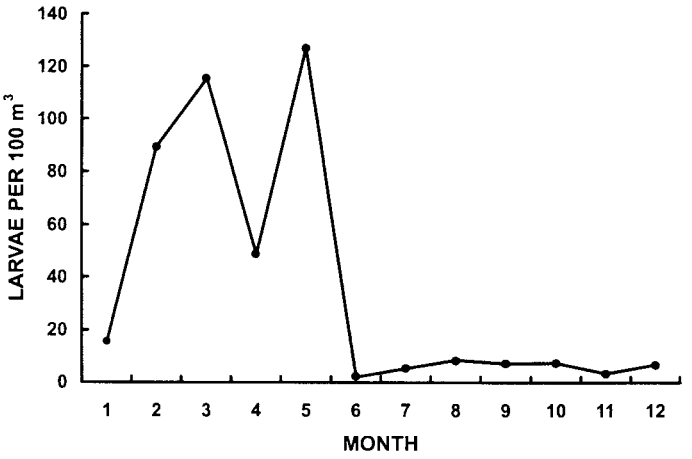



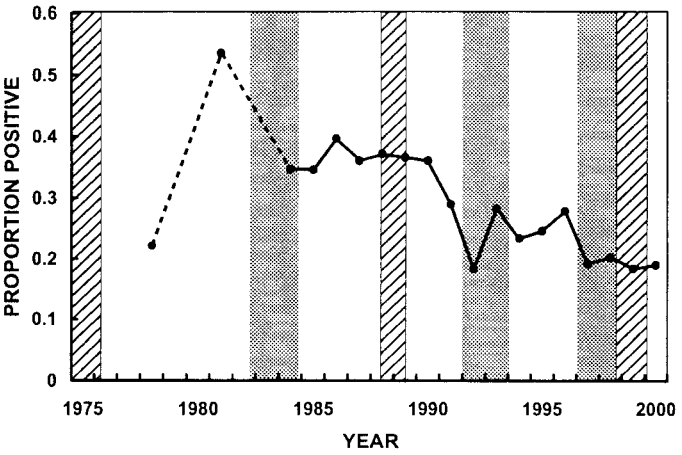



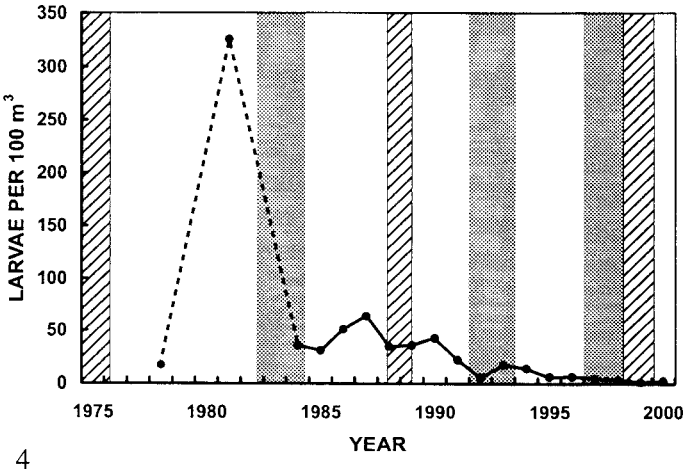

CalCOFI: 1977 - 1984
Total Larvae 120275
San Diego
2323.4 1161.7 580.8 116.2 <116.2
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 149592
San Diego
<15.2 15.2 76.2 152.5 305.0
Average Larvae per 100 m³

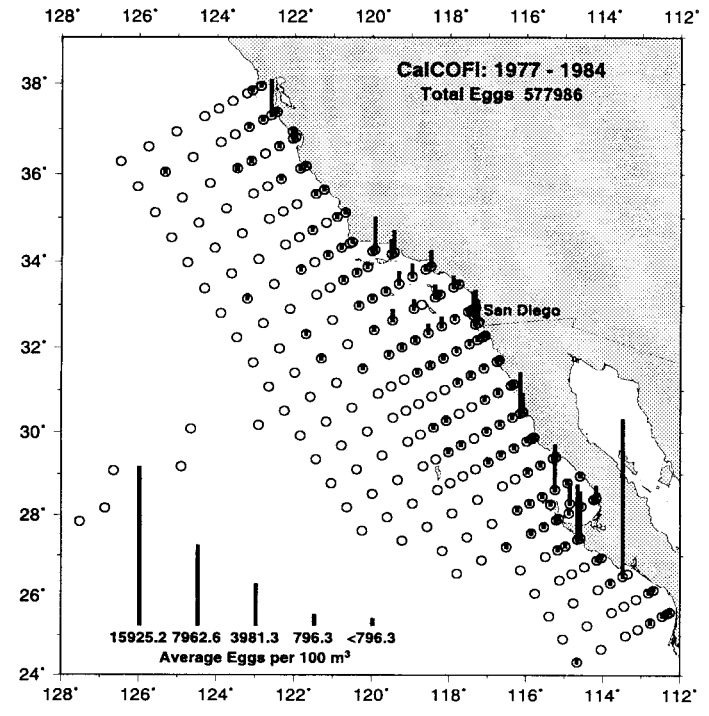

PROPORTION POSITIVE
MONTH

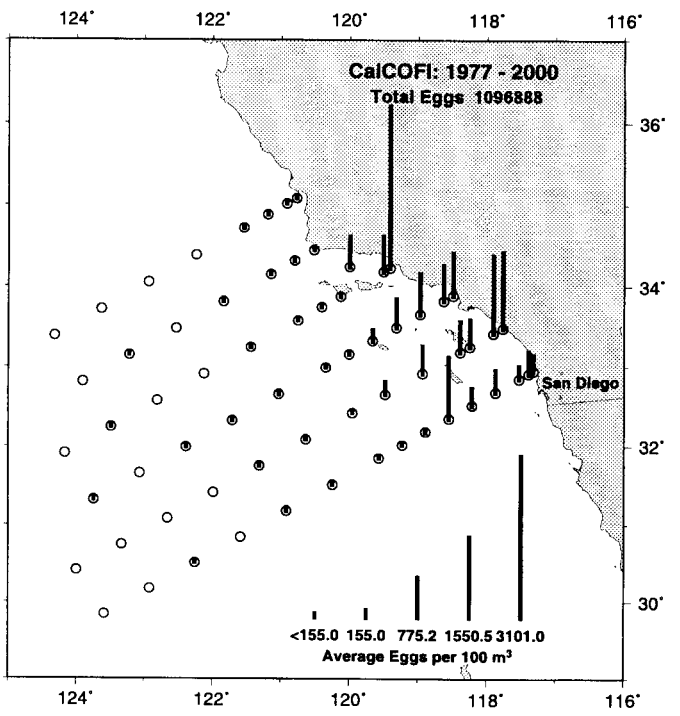

LARVAE PER 100 m³
MONTH

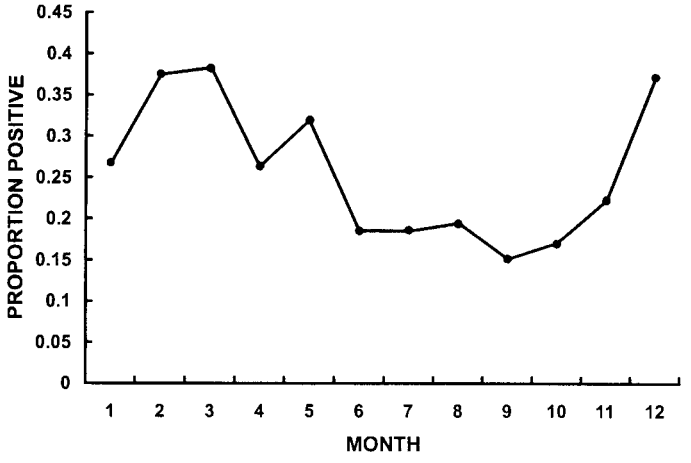

PROPORTION POSITIVE
YEAR

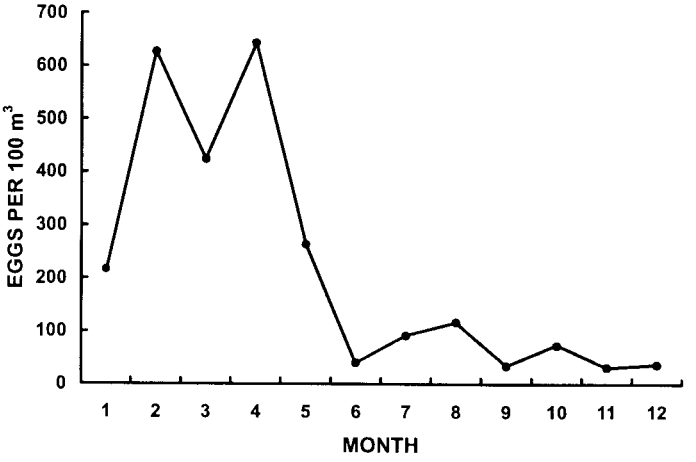

LARVAE PER 100 m³
YEAR

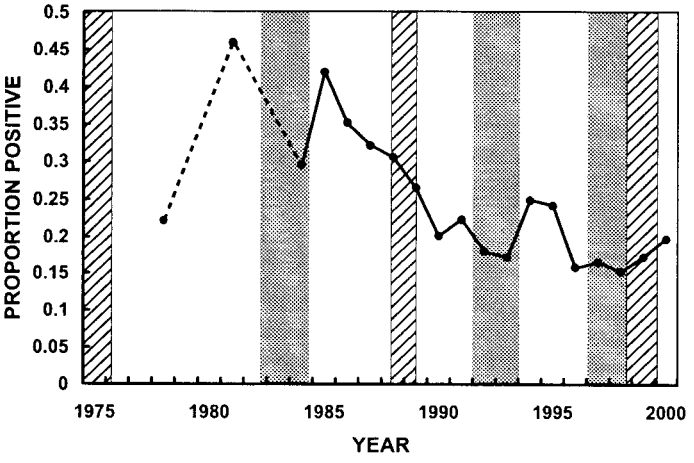
ENGRAULIDAE Northern anchovy eggs ***Engraulis mordax* eggs**

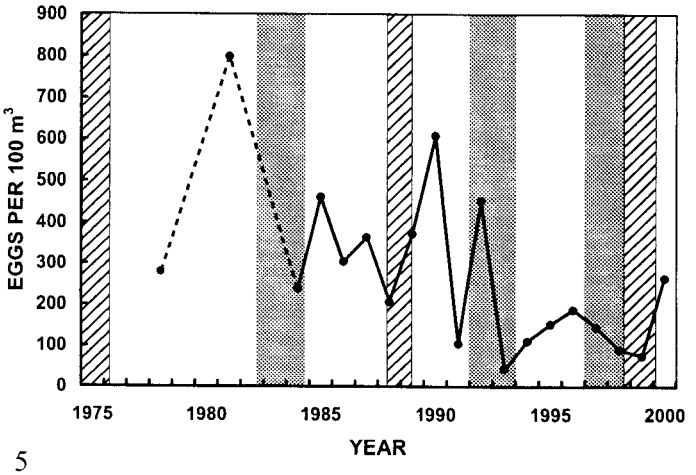


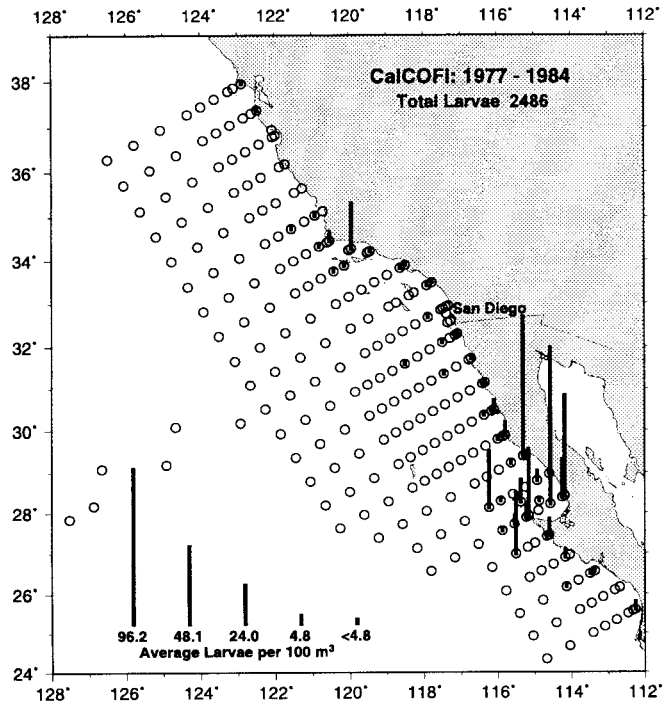



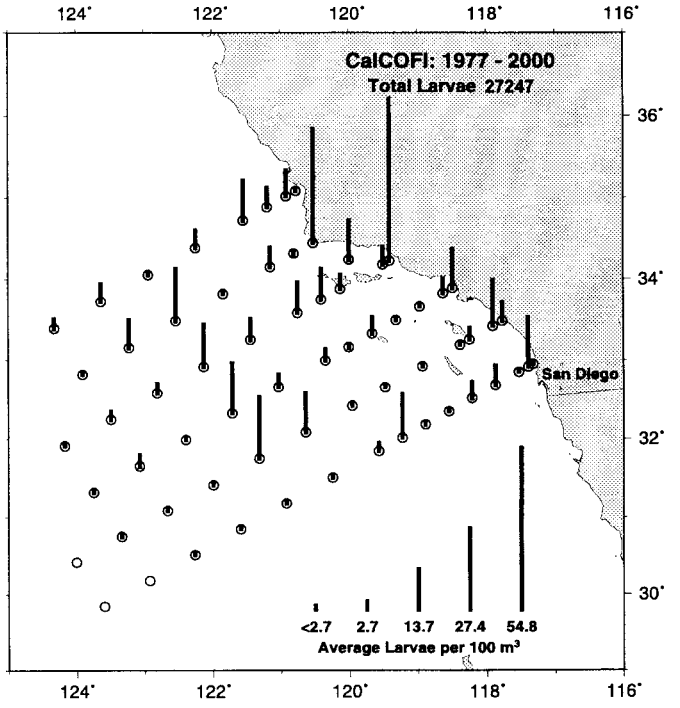



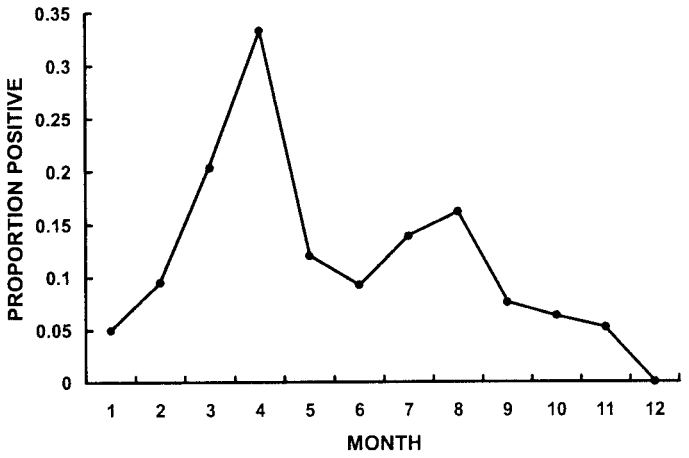



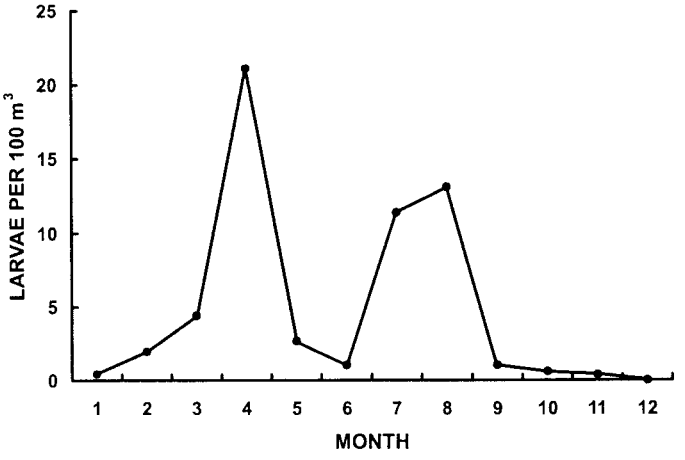



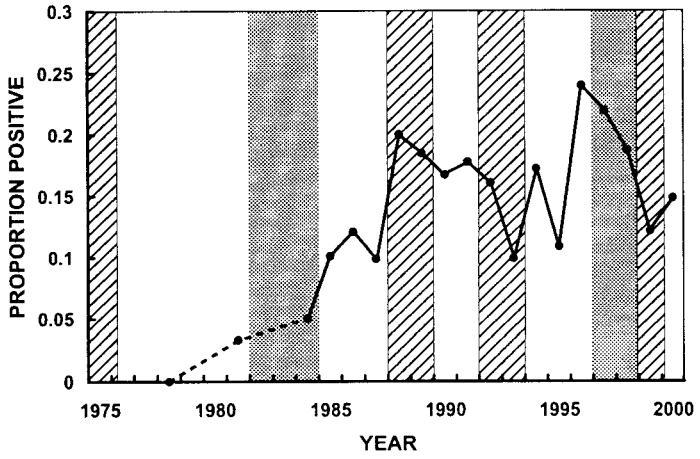



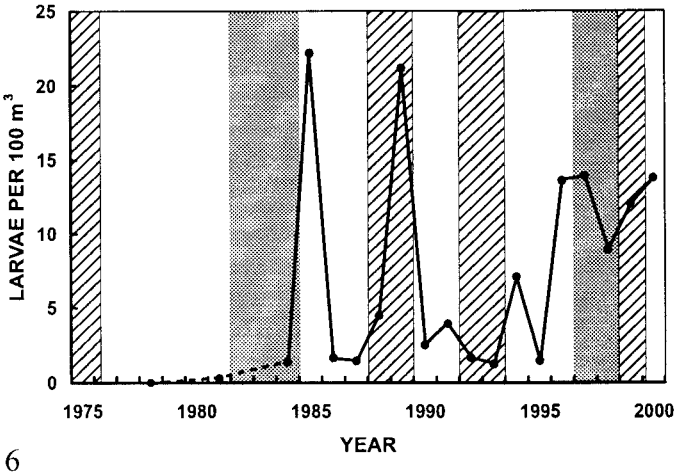

CalCOFI: 1977 - 1984
Total Larvae 2486
San Diego
96.2 48.1 24.0 4.8 <4.8
Average Larvae per 100 m³

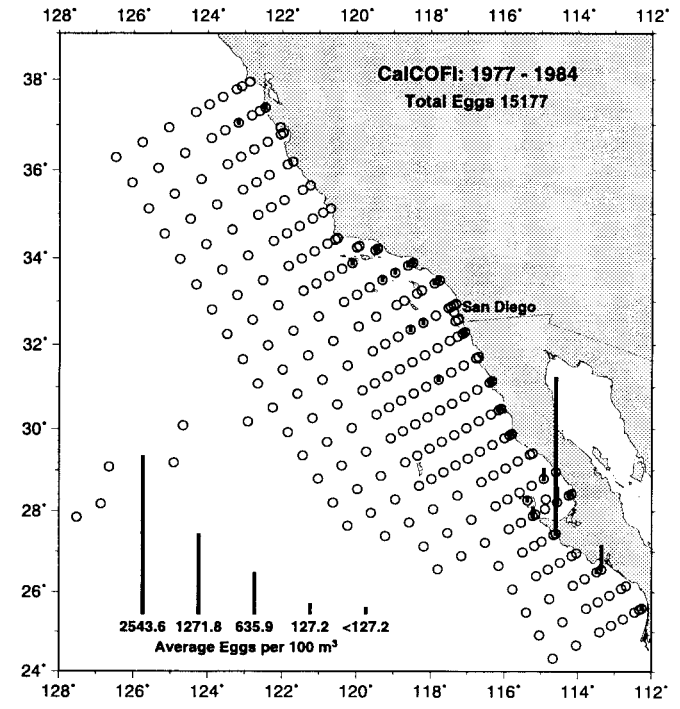

CalCOFI: 1977 - 2000
Total Larvae 27247
San Diego
<2.7 2.7 13.7 27.4 54.8
Average Larvae per 100 m³

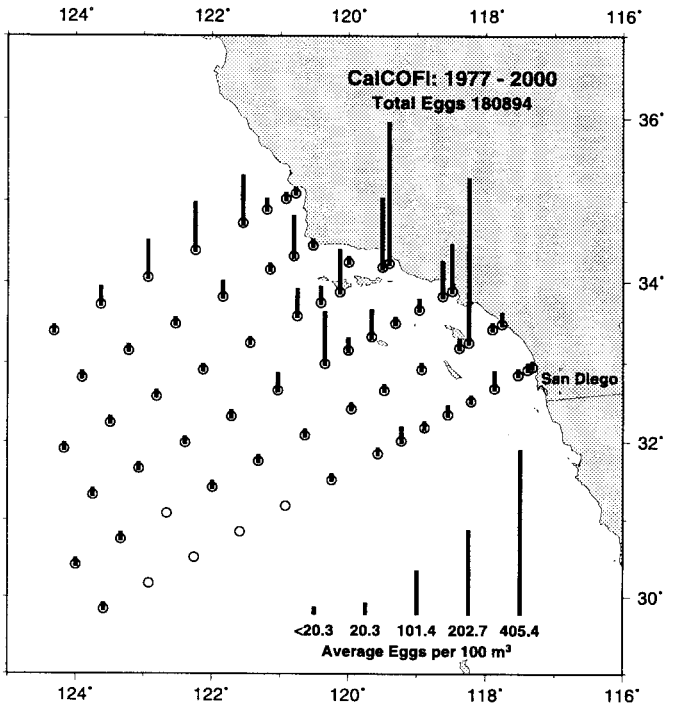

PROPORTION POSITIVE
MONTH

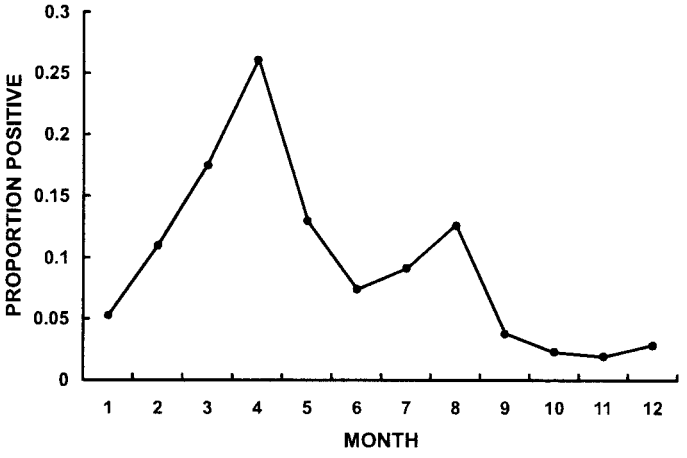

LARVAE PER 100 m³
MONTH

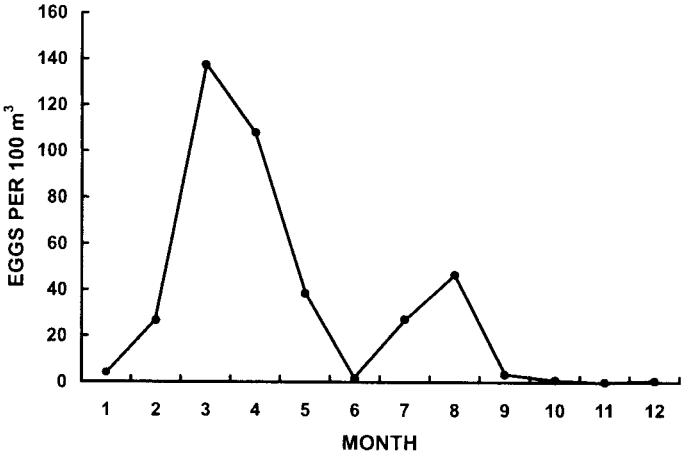

PROPORTION POSITIVE
YEAR

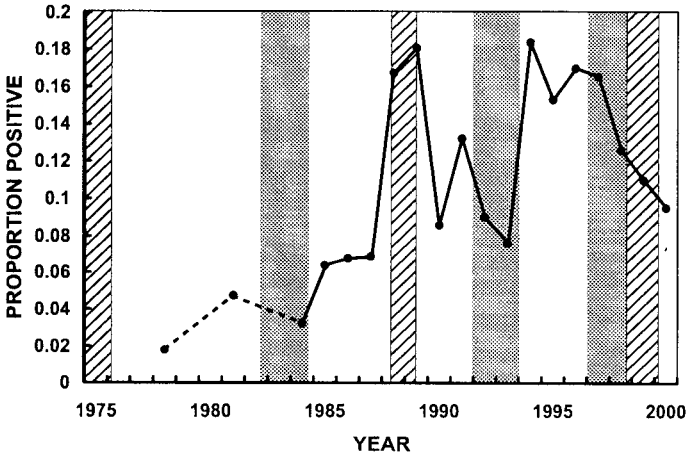

LARVAE PER 100 m³
YEAR

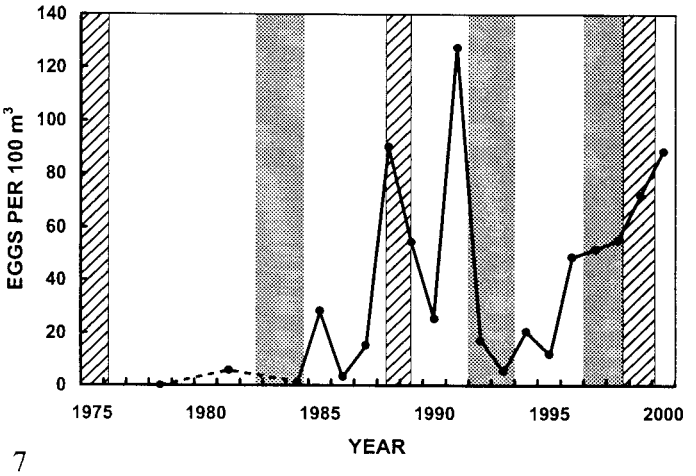

CalCOFI: 1977 - 1984
Total Eggs 15177
San Diego
2543.6 1271.8 635.9 127.2 <127.2
Average Eggs per 100 m³


CalCOFI: 1977 - 2000
Total Eggs 180894
San Diego
<20.3 20.3 101.4 202.7 405.4
Average Eggs per 100 m³

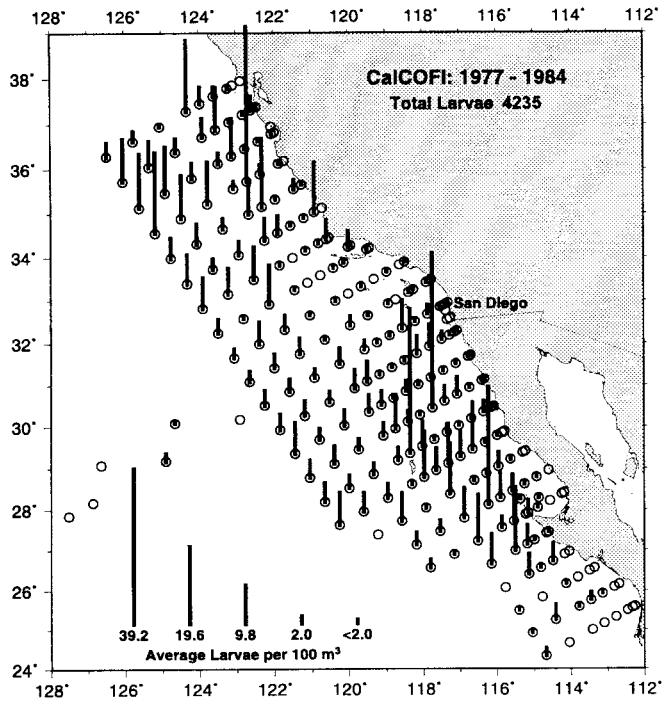

PROPORTION POSITIVE
MONTH

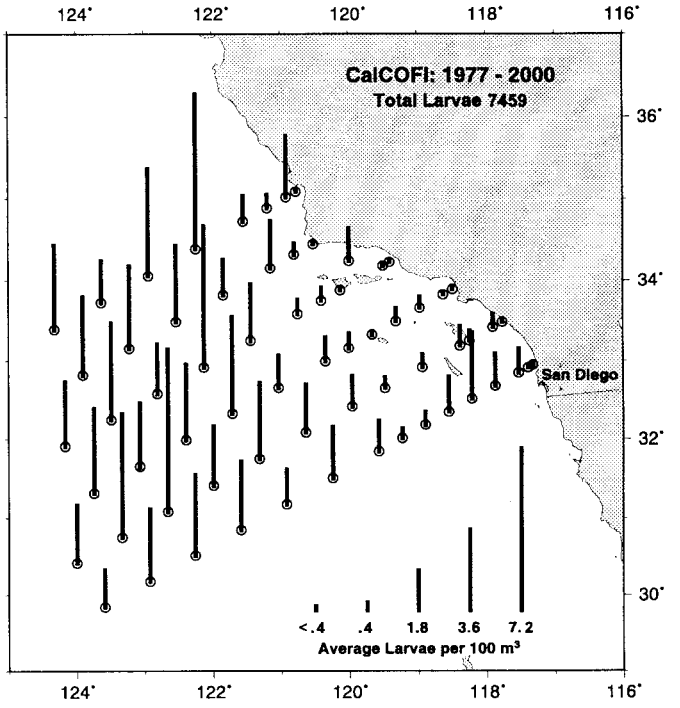

EGGS PER 100 m³
MONTH

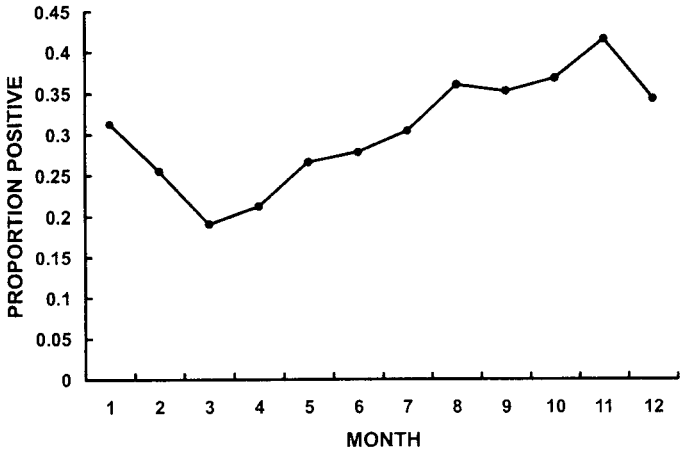

PROPORTION POSITIVE
YEAR

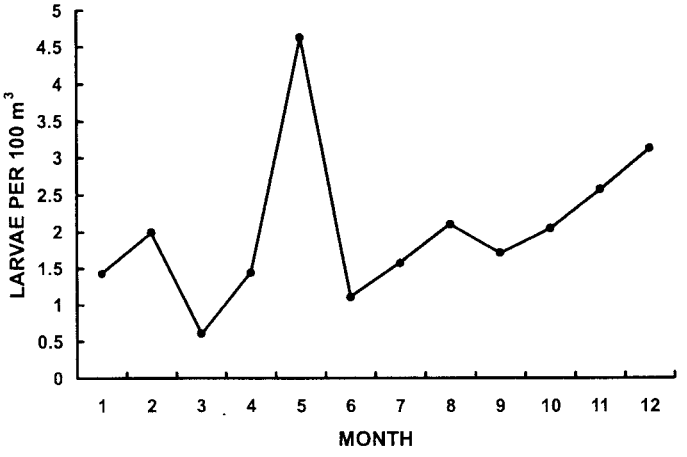

EGGS PER 100 m³
YEAR

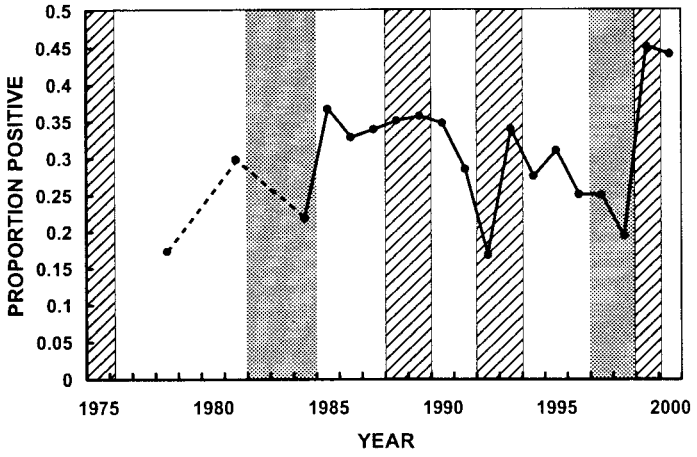
***Cololabis saira* larvae** Pacific saury larvae SCOMBERESOCIDAE

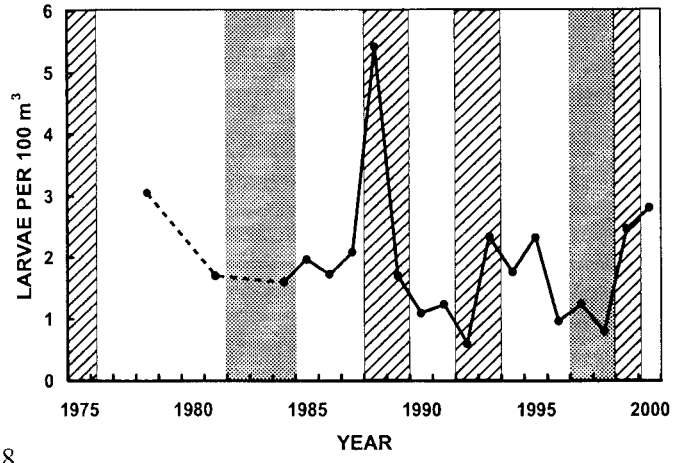


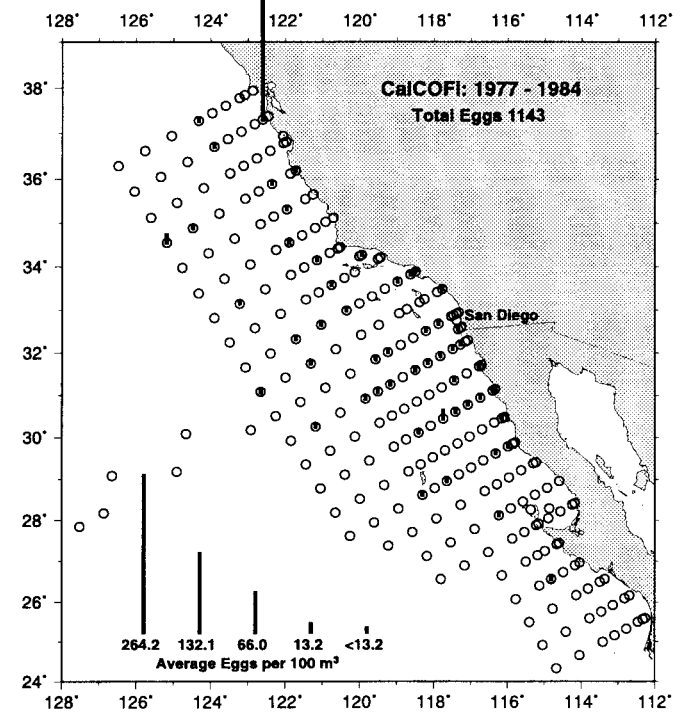



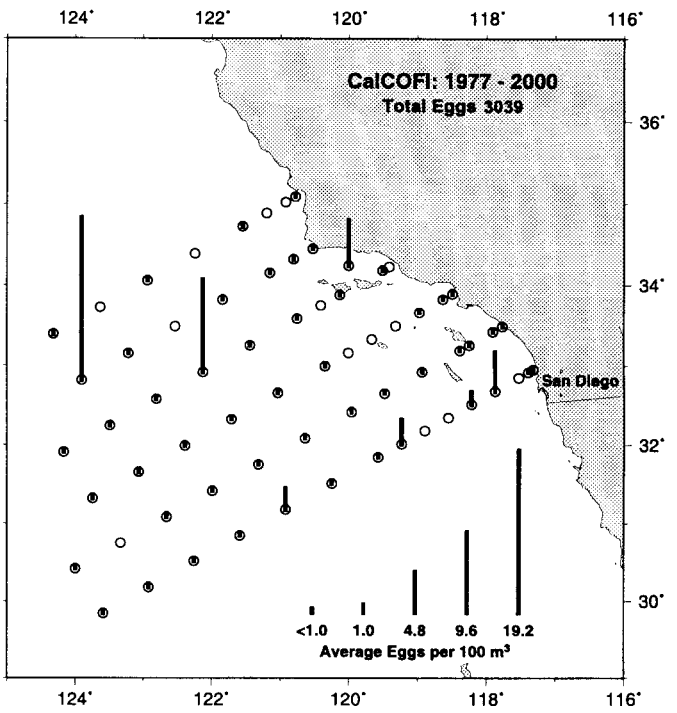



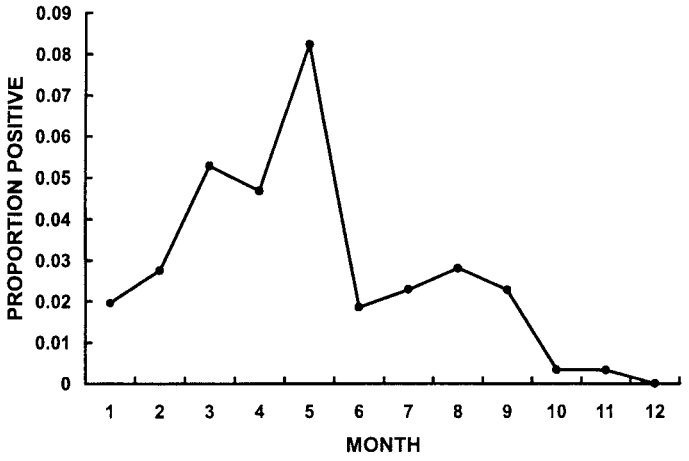



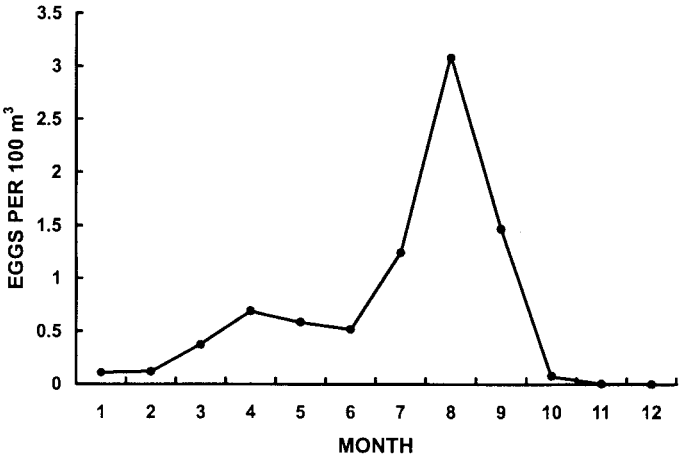



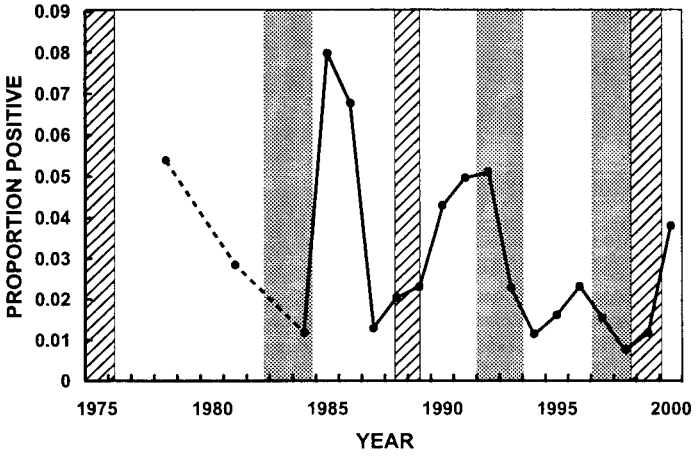
SCOMBERESOCIDAE Pacific saury eggs ***Cololabis saira* eggs**

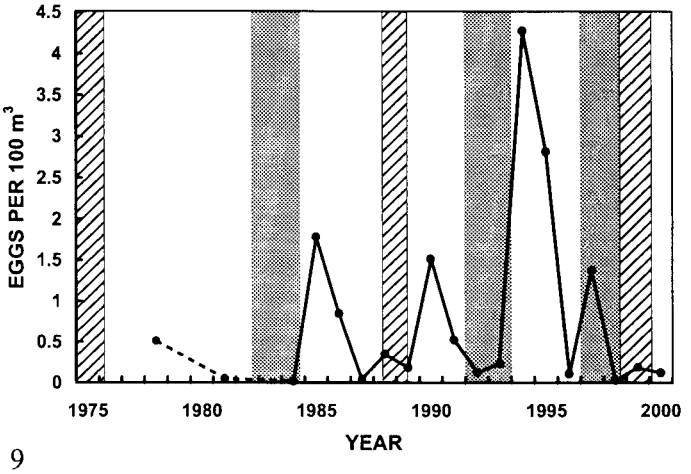


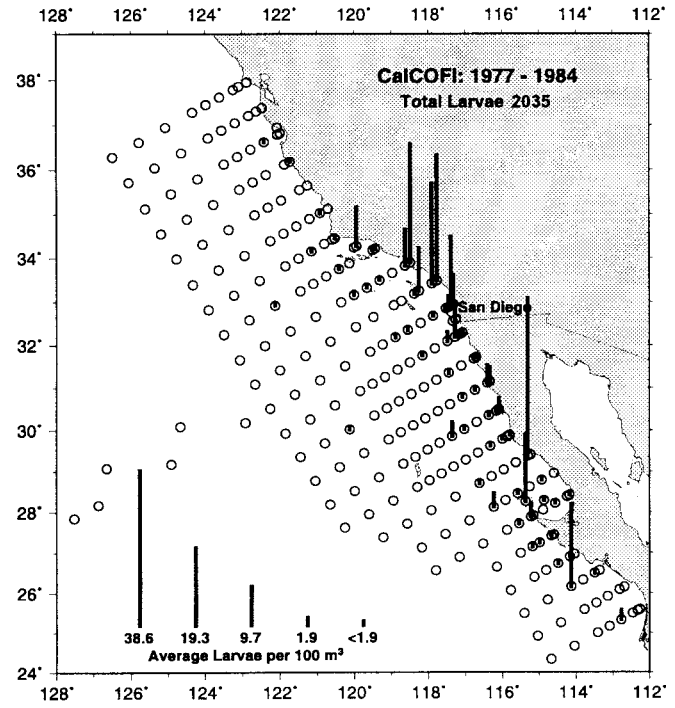



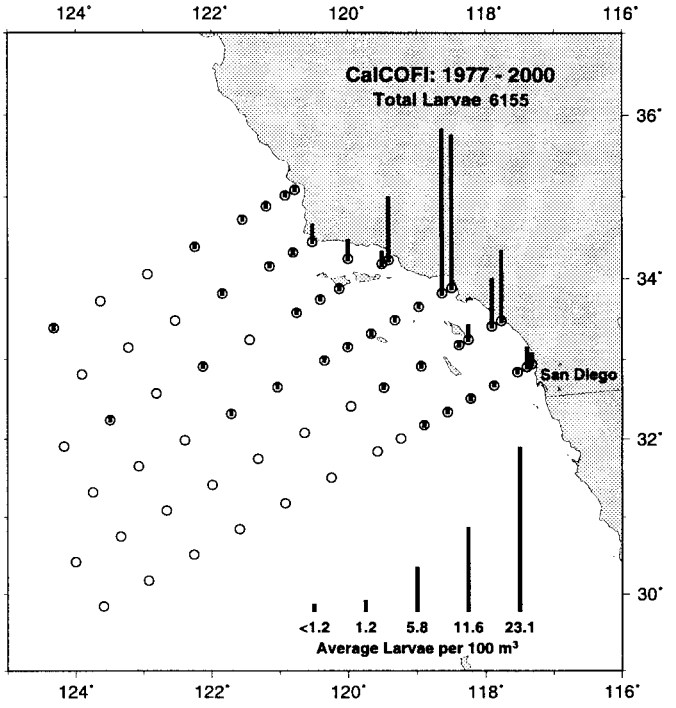



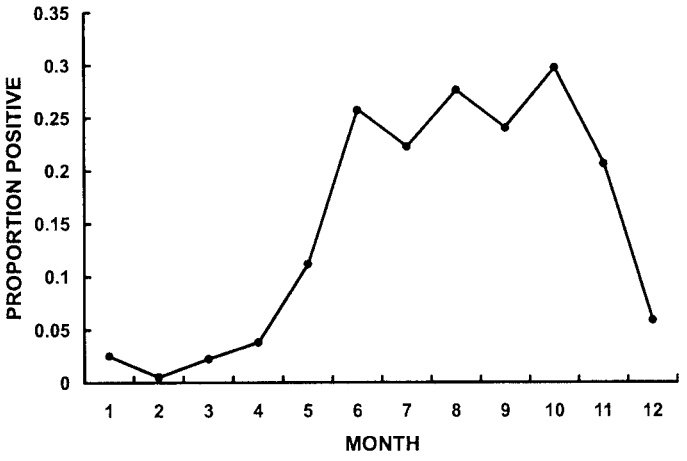



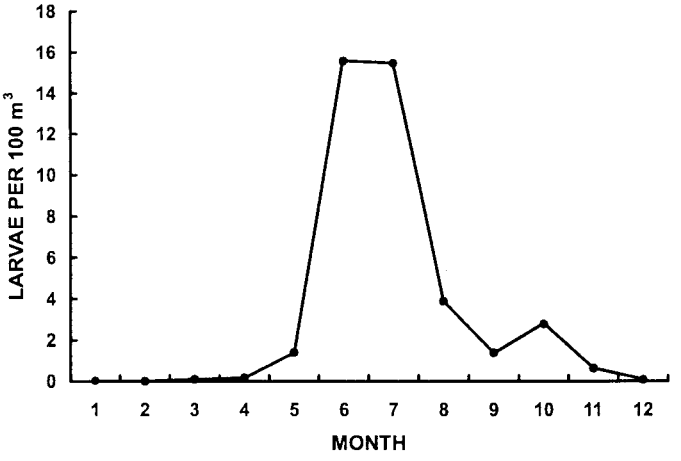



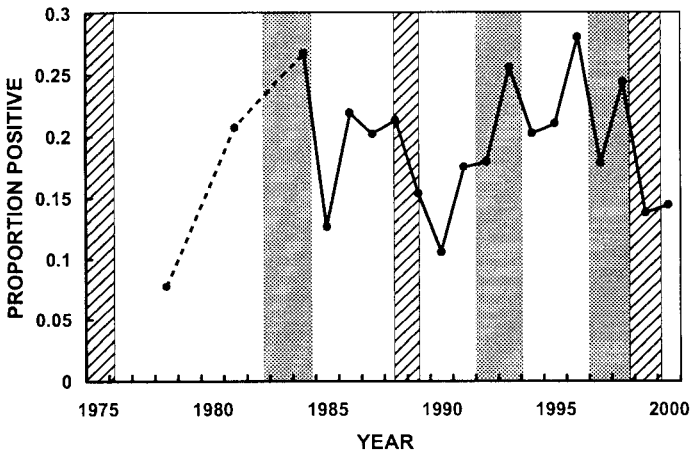
***Hypsoblennius jenkinsi*** Mussel blenny BLENNIIDAE

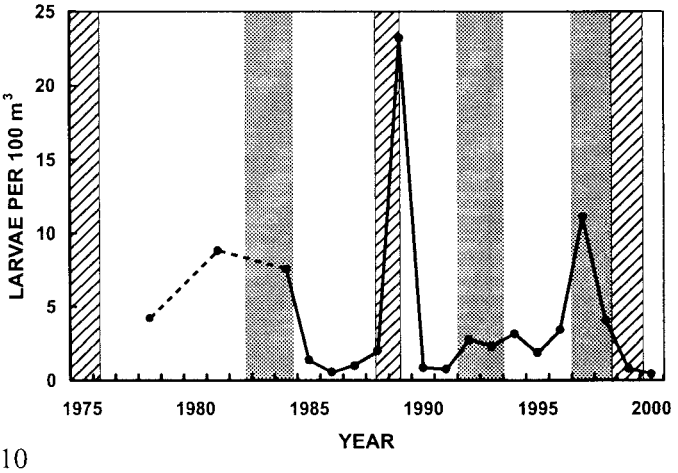


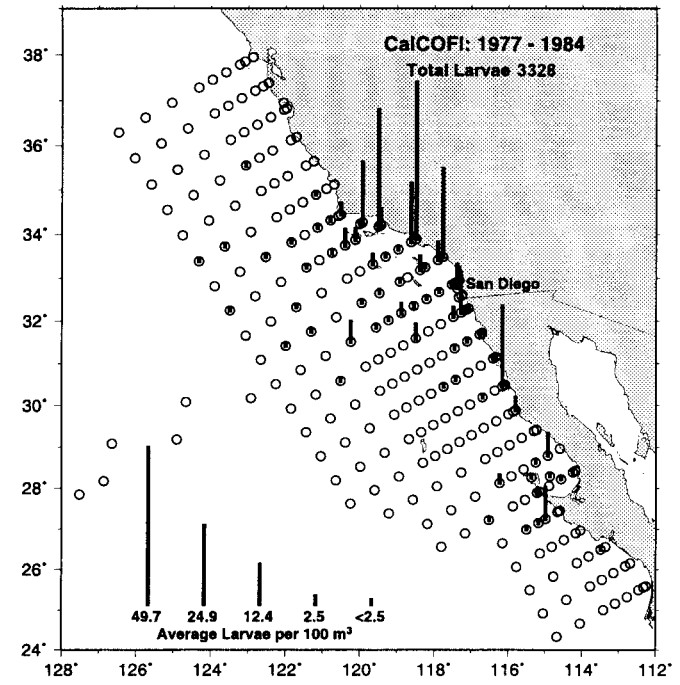



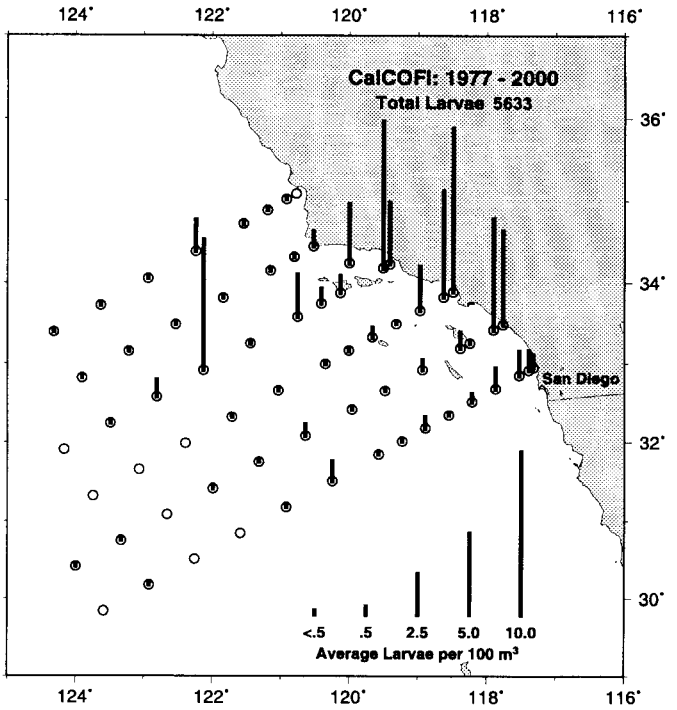



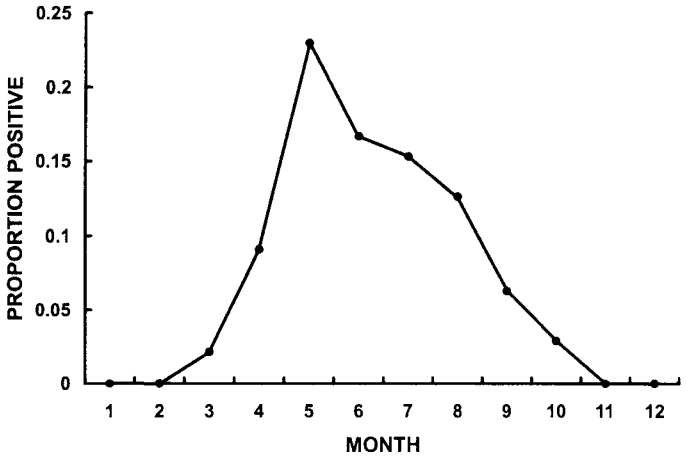



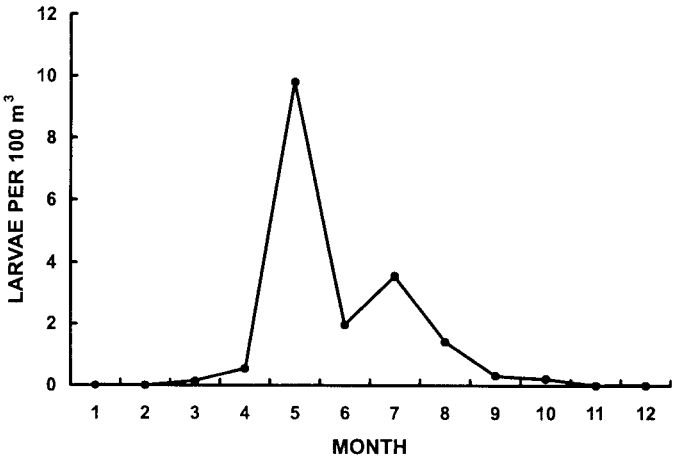



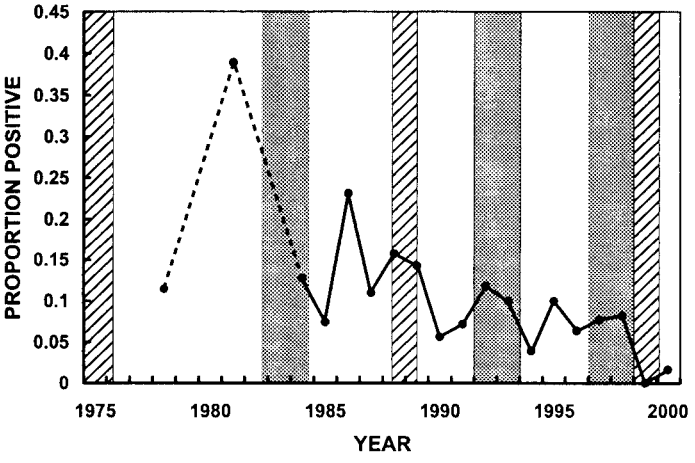



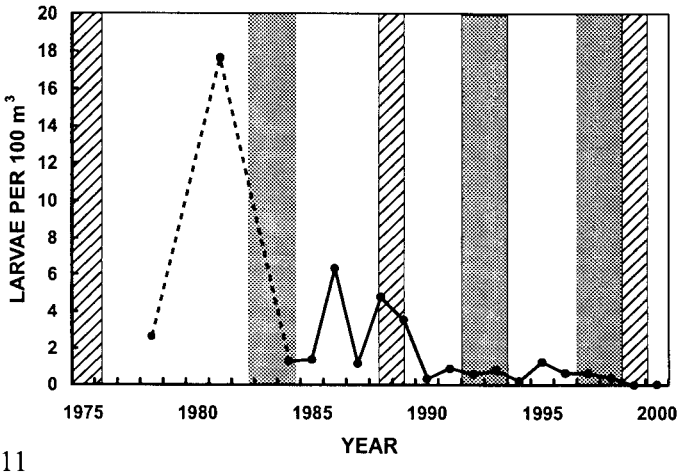

CalCOFI: 1977 - 1984
Total Larvae 3328
San Diego
49.7 24.9 12.4 2.5 <2.5
Average Larvae per 100 m³
38° 36° 34° 32° 30° 28° 26° 24°
128° 126° 124° 122° 120° 118° 116° 114° 112°

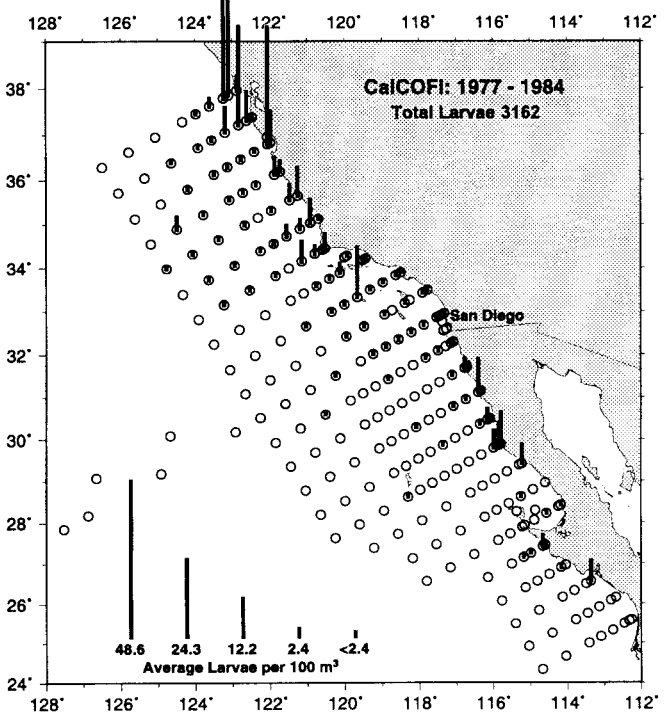

CalCOFI: 1977 - 2000
Total Larvae 5633
San Diego
<.5 .5 2.5 5.0 10.0
Average Larvae per 100 m³
124° 122° 120° 118° 116°
36° 34° 32° 30°

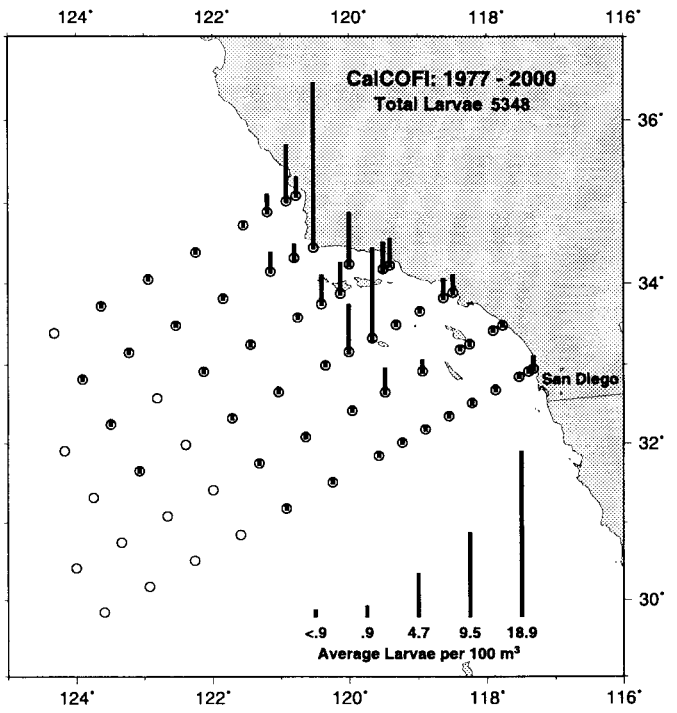

PROPORTION POSITIVE
0.25 0.2 0.15 0.1 0.05 0
1 2 3 4 5 6 7 8 9 10 11 12
MONTH

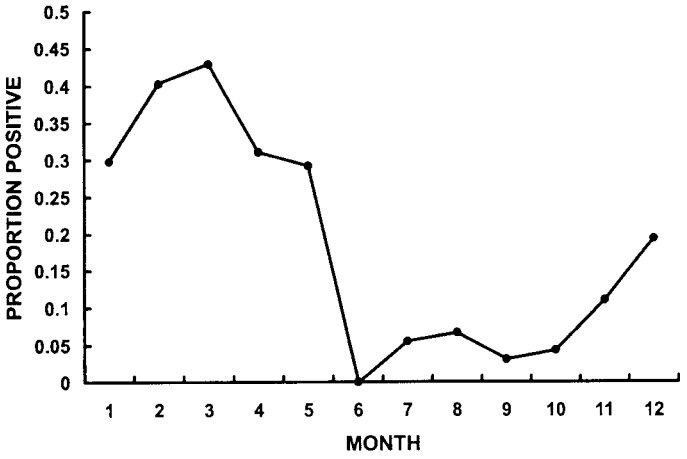

LARVAE PER 100 m³
12 10 8 6 4 2 0
1 2 3 4 5 6 7 8 9 10 11 12
MONTH

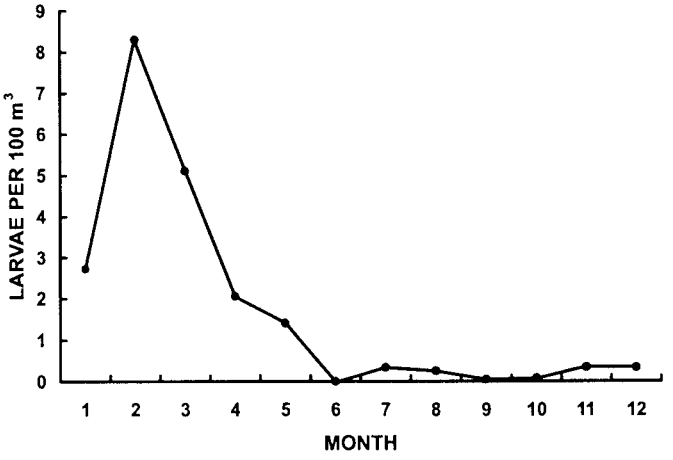

PROPORTION POSITIVE
0.45 0.4 0.35 0.3 0.25 0.2 0.15 0.1 0.05 0
1975 1980 1985 1990 1995 2000
YEAR

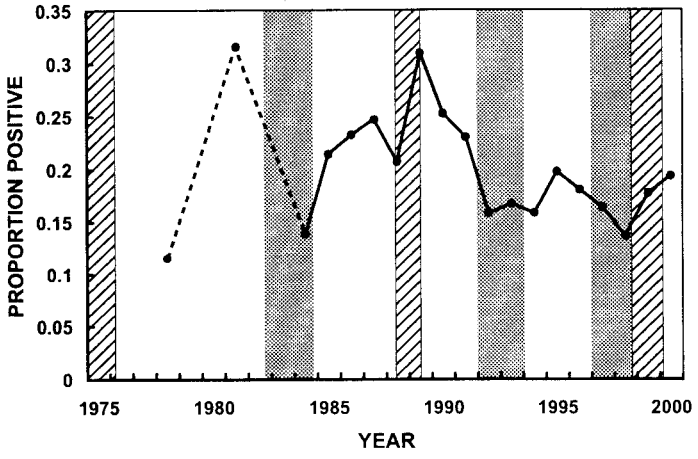

LARVAE PER 100 m³
20 18 16 14 12 10 8 6 4 2 0
1975 1980 1985 1990 1995 2000
YEAR

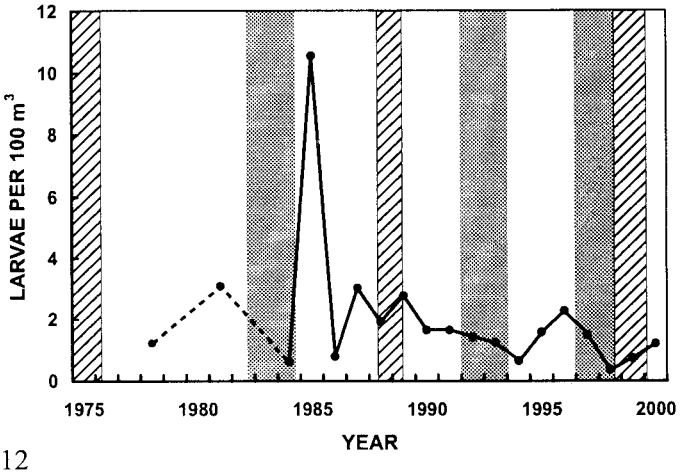

CalCOFI: 1977 - 1984
Total Larvae 3162
San Diego
48.6 24.3 12.2 2.4 <2.4
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 5348
San Diego
<.9 .9 4.7 9.5 18.9
Average Larvae per 100 m³

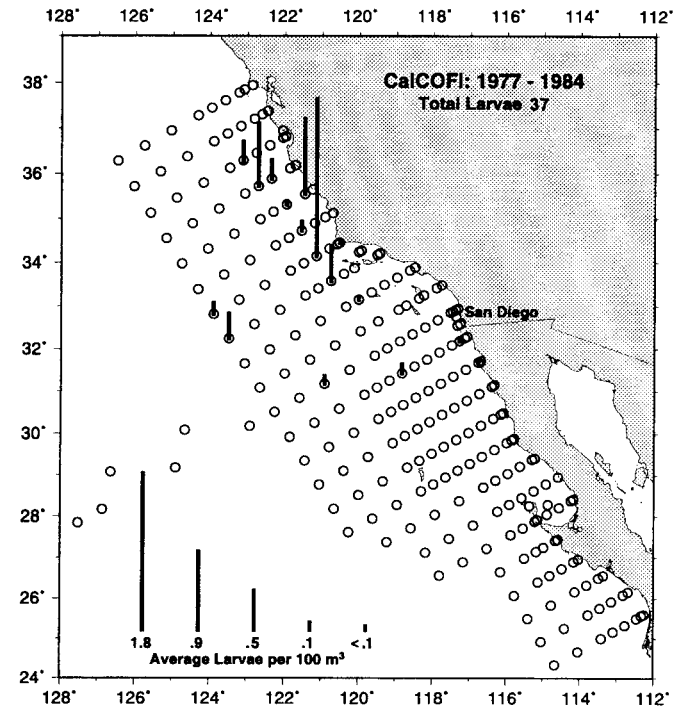

PROPORTION POSITIVE
MONTH

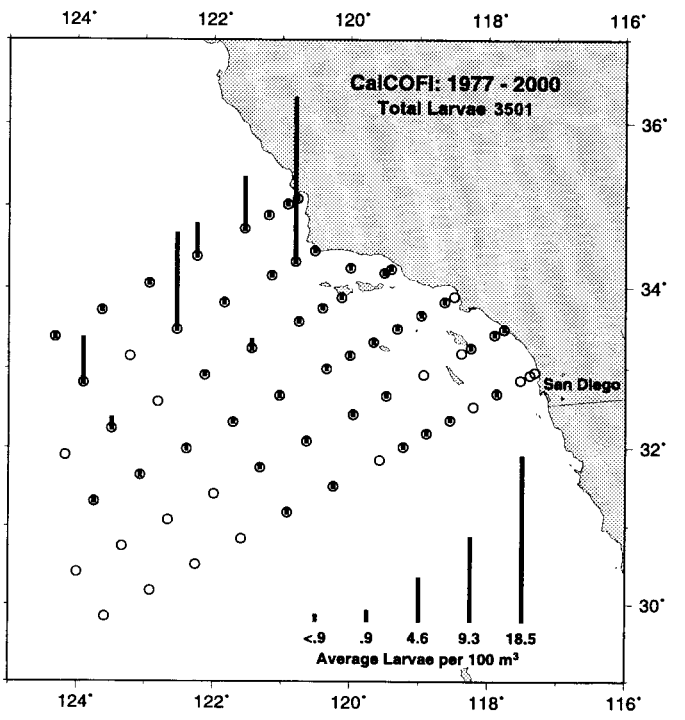

LARVAE PER 100 m³
MONTH

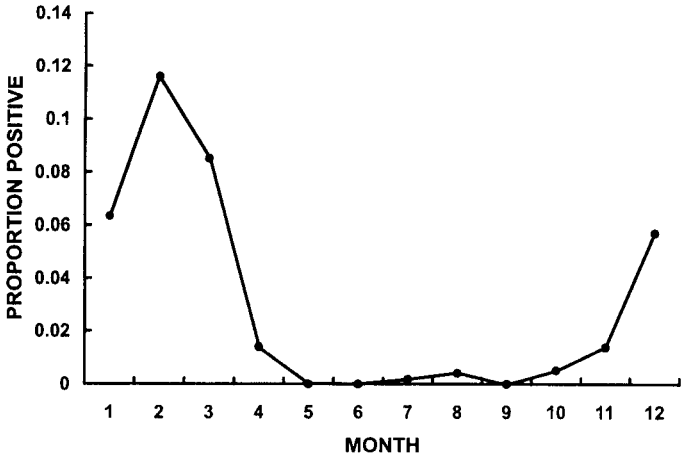

PROPORTION POSITIVE
YEAR

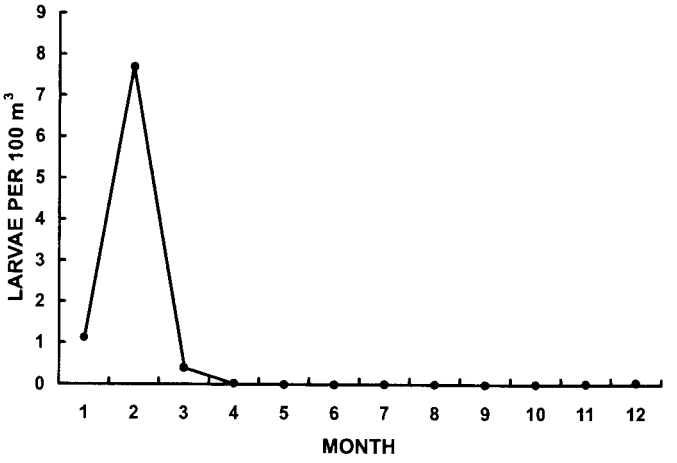

LARVAE PER 100 m³
YEAR

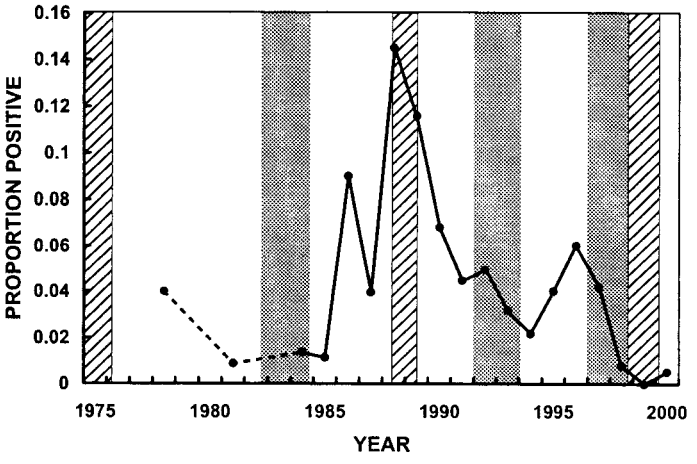
MERLUCCIIDAE Pacific hake or whiting ***Merluccius productus***

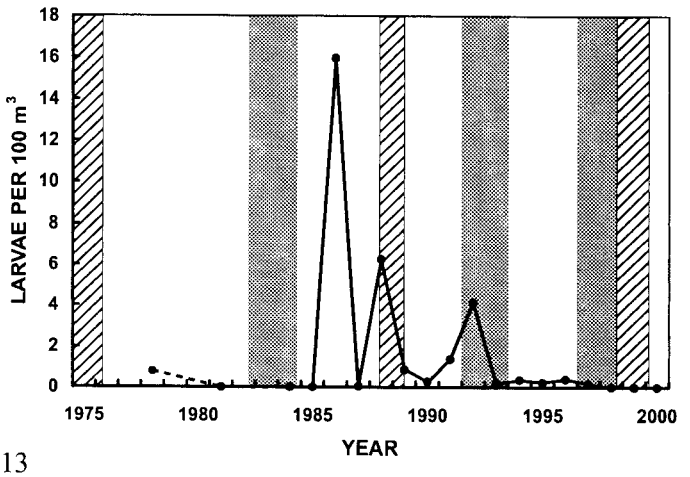


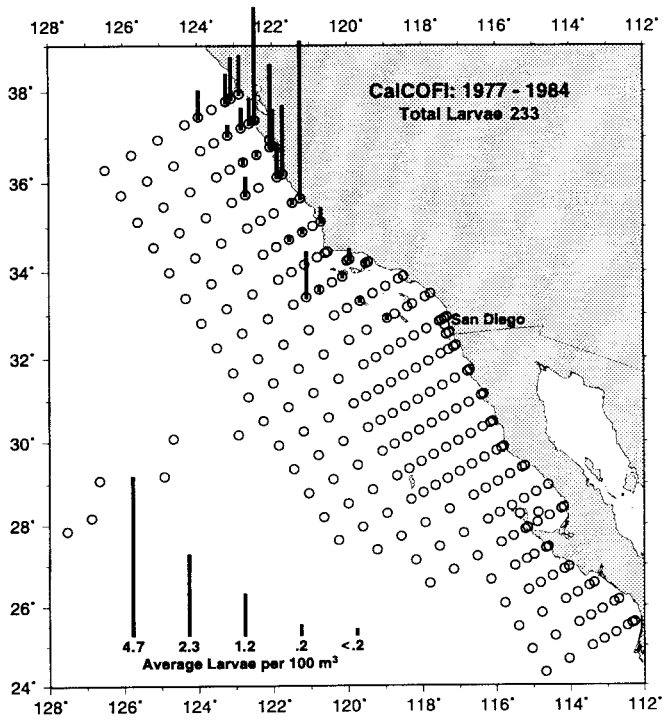



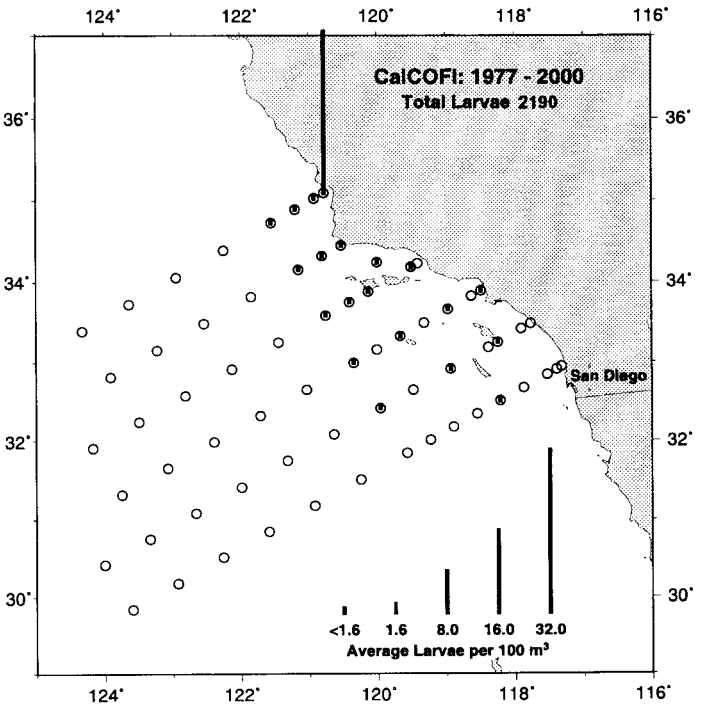



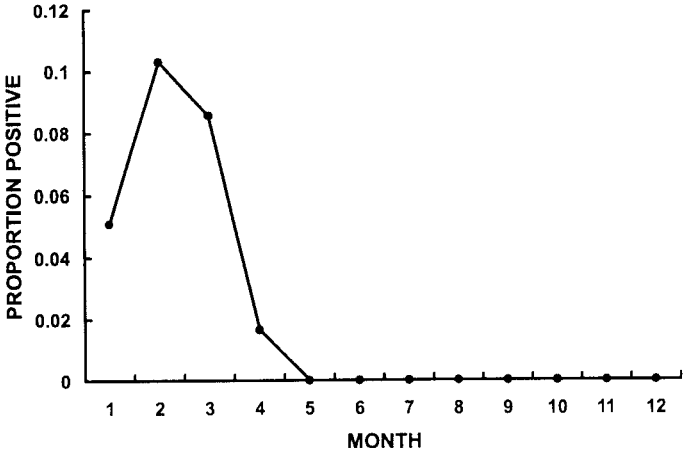



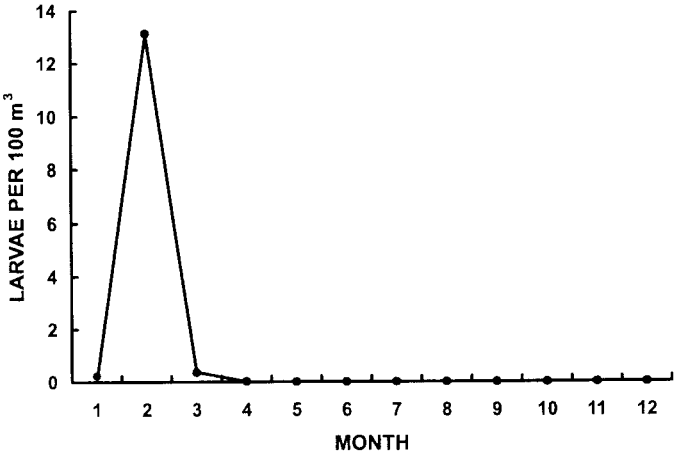



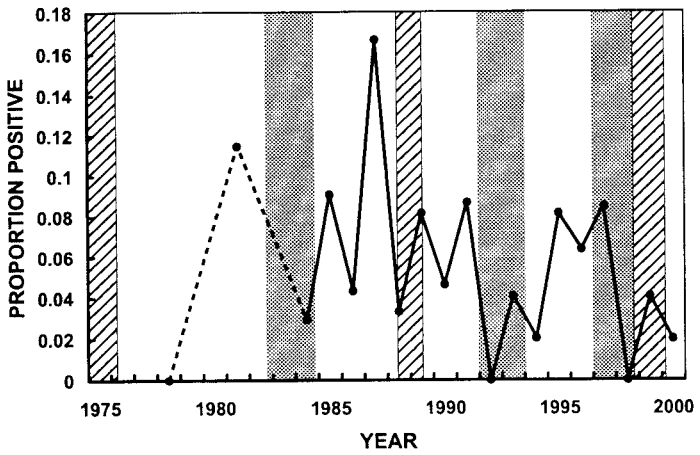



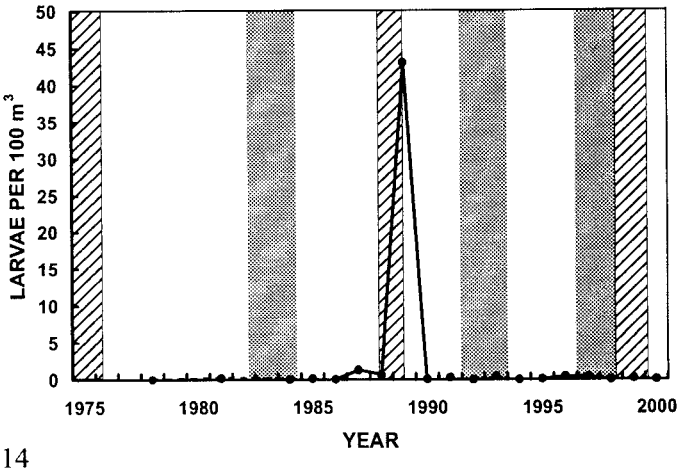

CalCOFI: 1977 - 1984
Total Larvae 233
San Diego
4.7 2.3 1.2 .2 <.2
Average Larvae per 100 m³

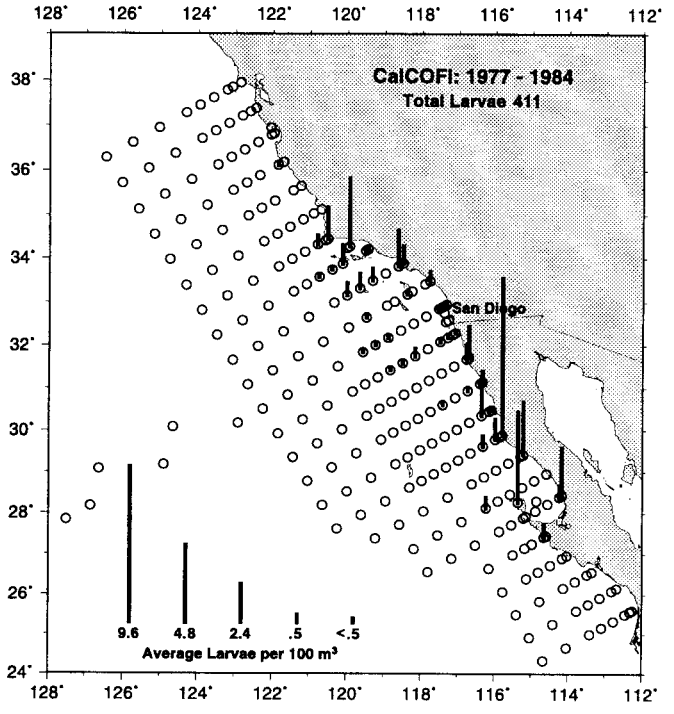

CalCOFI: 1977 - 2000
Total Larvae 2190
San Diego
<1.6 1.6 8.0 16.0 32.0
Average Larvae per 100 m³

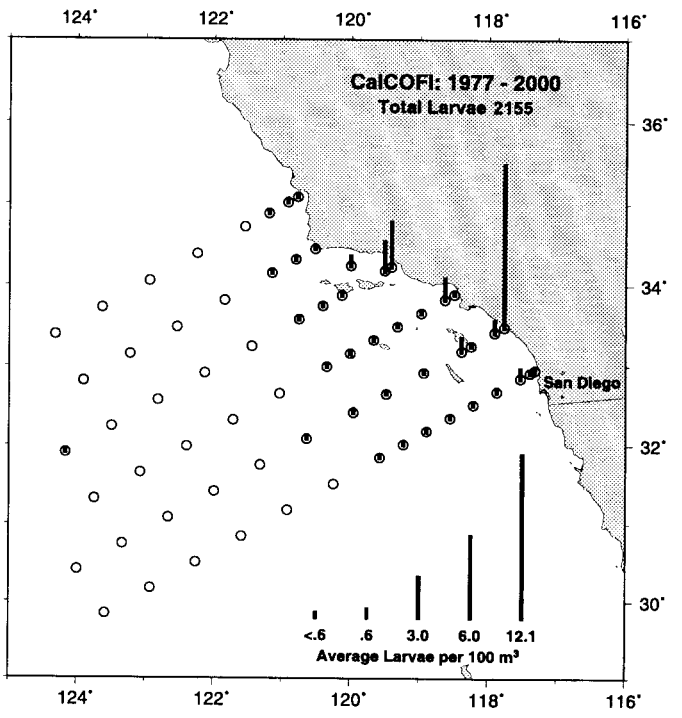

PROPORTION POSITIVE
MONTH

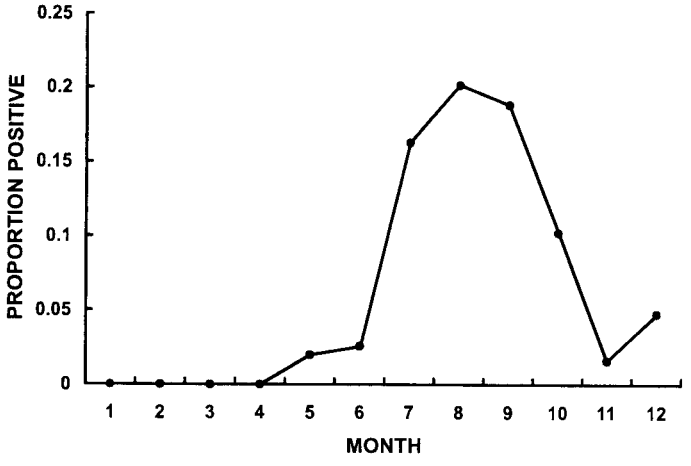

LARVAE PER 100 m³
MONTH

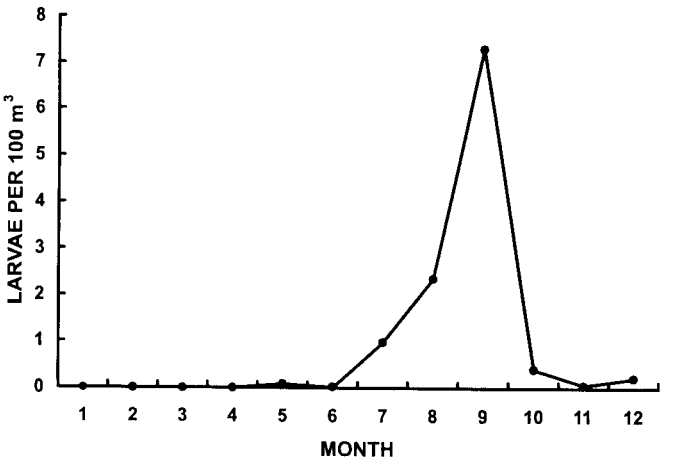

PROPORTION POSITIVE
YEAR

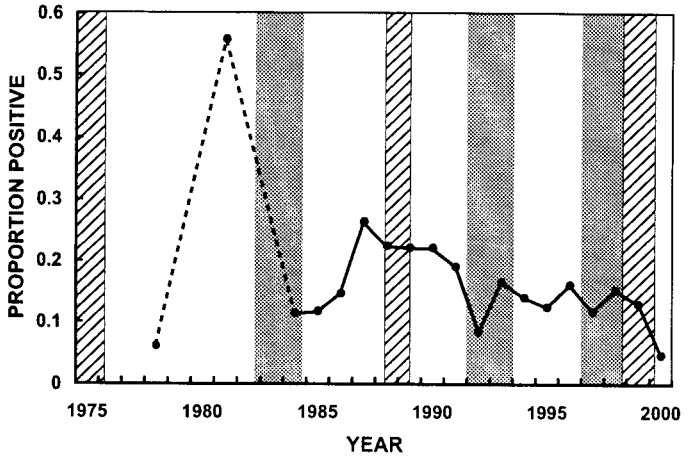

LARVAE PER 100 m³
YEAR

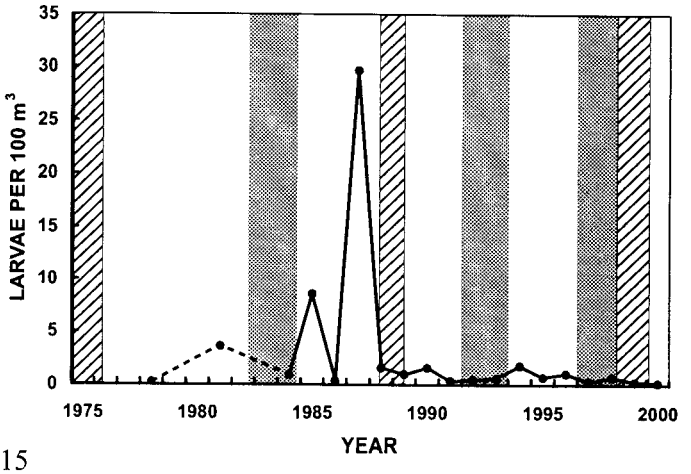

CalCOFI: 1977 - 1984
Total Larvae 411
San Diego
9.6
4.8
2.4
.5
<.5
Average Larvae per 100 m³

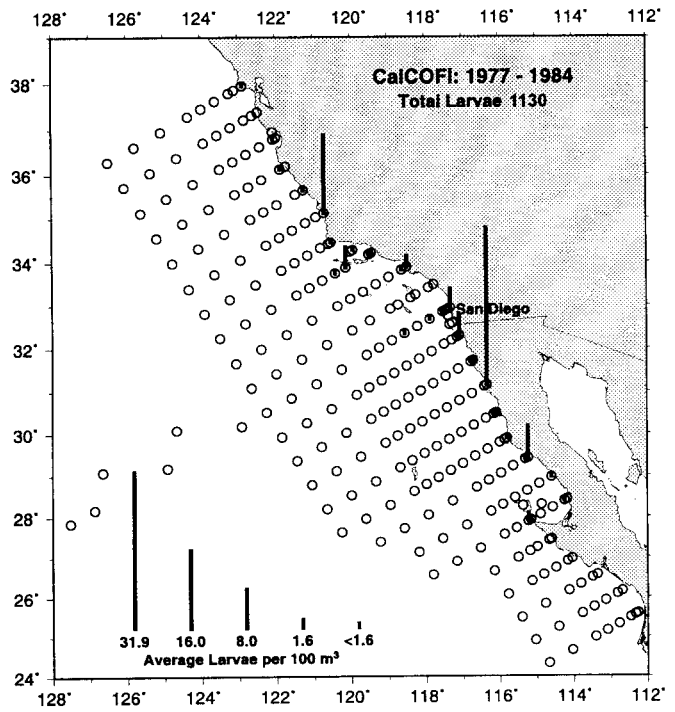

CalCOFI: 1977 - 2000
Total Larvae 2155
San Diego
<.6
.6
3.0
6.0
12.1
Average Larvae per 100 m³

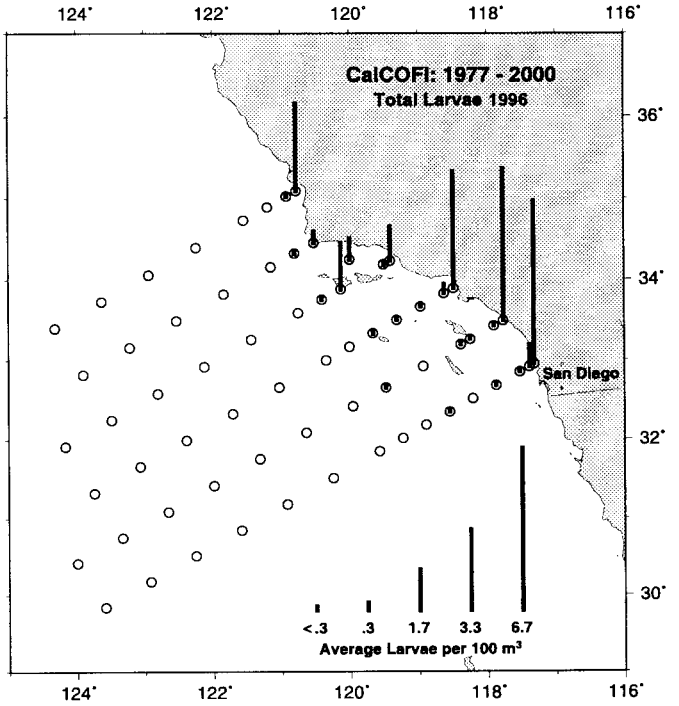

PROPORTION POSITIVE
MONTH

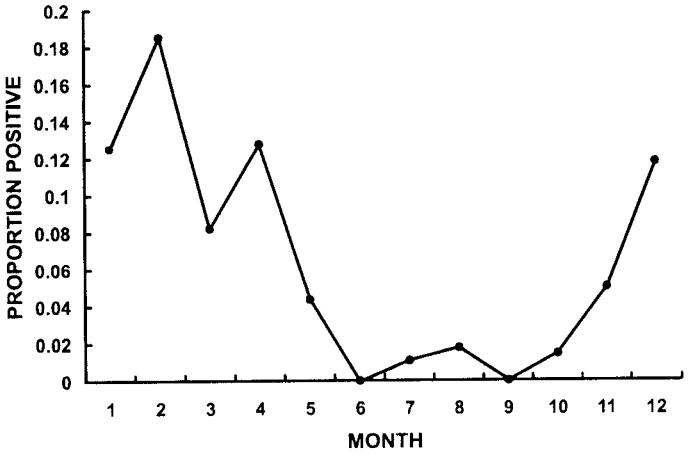

LARVAE PER 100 m³
MONTH

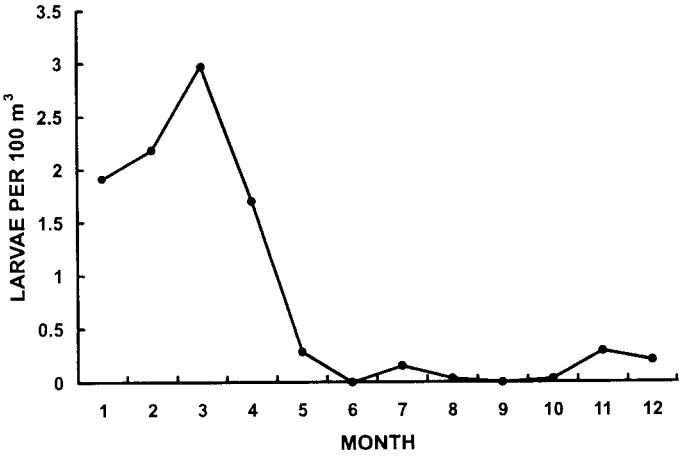

PROPORTION POSITIVE
YEAR

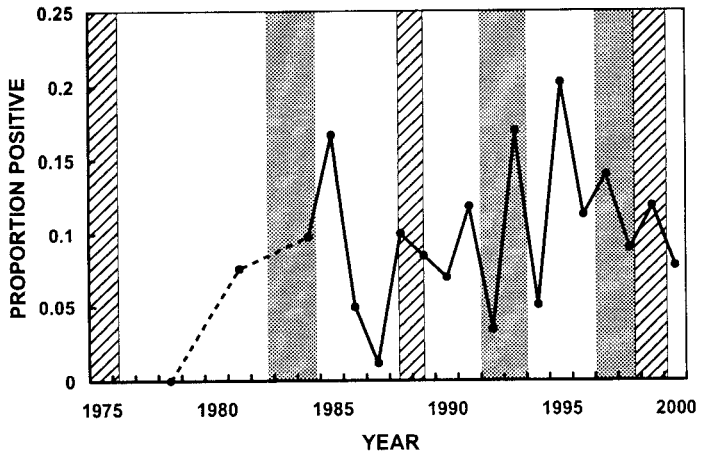

LARVAE PER 100 m³
YEAR

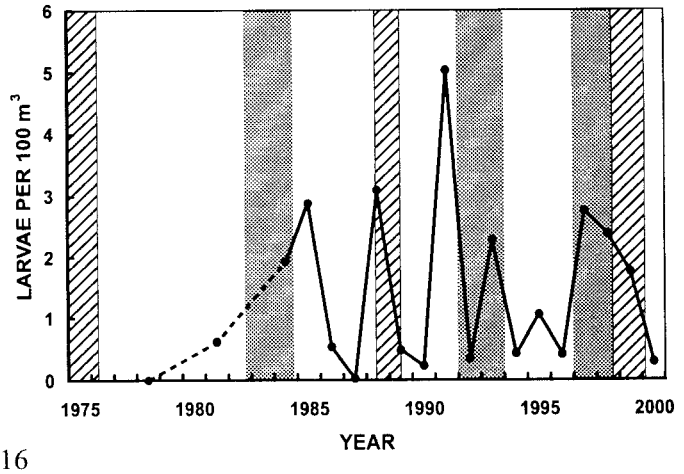

CalCOFI: 1977 - 1984
Total Larvae 1130
San Diego
31.9 16.0 8.0 1.6 <1.6
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 1996
San Diego
<.3 .3 1.7 3.3 6.7
Average Larvae per 100 m³

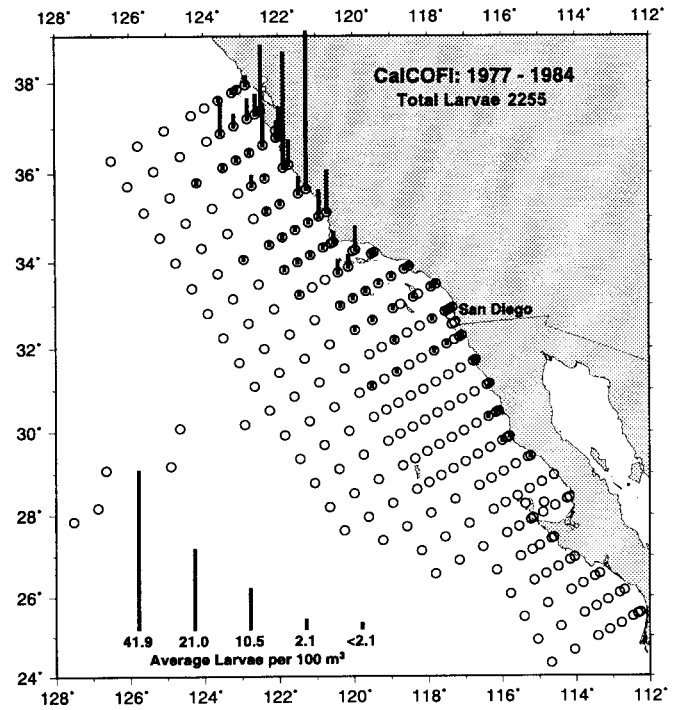

PROPORTION POSITIVE
MONTH

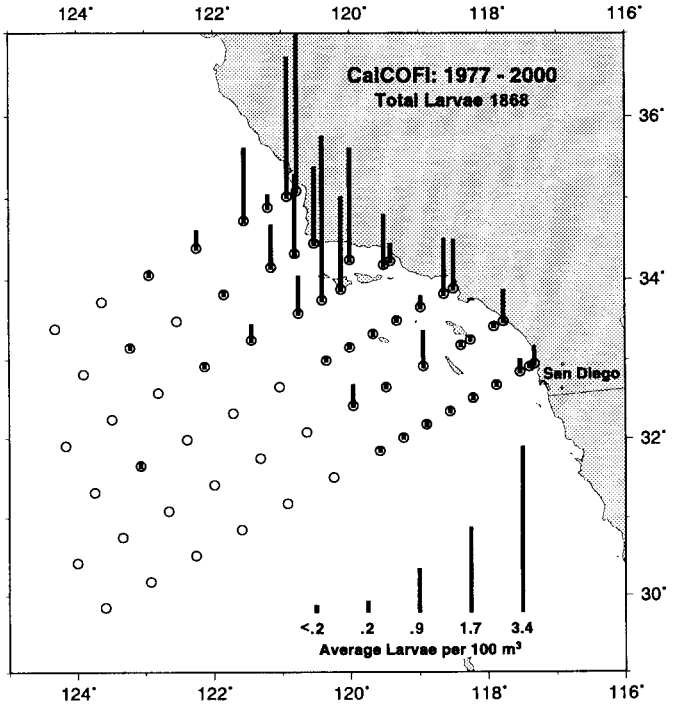

LARVAE PER 100 m³
MONTH

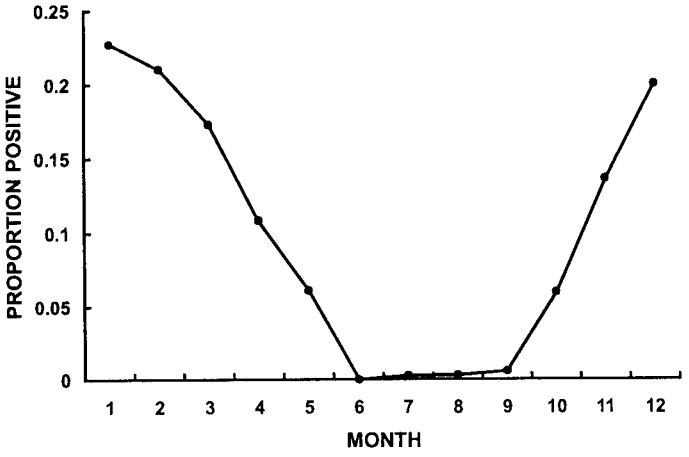

PROPORTION POSITIVE
YEAR

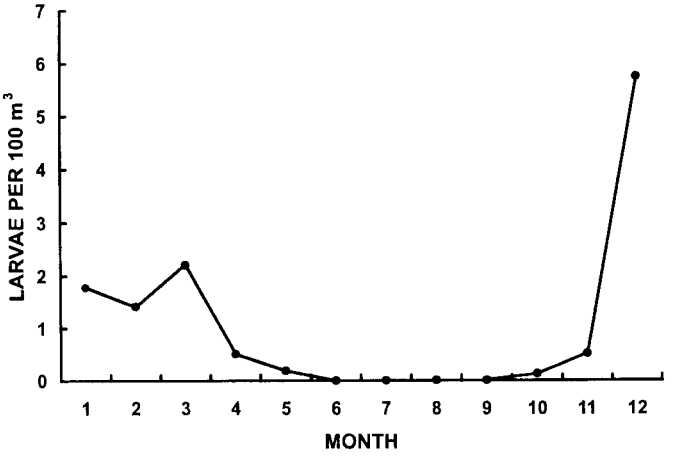

LARVAE PER 100 m³
YEAR

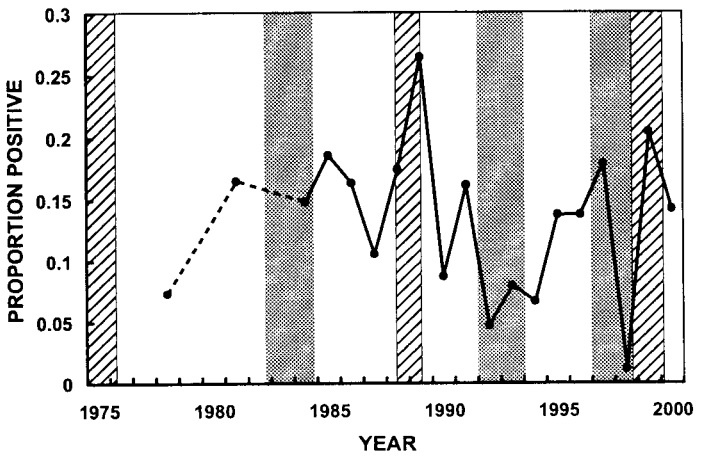
COTTIDAE Cabezon ***Scorpaenichthys marmoratus***

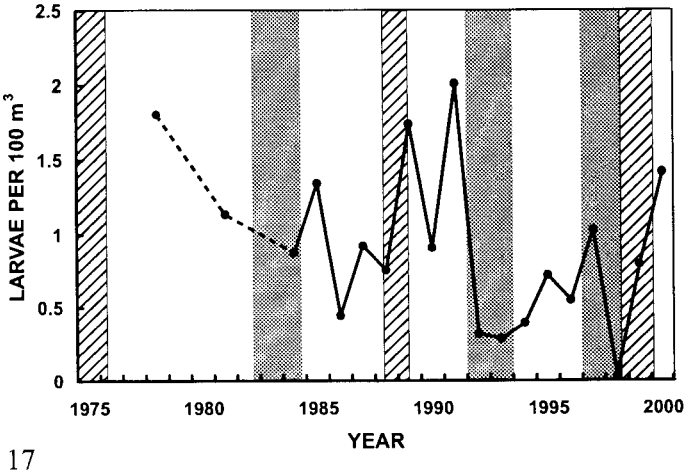


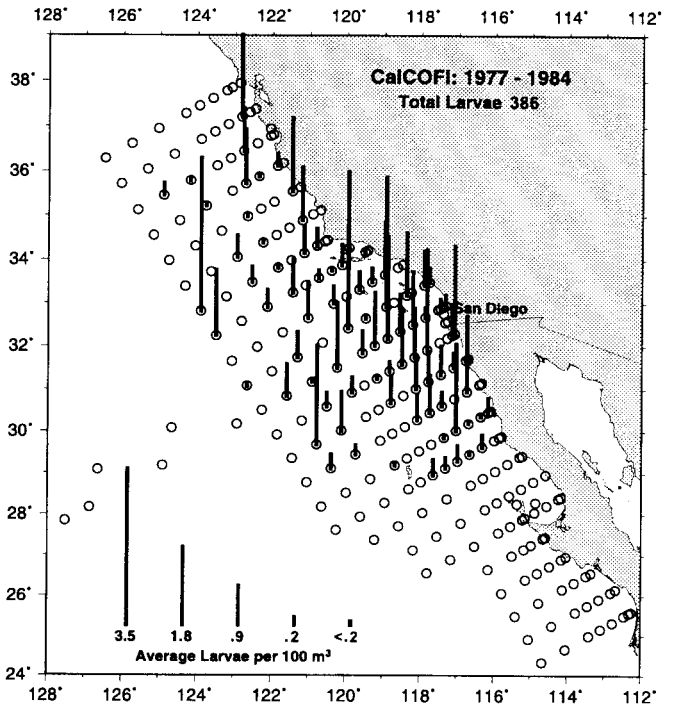



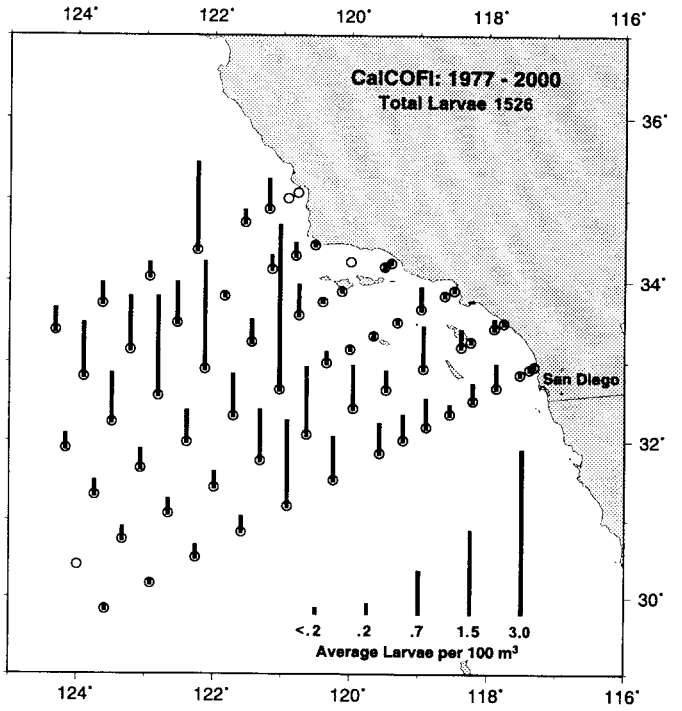



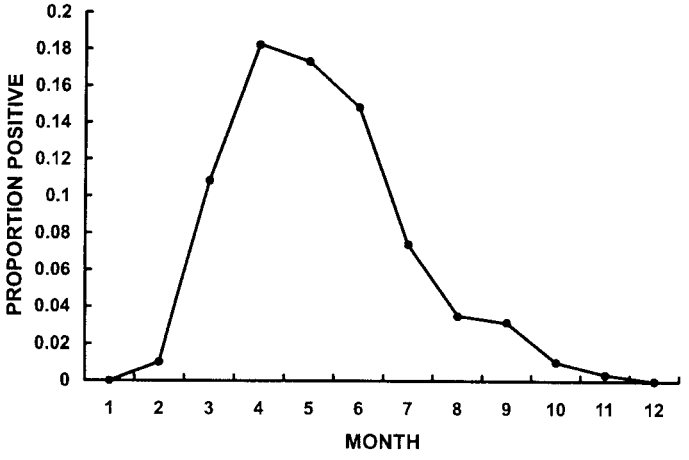



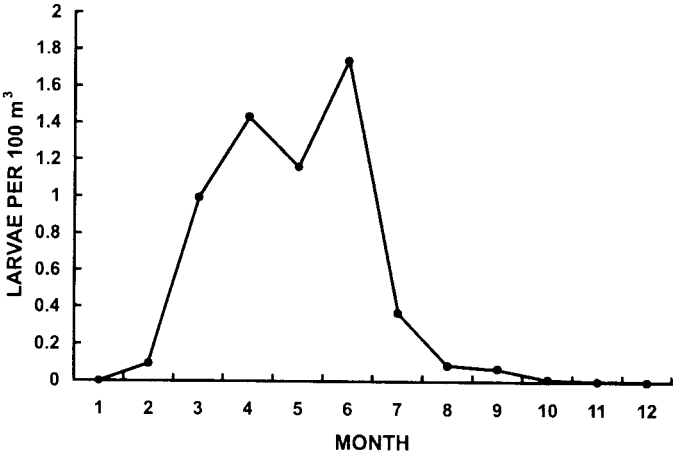



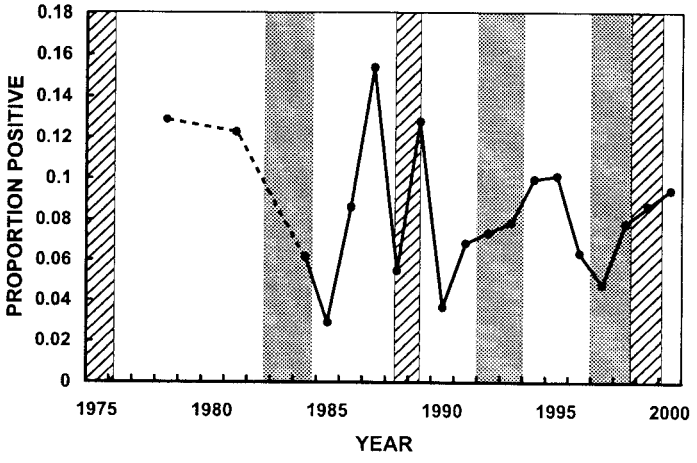



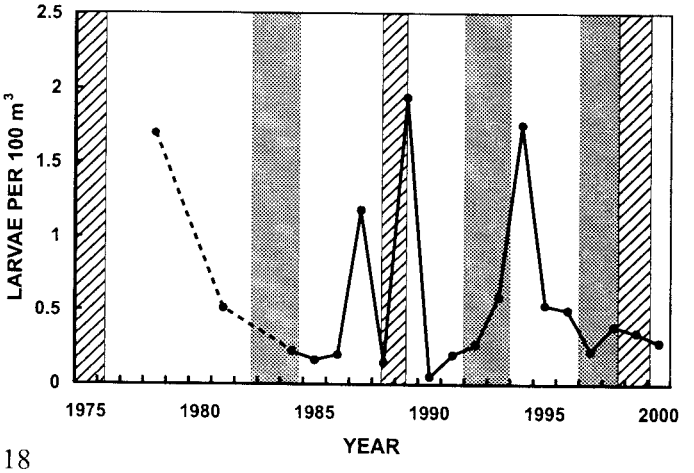

CalCOFI: 1977 - 1984
Total Larvae 386
San Diego
3.5 1.8 .9 .2 <.2
Average Larvae per 100 m³

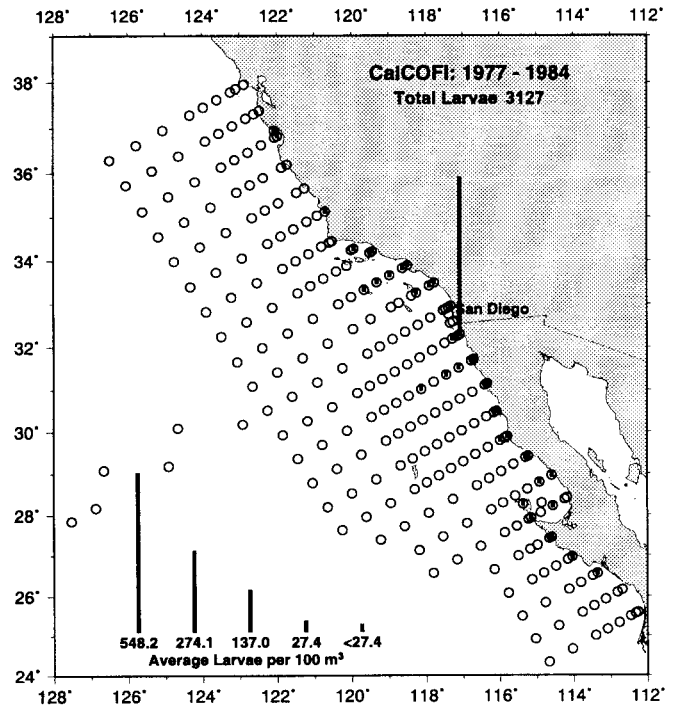

CalCOFI: 1977 - 2000
Total Larvae 1526
San Diego
<.2 .2 .7 1.5 3.0
Average Larvae per 100 m³

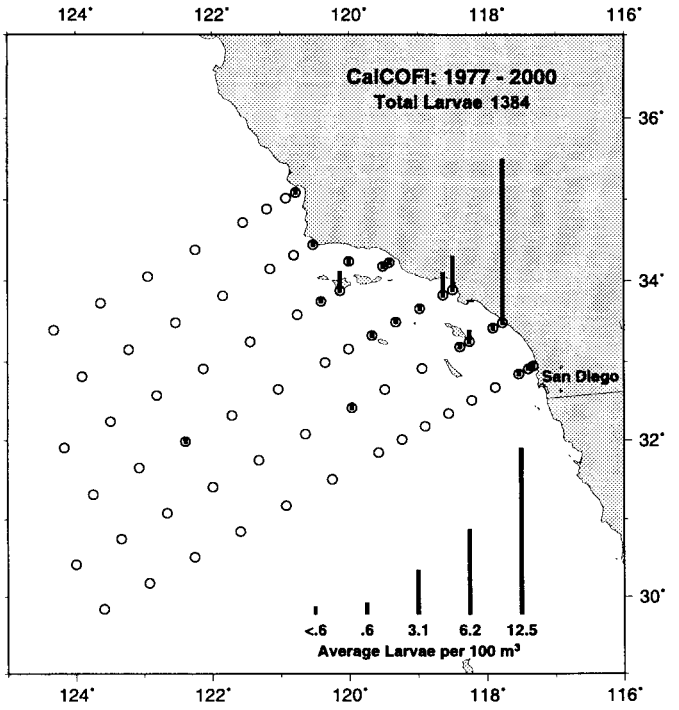

PROPORTION POSITIVE
MONTH

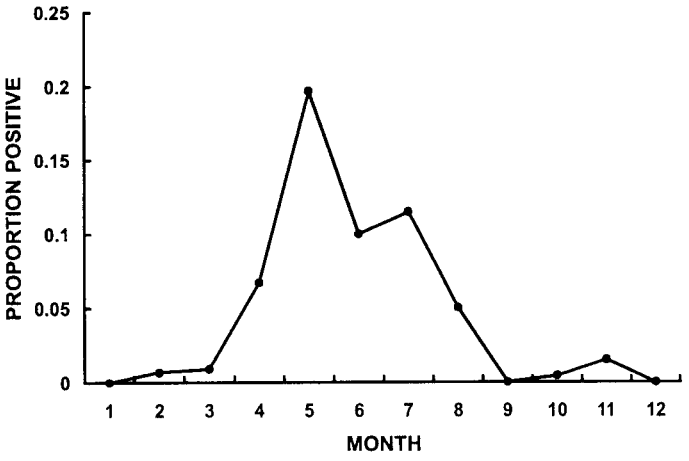

LARVAE PER 100 m³
MONTH

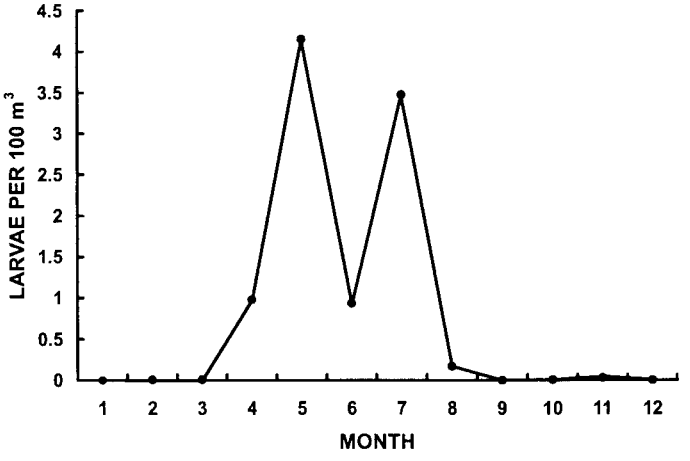

PROPORTION POSITIVE
YEAR

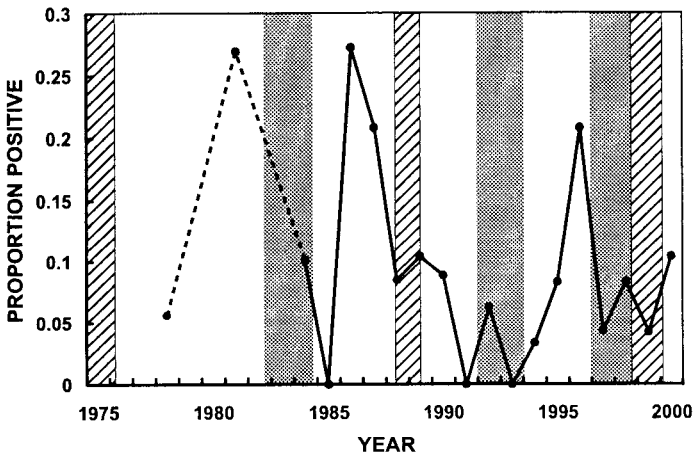

LARVAE PER 100 m³
YEAR

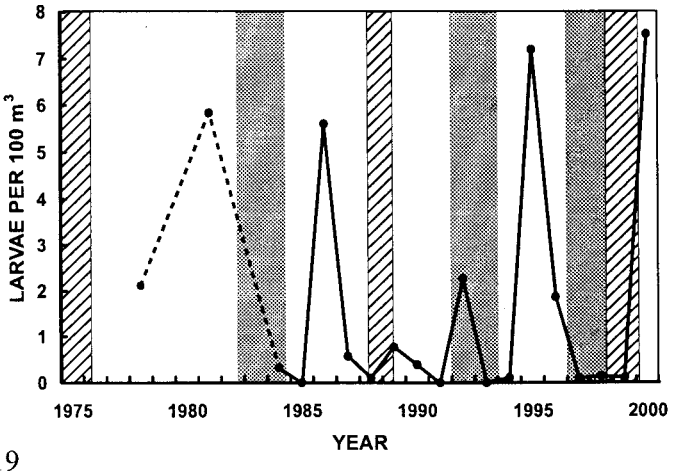

CalCOFI: 1977 - 1984
Total Larvae 3127
San Diego
548.2 274.1 137.0 27.4 <27.4
Average Larvae per 100 m³

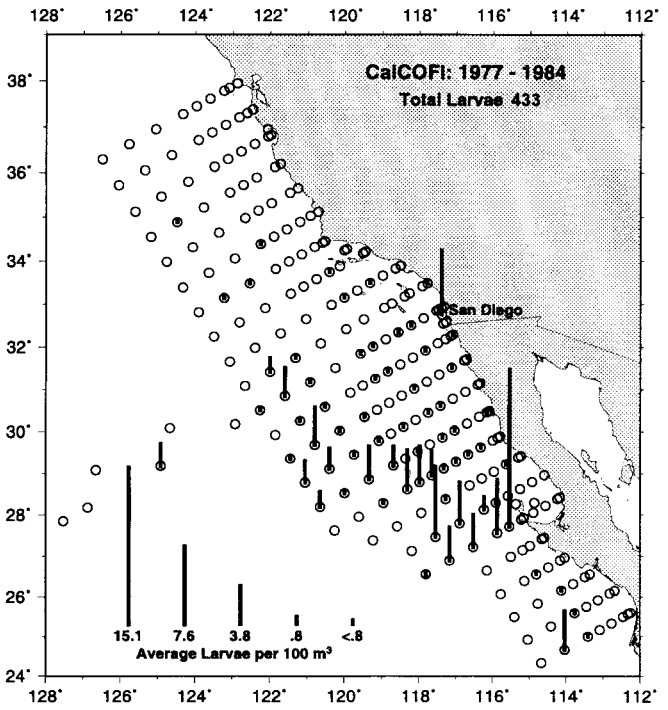

CalCOFI: 1977 - 2000
Total Larvae 1384
San Diego
<.6 .6 3.1 6.2 12.5
Average Larvae per 100 m³

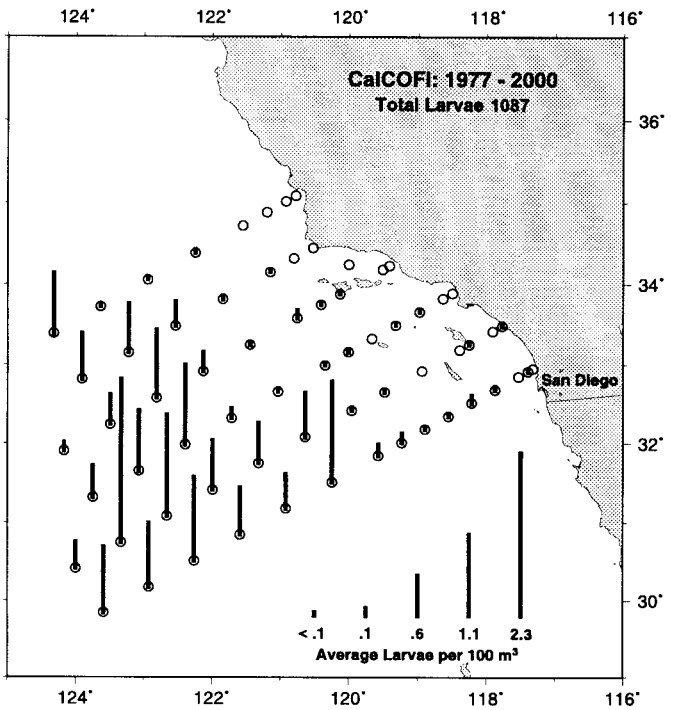

PROPORTION POSITIVE
MONTH

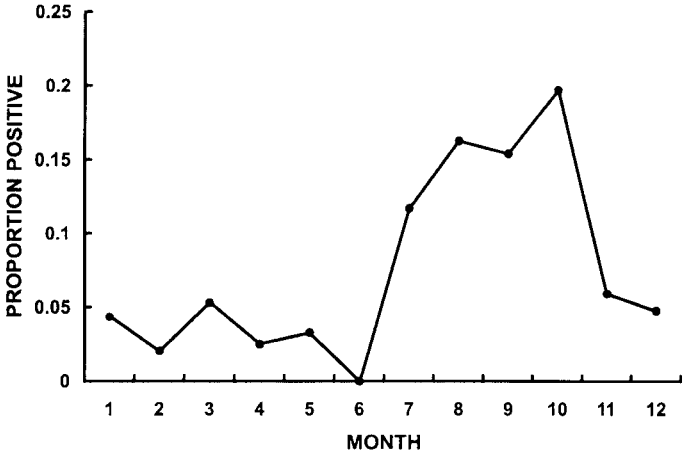

LARVAE PER 100 m³
MONTH

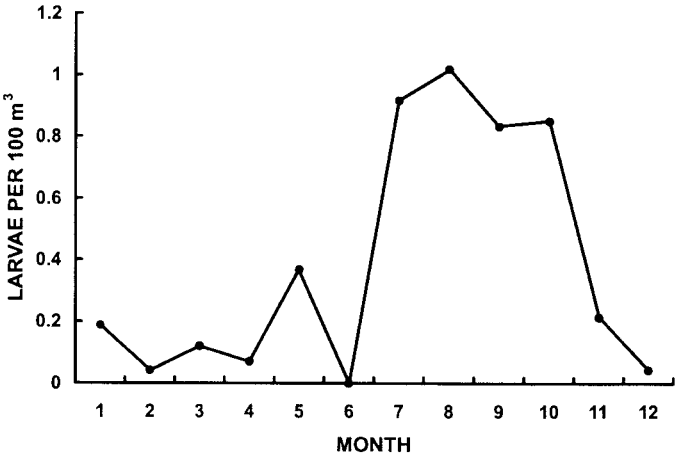

PROPORTION POSITIVE
YEAR

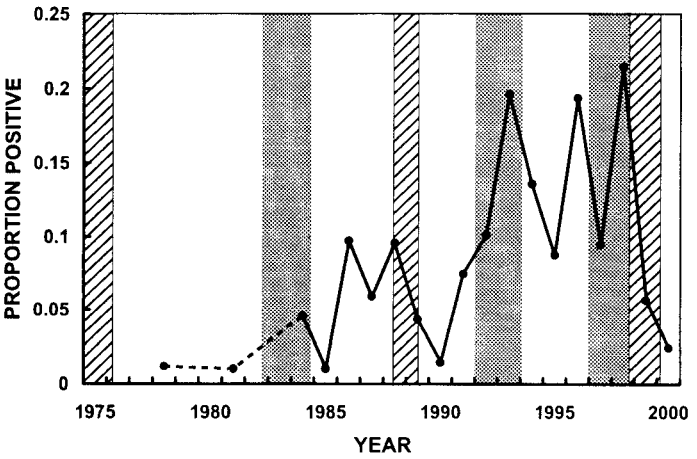

LARVAE PER 100 m³
YEAR

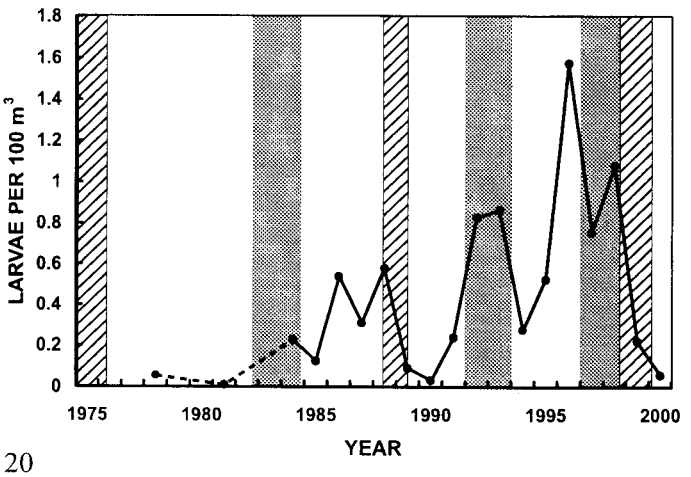

CalCOFI: 1977 - 1984
Total Larvae 433
San Diego
15.1 7.6 3.8 .8 <.8
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 1087
San Diego
< .1 .1 .6 1.1 2.3
Average Larvae per 100 m³

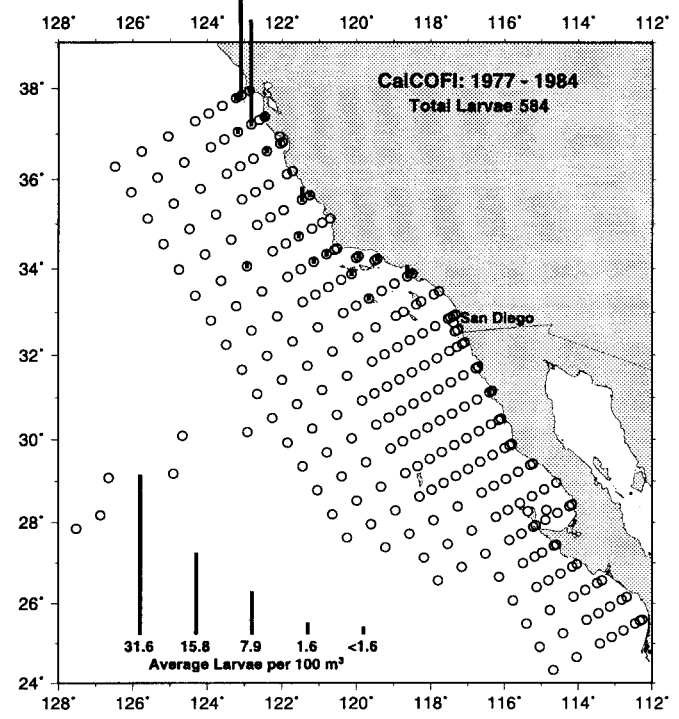

PROPORTION POSITIVE
MONTH

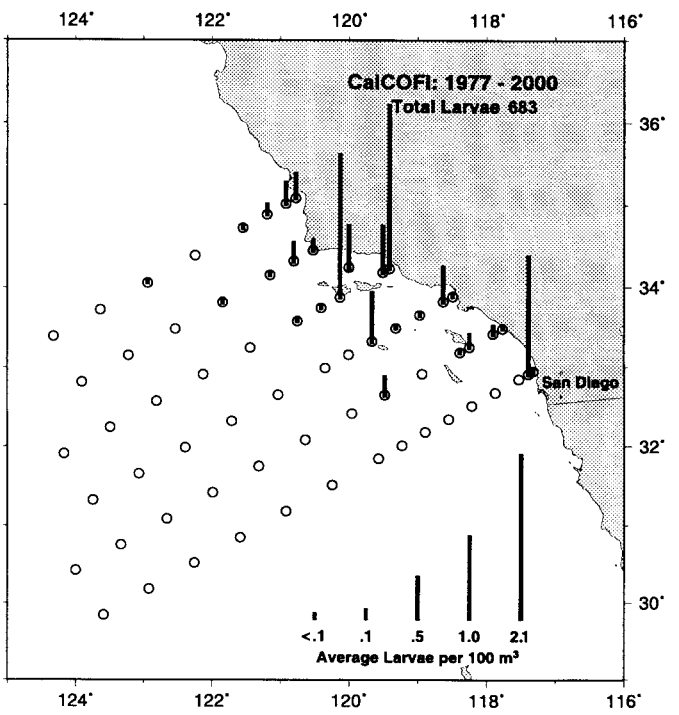

LARVAE PER 100 m³
MONTH

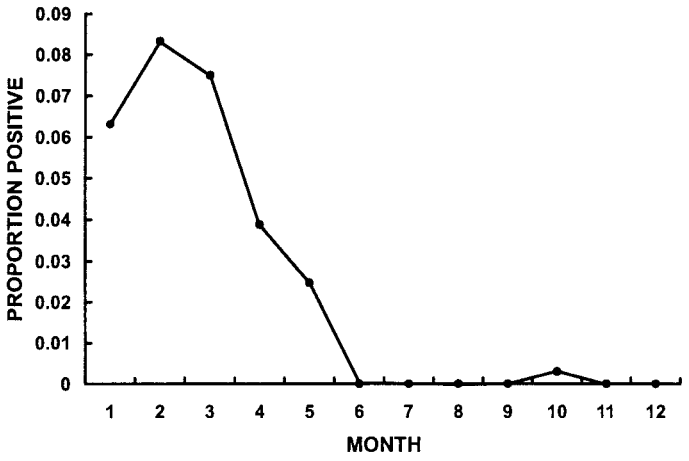

PROPORTION POSITIVE
YEAR

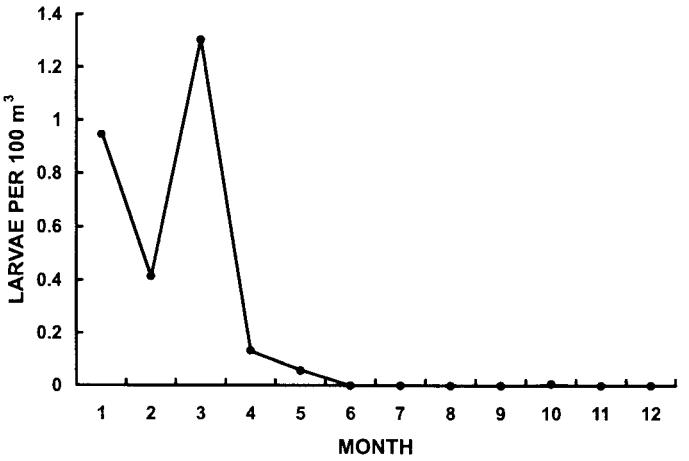

LARVAE PER 100 m³
YEAR

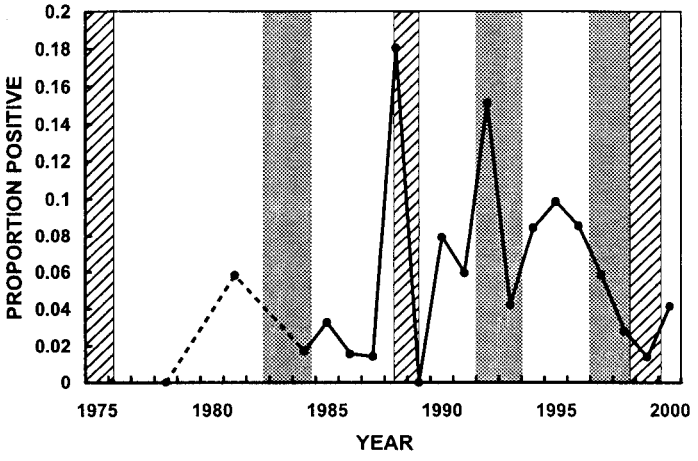
SEBASTIDAE | Shortbelly rockfish | ***Sebastes jordani***

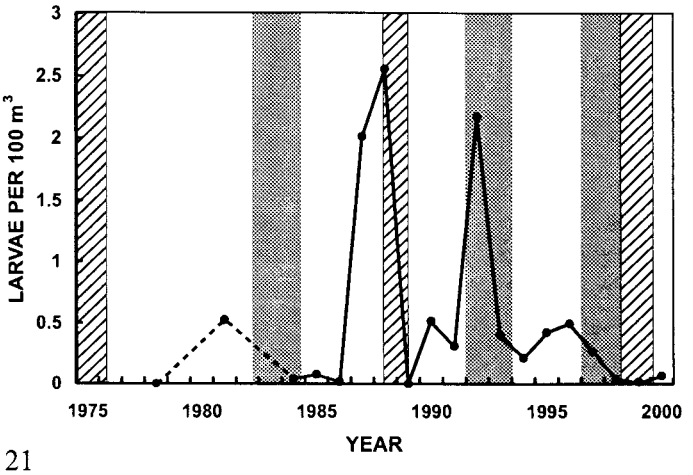


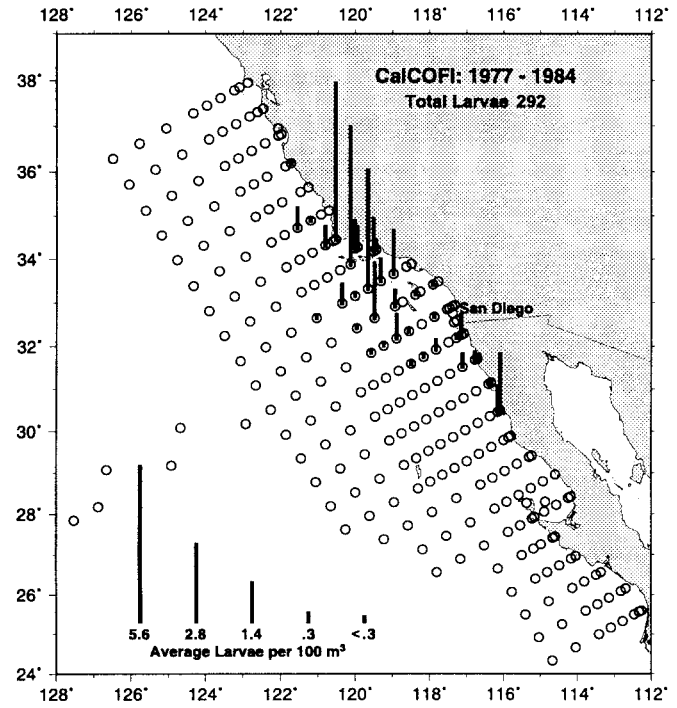



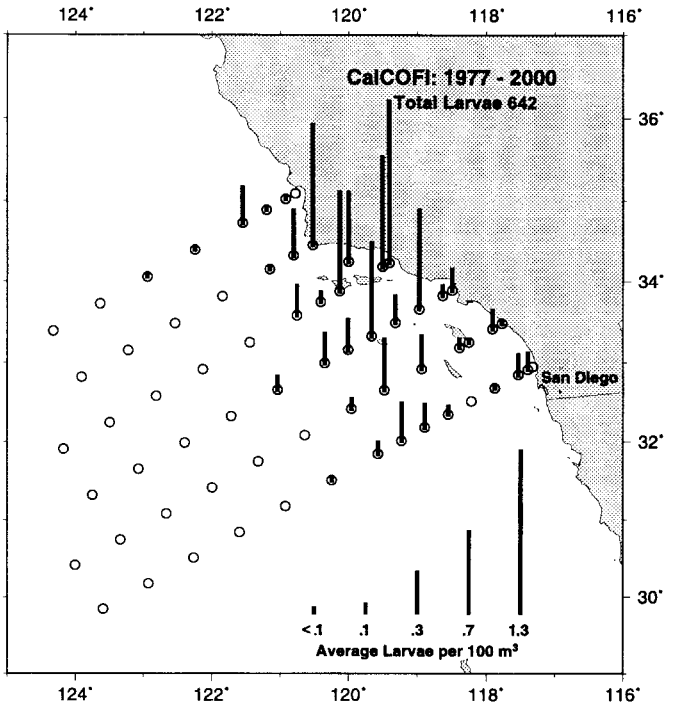



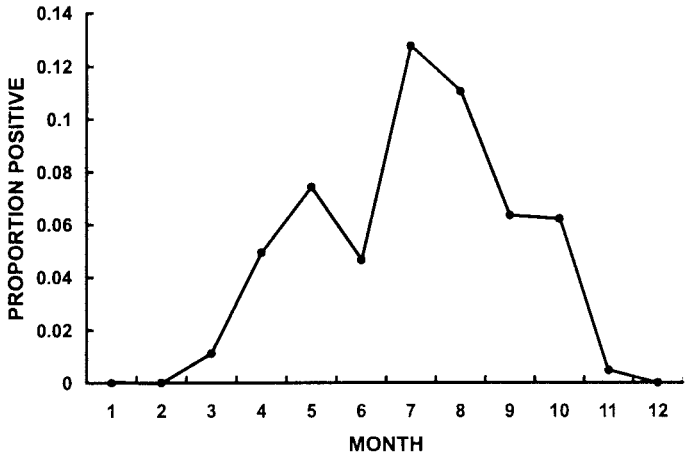



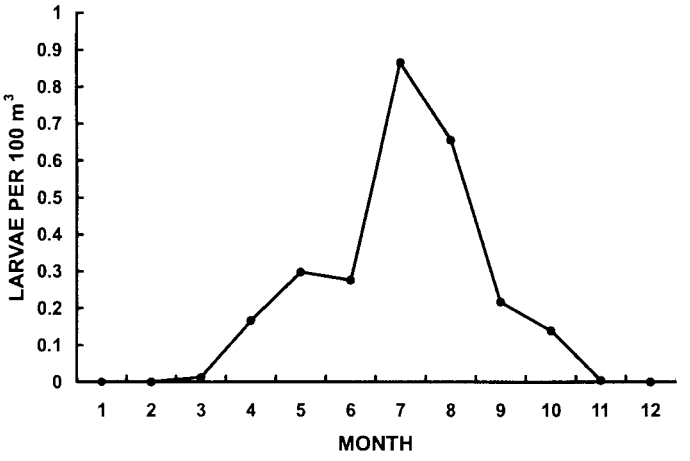



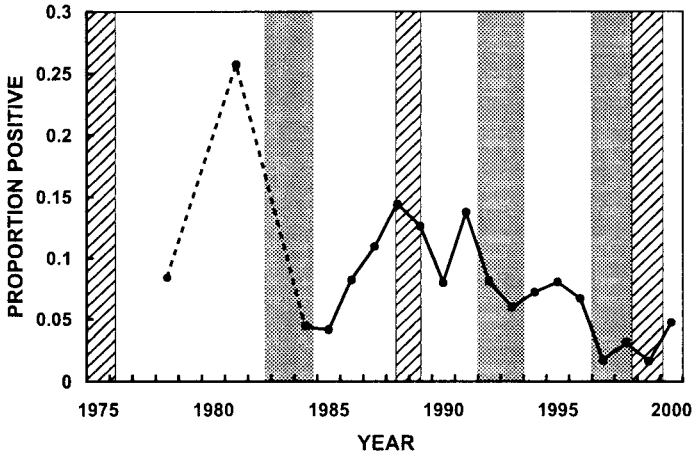



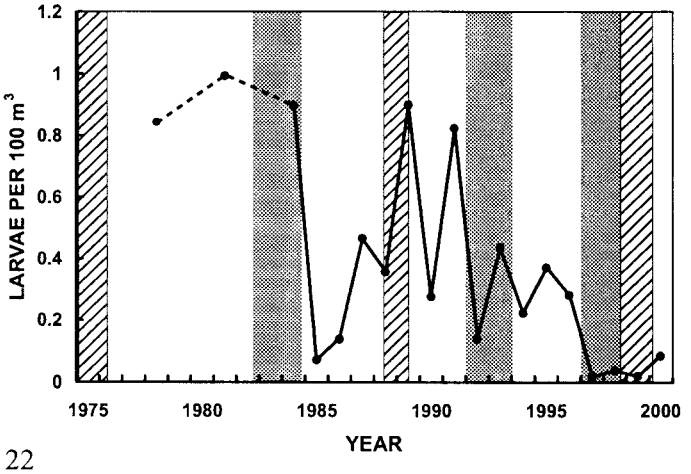

CalCOFI: 1977 - 1984
Total Larvae 292
San Diego
5.6 2.8 1.4 .3 <.3
Average Larvae per 100 m³

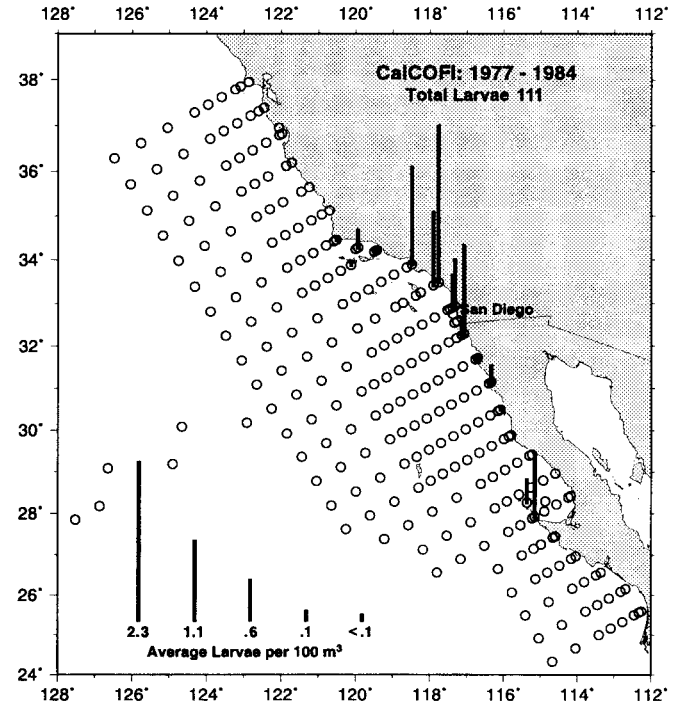

CalCOFI: 1977 - 2000
Total Larvae 642
San Diego
<.1 .1 .3 .7 1.3
Average Larvae per 100 m³

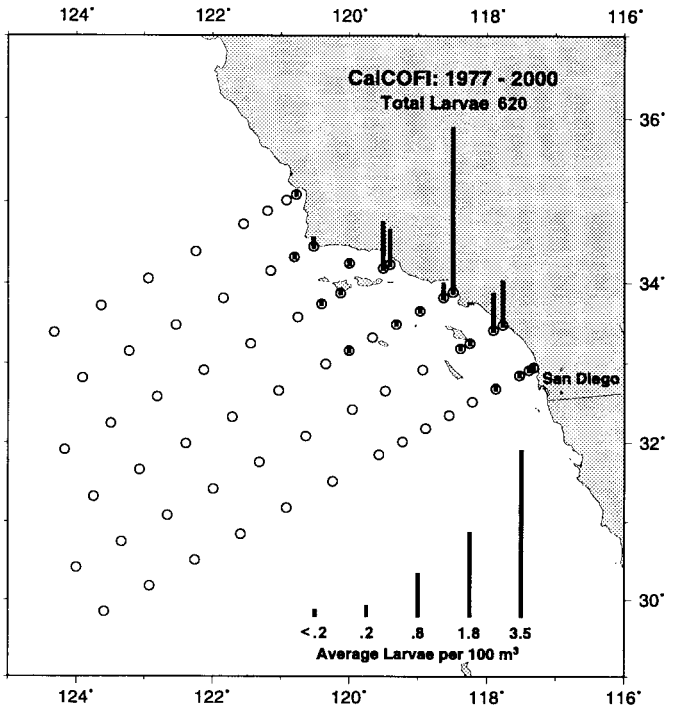

PROPORTION POSITIVE
MONTH

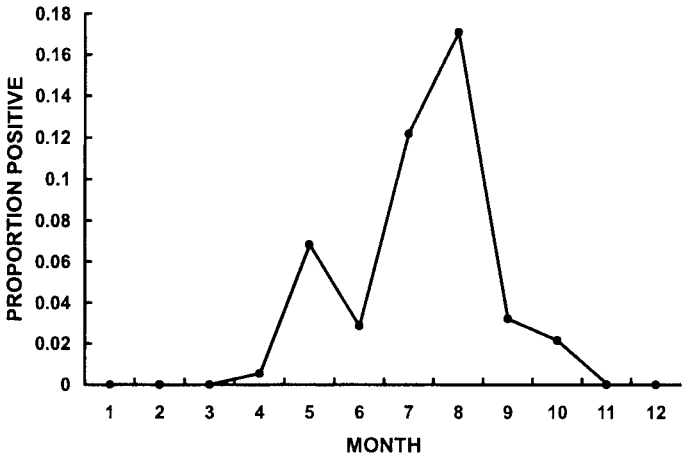

LARVAE PER 100 m³
MONTH

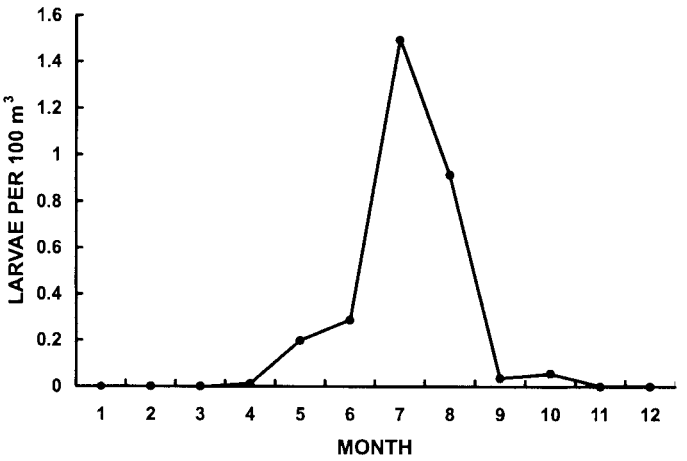

PROPORTION POSITIVE
YEAR

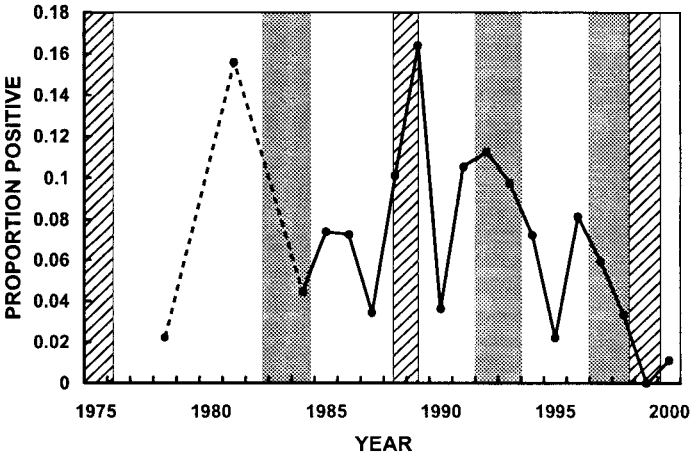

LARVAE PER 100 m³
YEAR

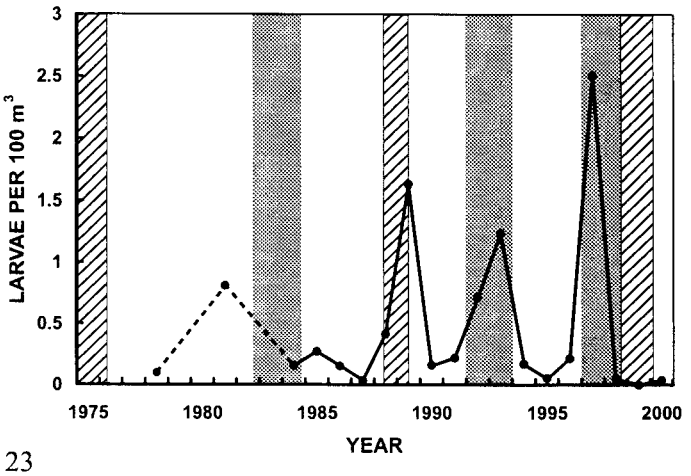

CalCOFI: 1977 - 1984
Total Larvae 111
San Diego
2.3 1.1 .6 .1 <.1
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 620
San Diego
<.2 .2 .8 1.8 3.5
Average Larvae per 100 m³

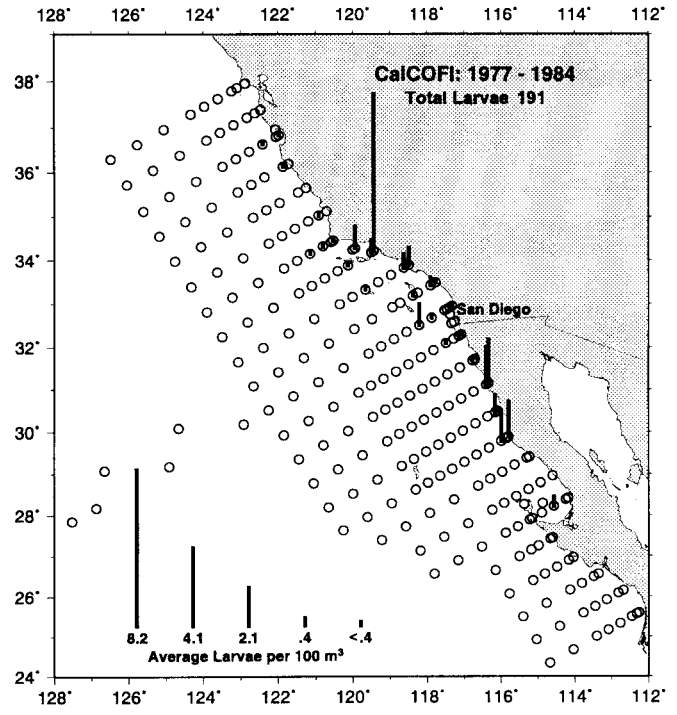

PROPORTION POSITIVE
MONTH

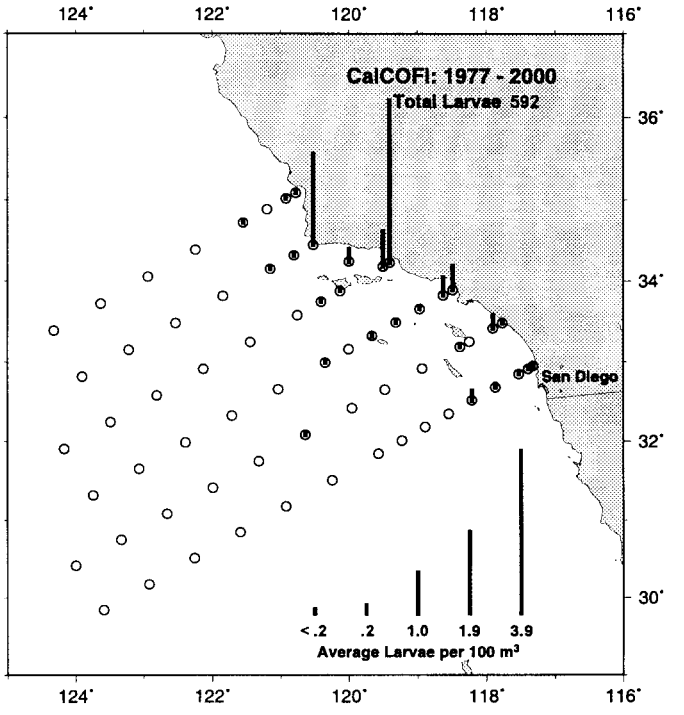

LARVAE PER 100 m³
MONTH

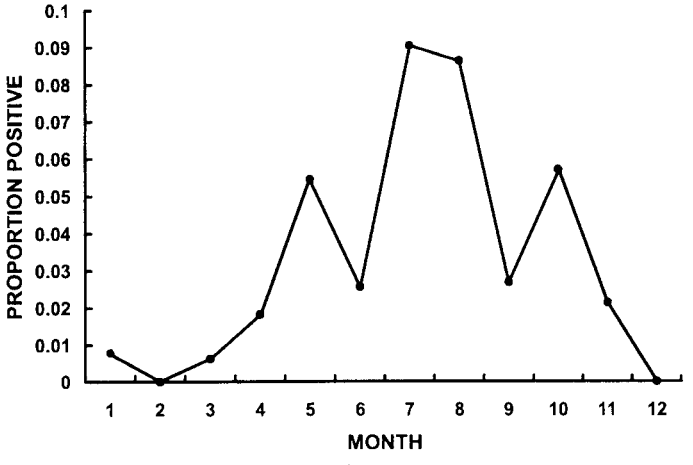

PROPORTION POSITIVE
YEAR

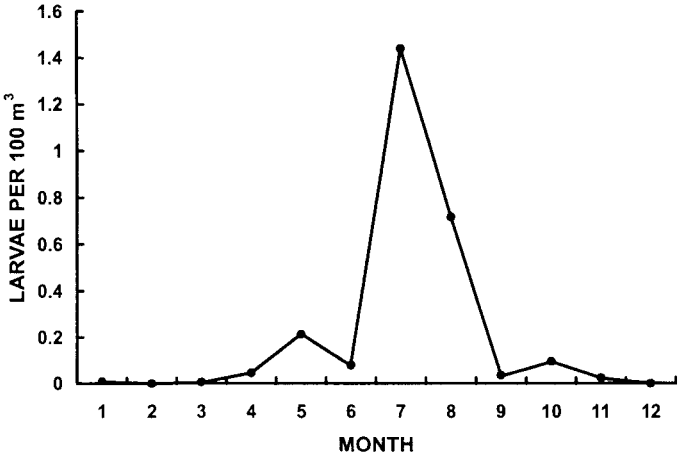

LARVAE PER 100 m³
YEAR

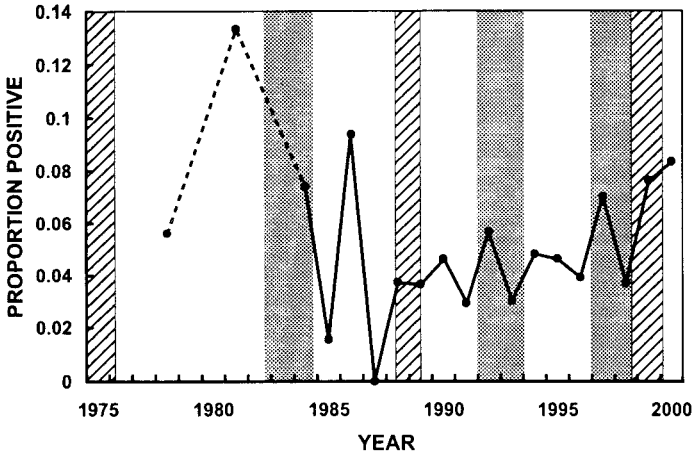
***Hypsoblennius gilberti*** Rockpool blenny BLENNIIDAE

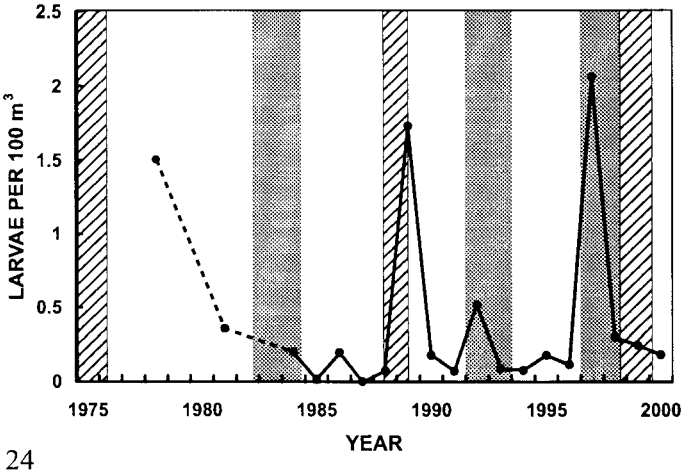


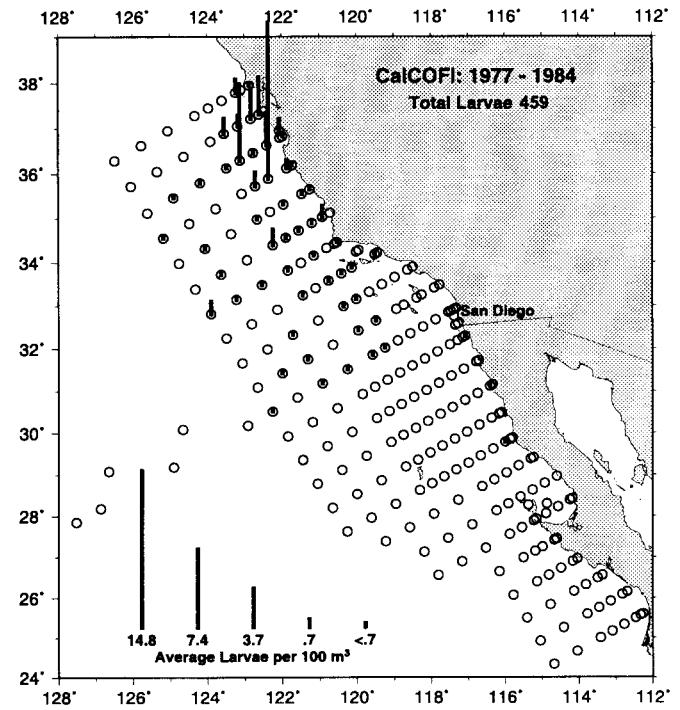



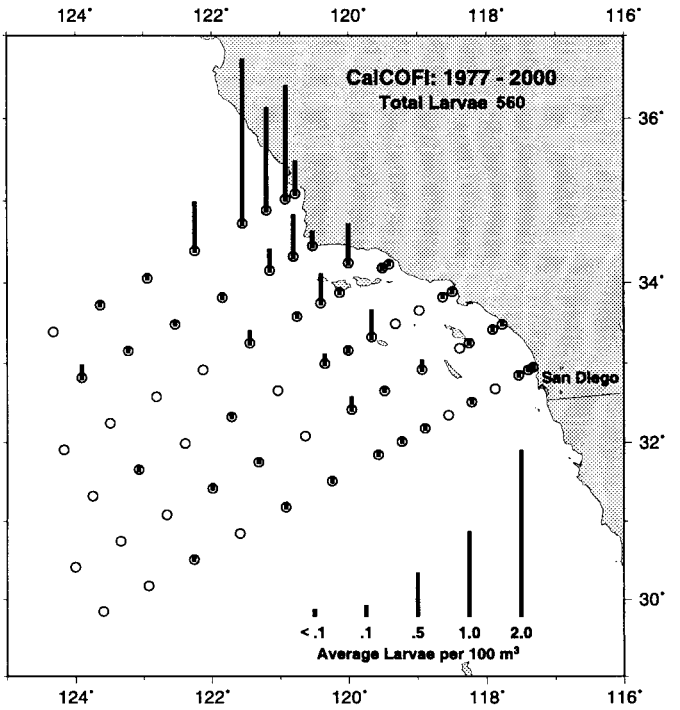



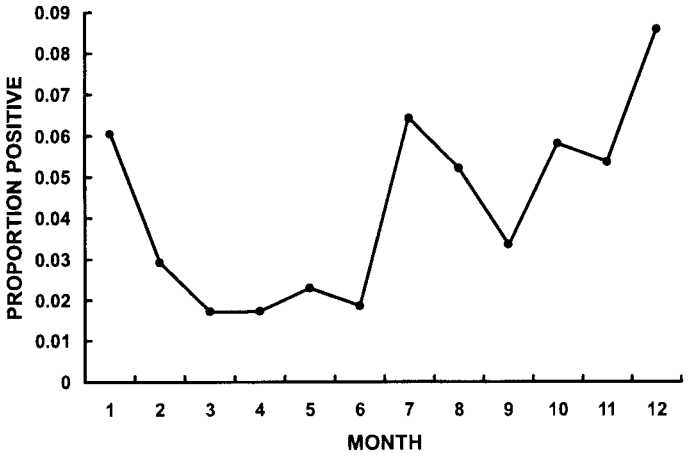



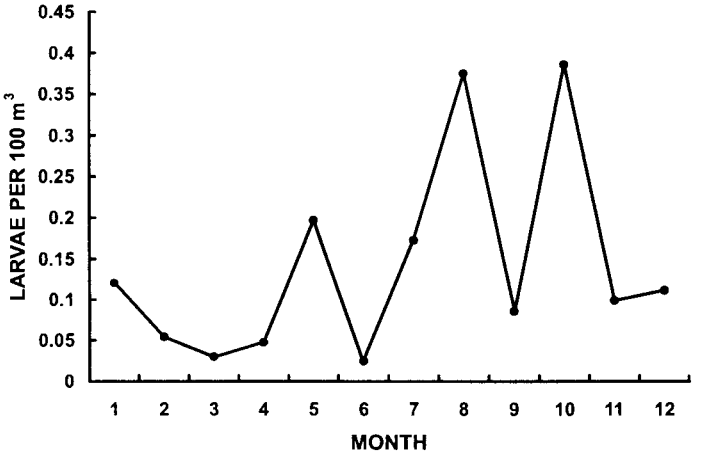



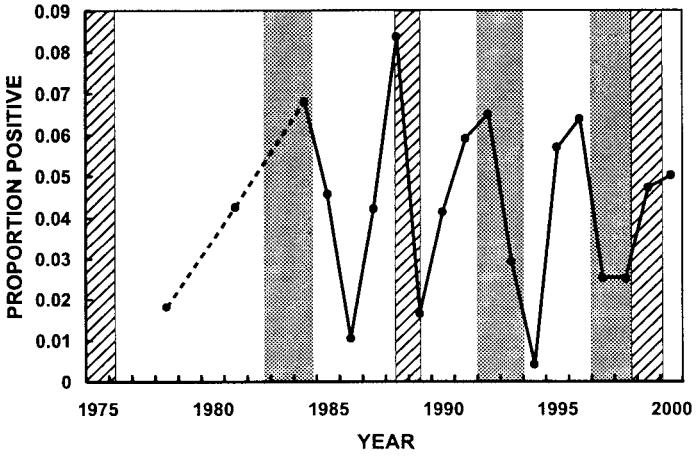



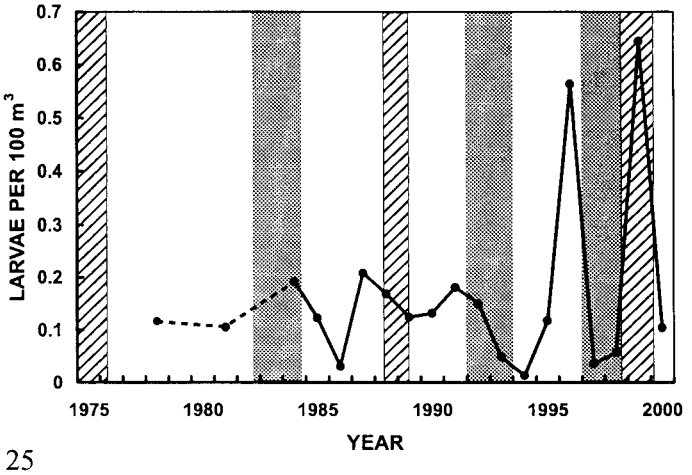

CalCOFI: 1977 - 1984
Total Larvae 459
San Diego
14.8 7.4 3.7 .7 <.7
Average Larvae per 100 m³

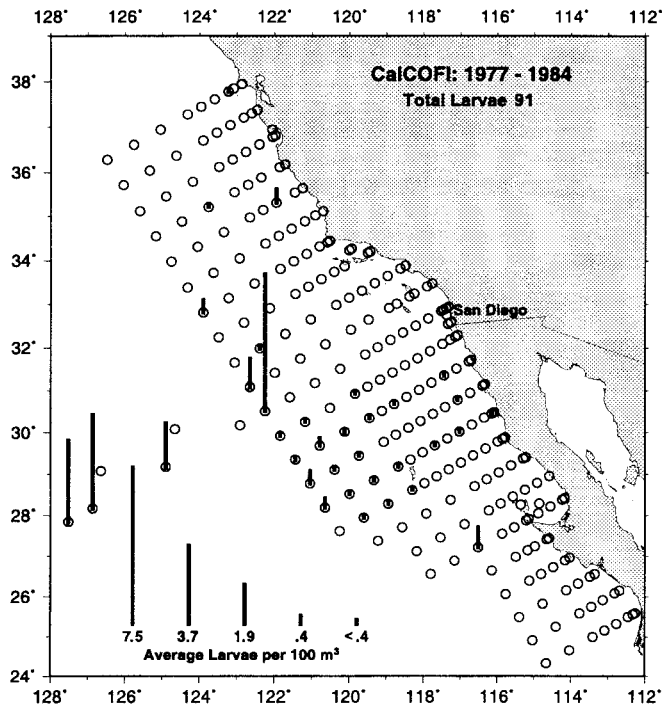

CalCOFI: 1977 - 2000
Total Larvae 560
San Diego
< .1 .1 .5 1.0 2.0
Average Larvae per 100 m³

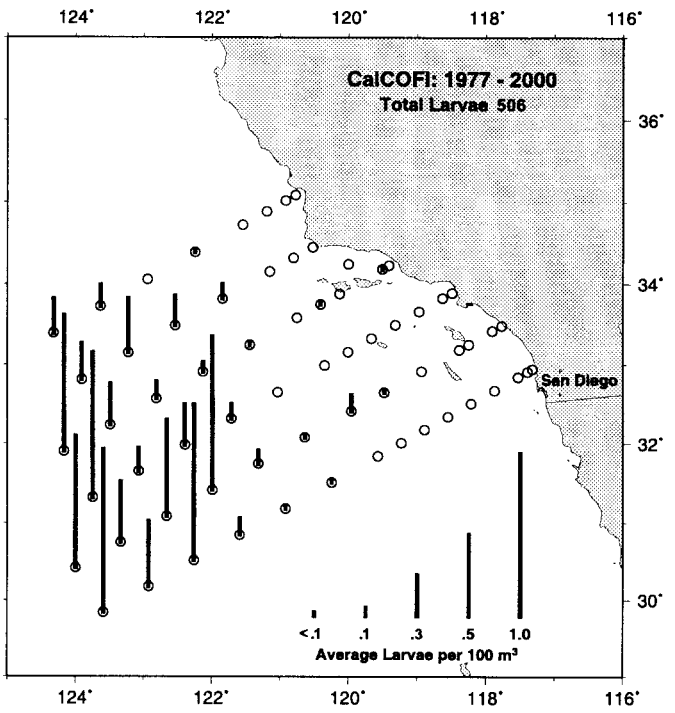

PROPORTION POSITIVE
MONTH

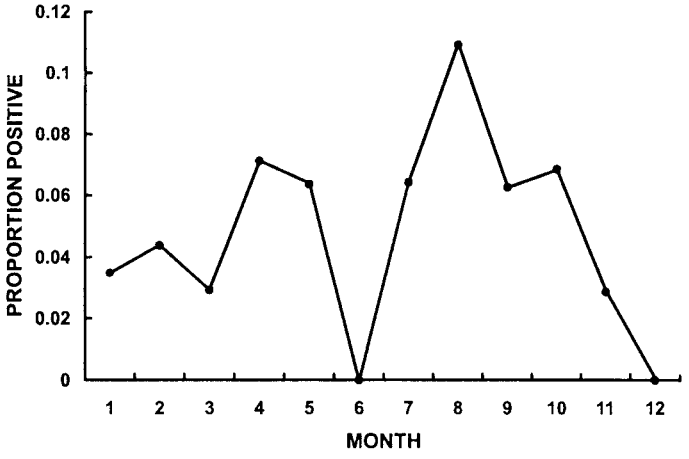

LARVAE PER 100 m³
MONTH

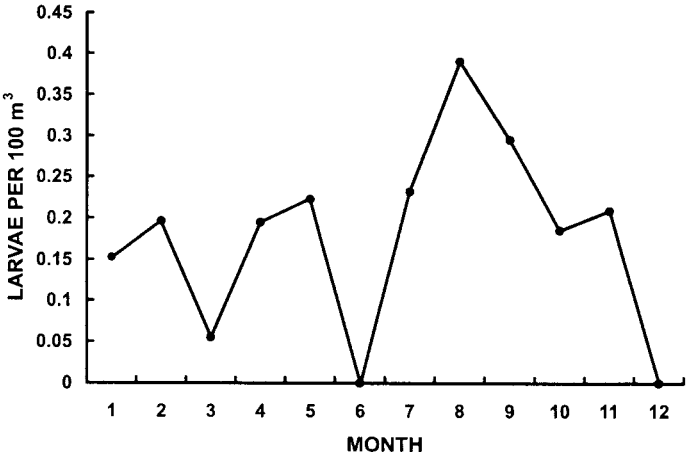

PROPORTION POSITIVE
YEAR

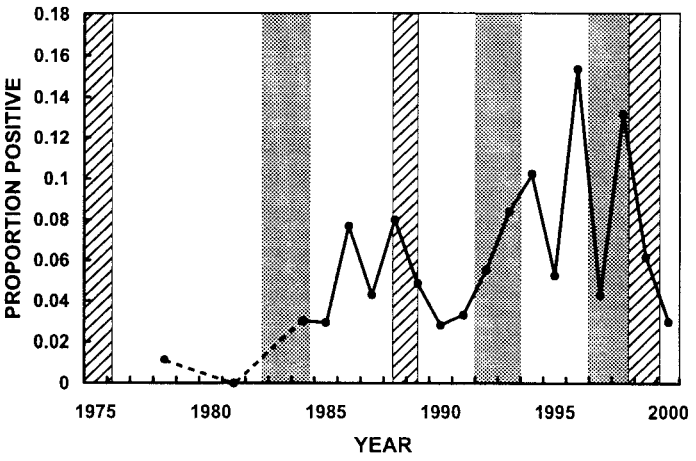

LARVAE PER 100 m³
YEAR

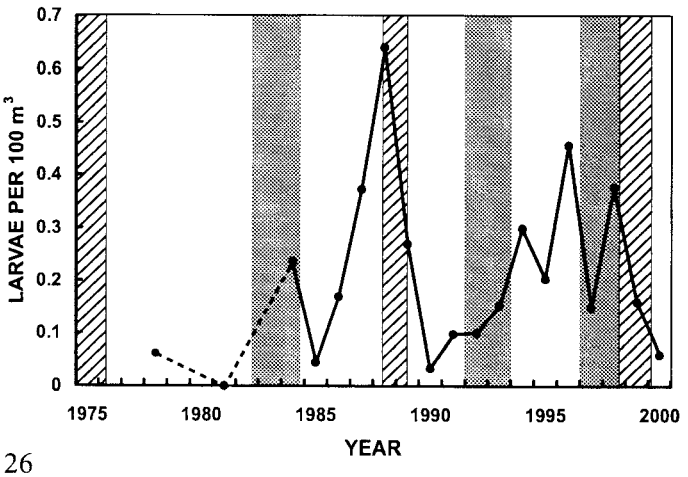

CalCOFI: 1977 - 1984
Total Larvae 91
San Diego
7.5 3.7 1.9 .4 <.4
Average Larvae per 100 m³

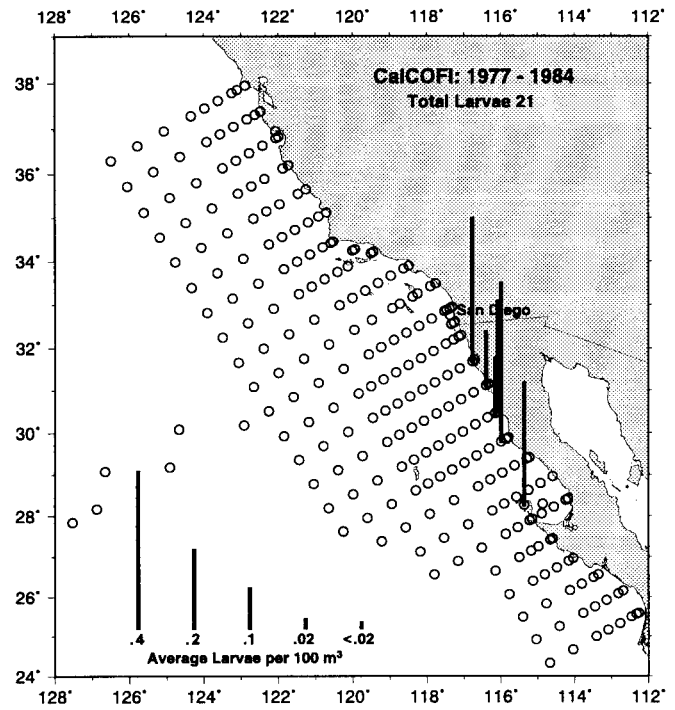

CalCOFI: 1977 - 2000
Total Larvae 506
San Diego
<.1 .1 .3 .5 1.0
Average Larvae per 100 m³

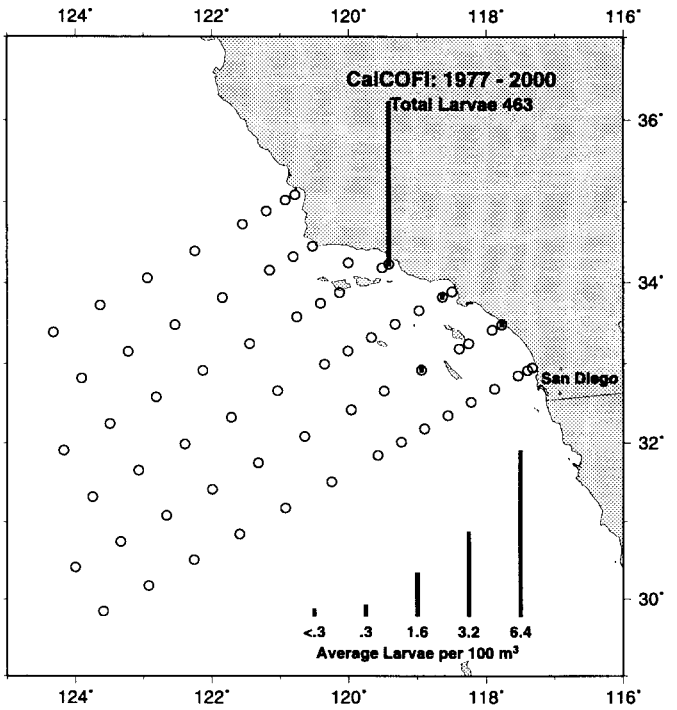

PROPORTION POSITIVE
MONTH

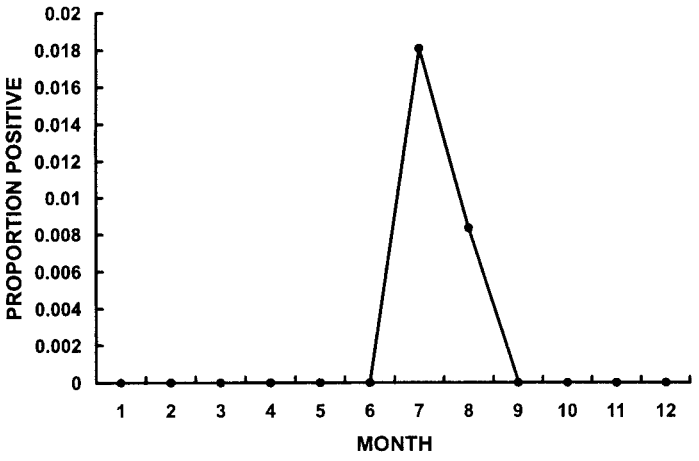

LARVAE PER 100 m³
MONTH

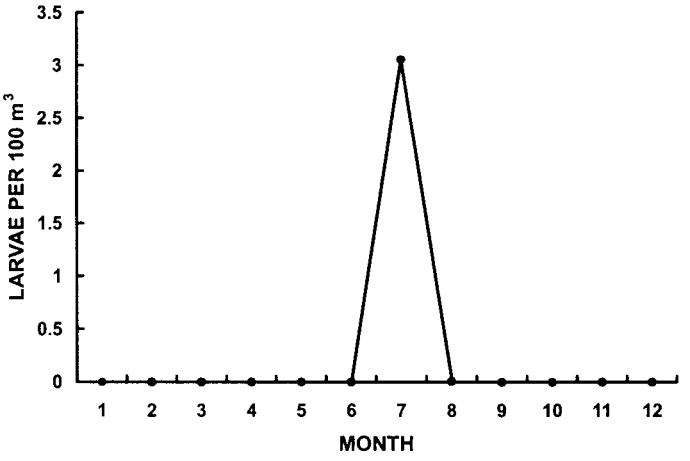

PROPORTION POSITIVE
YEAR

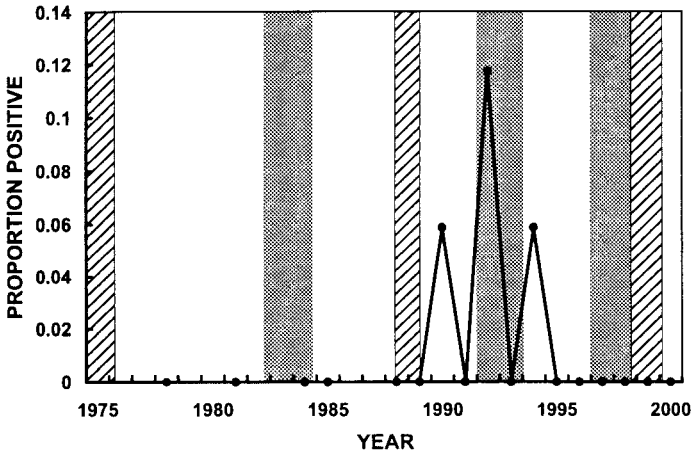

LARVAE PER 100 m³
YEAR

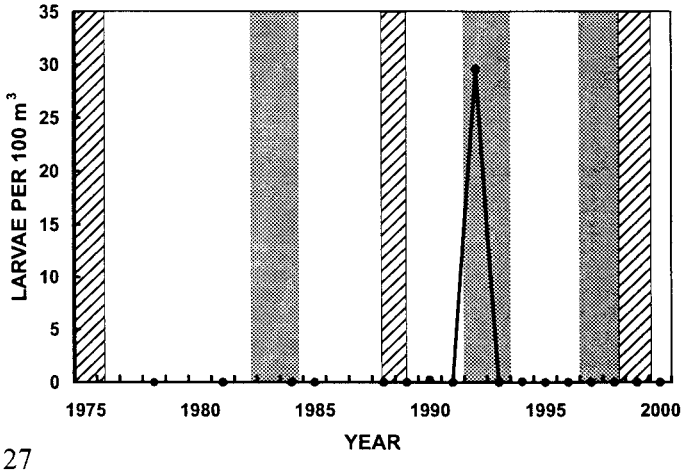

CalCOFI: 1977 - 1984
Total Larvae 21
San Diego
.4 .2 .1 .02 <.02
Average Larvae per 100 m³

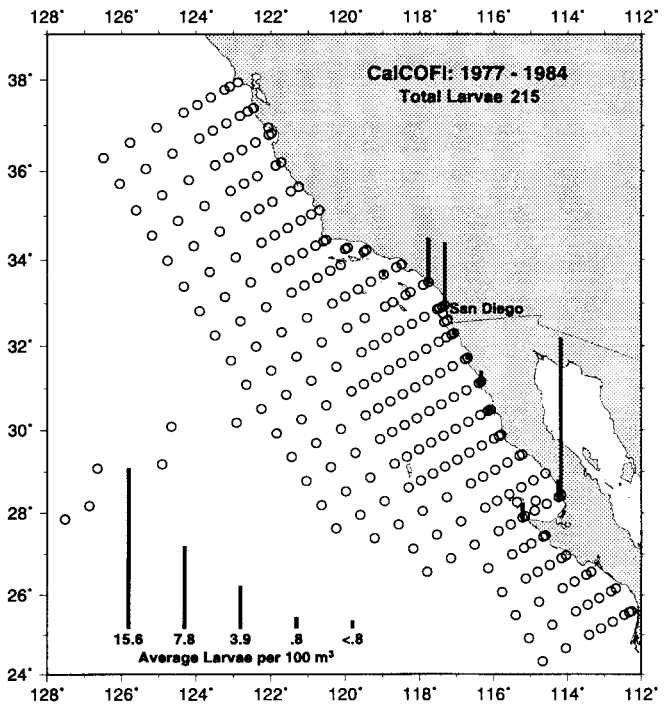

CalCOFI: 1977 - 2000
Total Larvae 463
San Diego
<.3 .3 1.6 3.2 6.4
Average Larvae per 100 m³

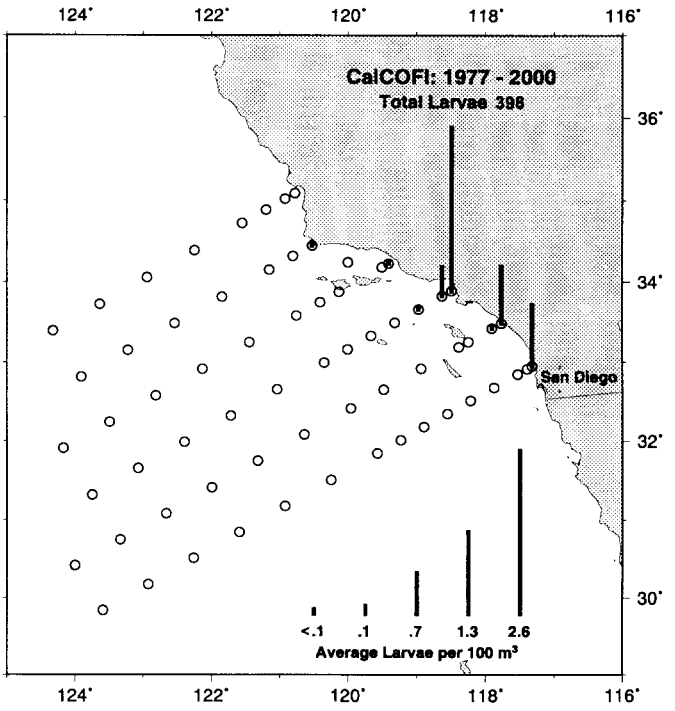

PROPORTION POSITIVE
MONTH

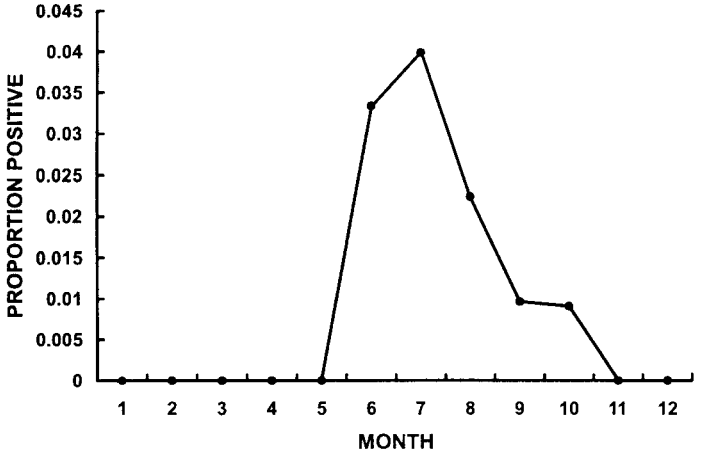

LARVAE PER 100 m³
MONTH

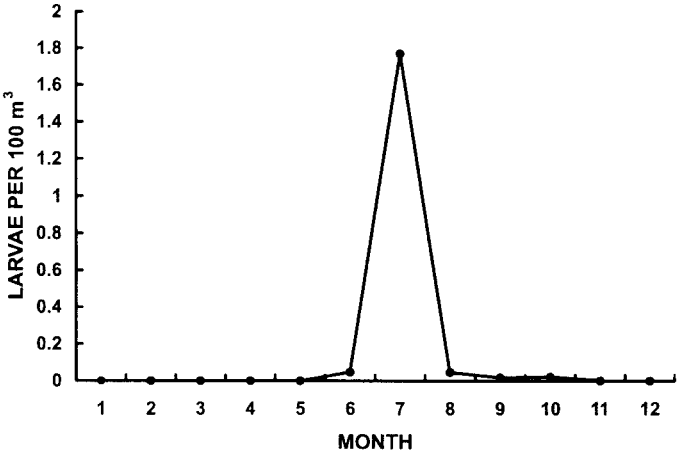

PROPORTION POSITIVE
YEAR

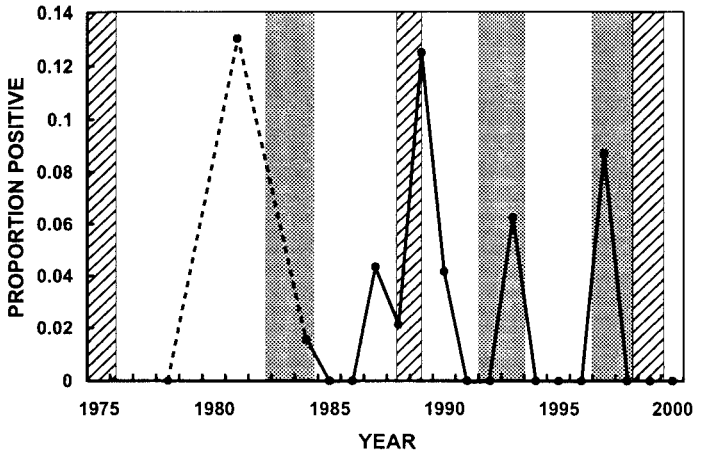

LARVAE PER 100 m³
YEAR

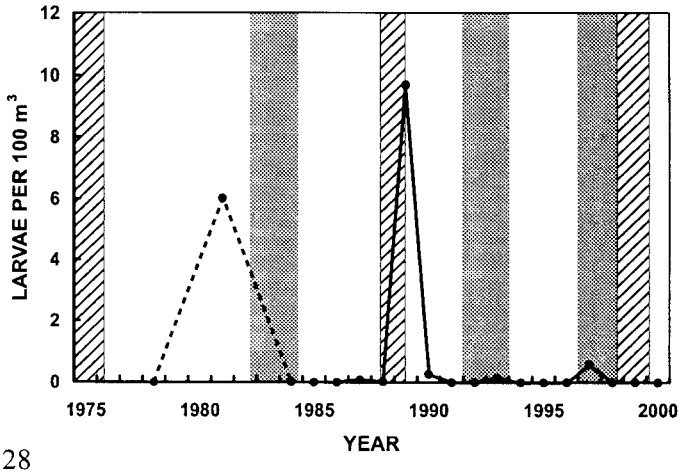

CalCOFI: 1977 - 1984
Total Larvae 215
San Diego
15.6 7.8 3.9 .8 <.8
Average Larvae per 100 m³

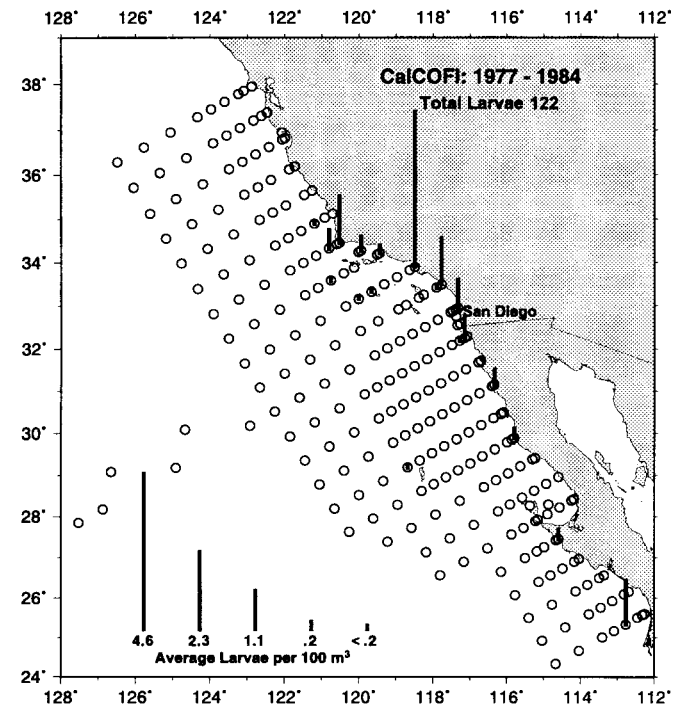

CalCOFI: 1977 - 2000
Total Larvae 398
San Diego
<.1 .1 .7 1.3 2.6
Average Larvae per 100 m³

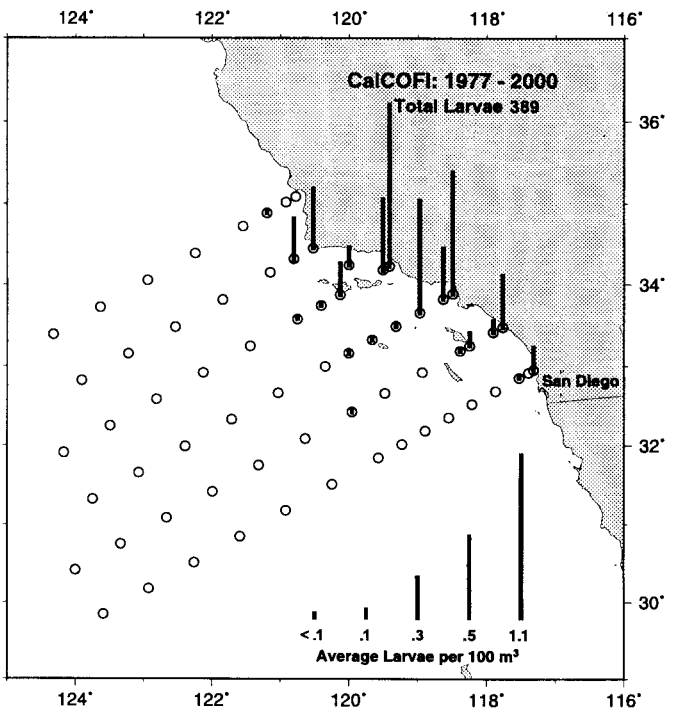

PROPORTION POSITIVE
MONTH

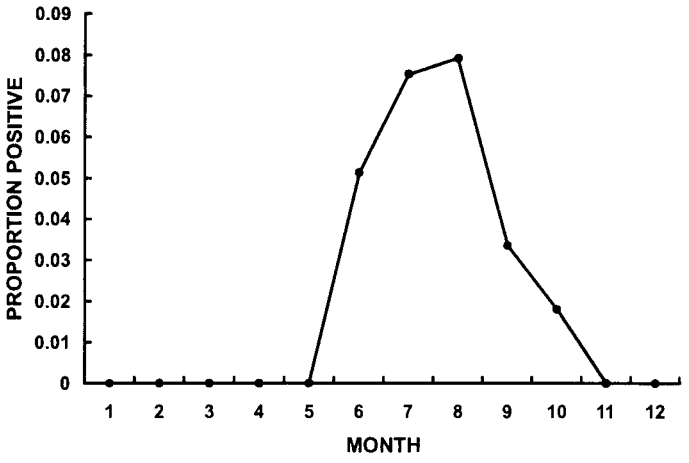

LARVAE PER 100 m³
MONTH

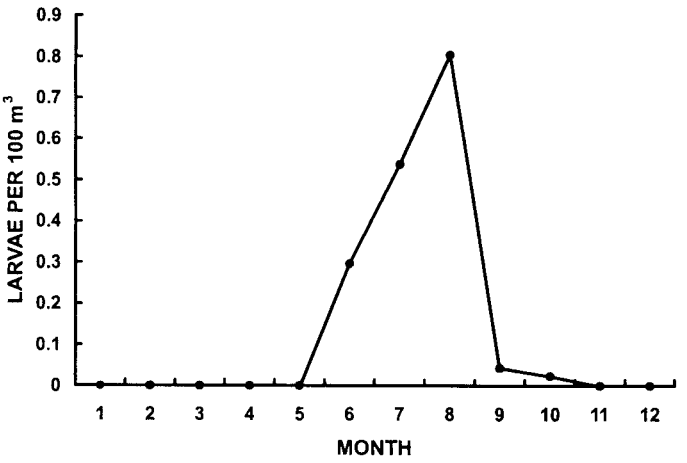

PROPORTION POSITIVE
YEAR

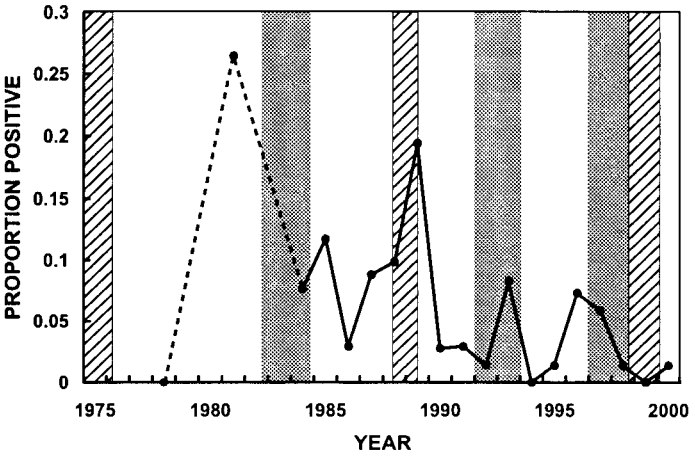

LARVAE PER 100 m³
YEAR

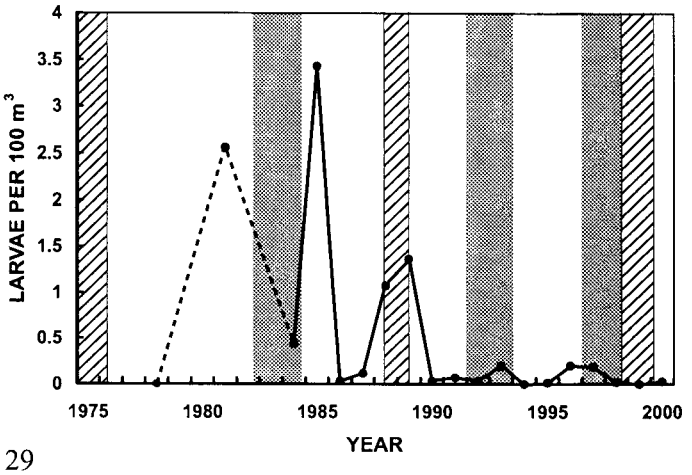

CalCOFI: 1977 - 1984
Total Larvae 122
San Diego
4.6
2.3
1.1
.2
<.2
Average Larvae per 100 m³

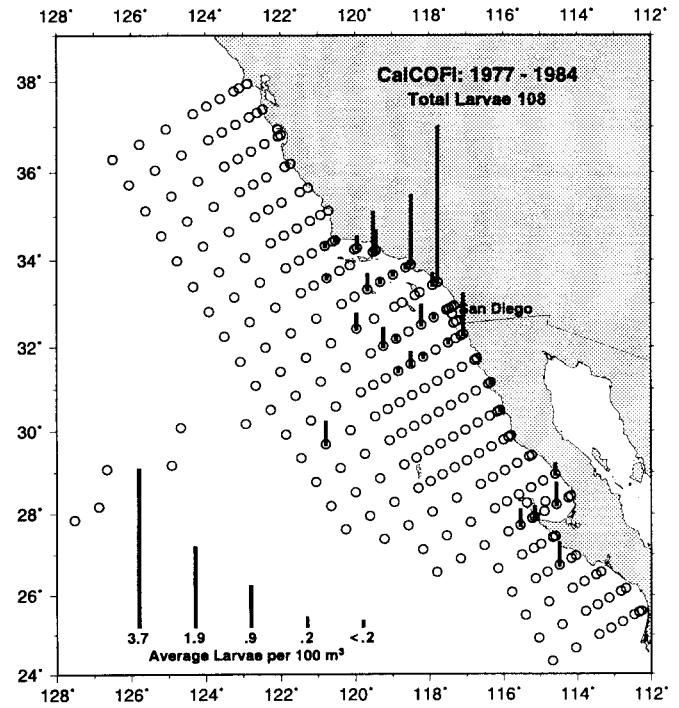

CalCOFI: 1977 - 2000
Total Larvae 389
San Diego
<.1
.1
.3
.5
1.1
Average Larvae per 100 m³

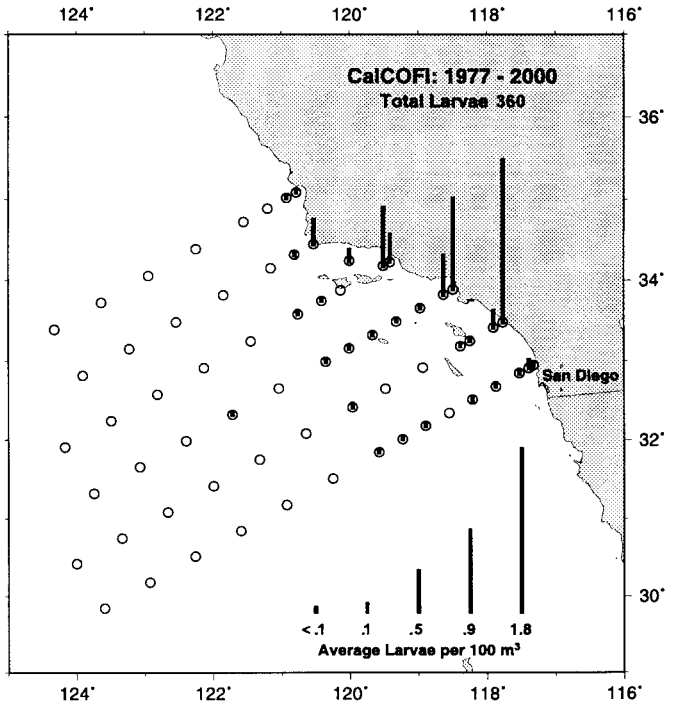

PROPORTION POSITIVE
MONTH

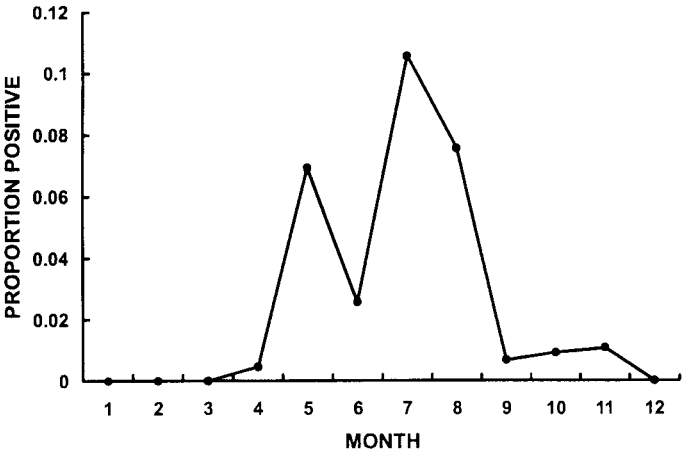

LARVAE PER 100 m³
MONTH

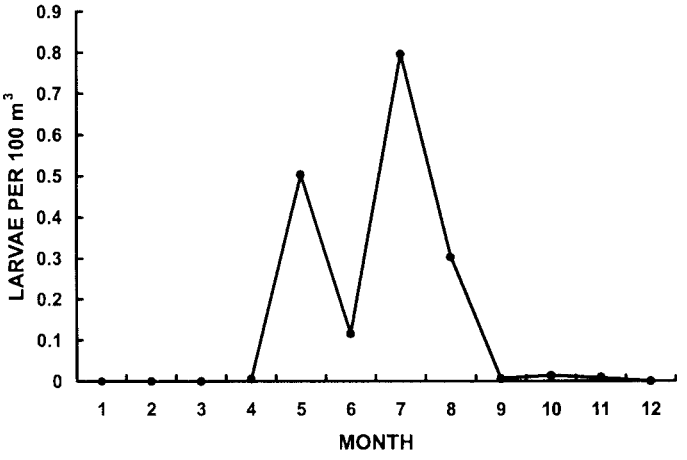

PROPORTION POSITIVE
YEAR

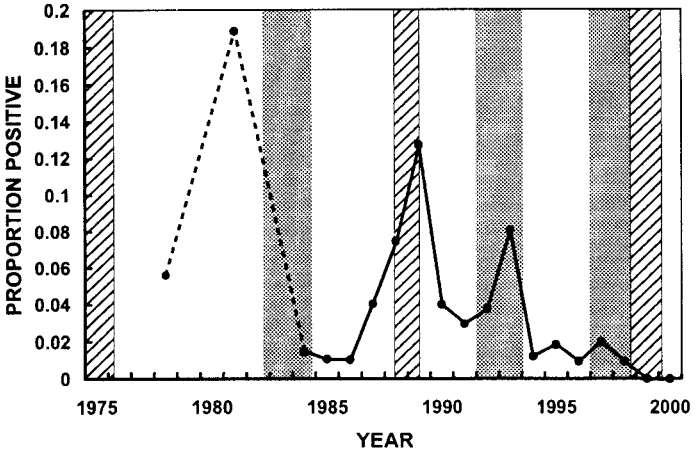

LARVAE PER 100 m³
YEAR

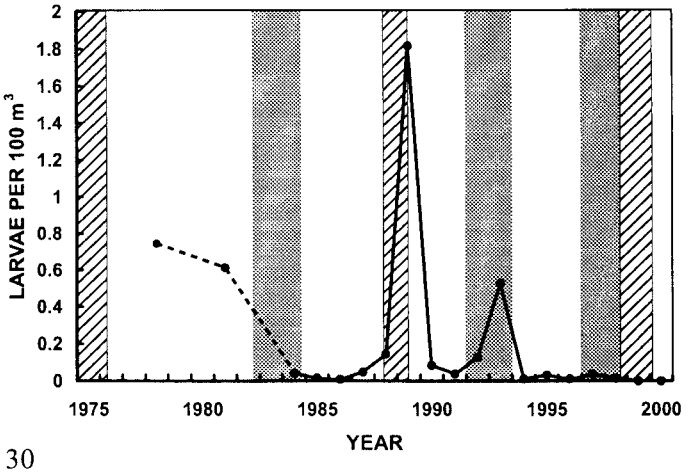

CalCOFI: 1977 - 1984
Total Larvae 108
San Diego
3.7 1.9 .9 .2 <.2
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 360
San Diego
<.1 .1 .5 .9 1.8
Average Larvae per 100 m³

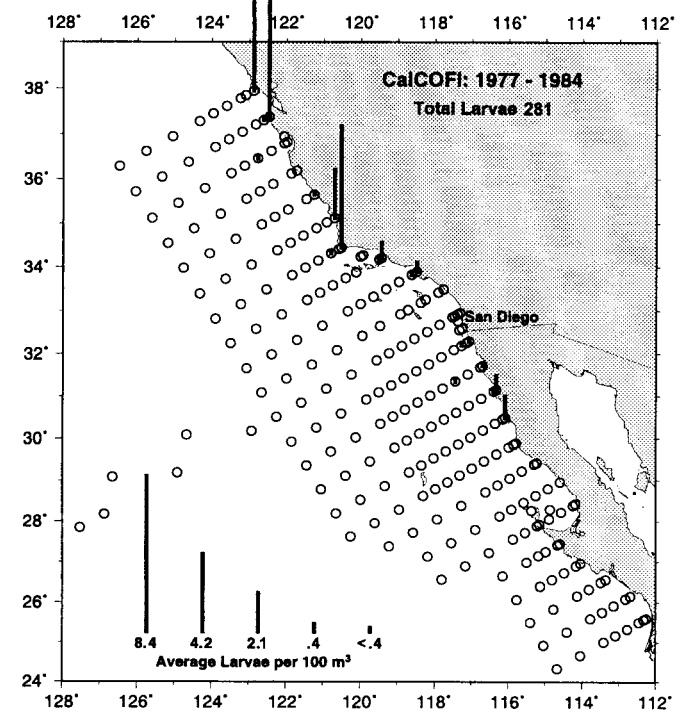

PROPORTION POSITIVE
MONTH

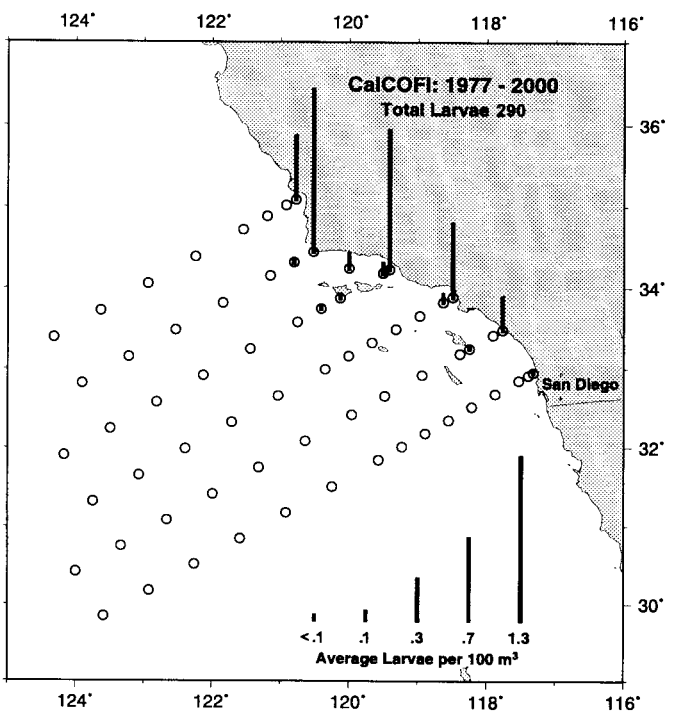

LARVAE PER 100 m³
MONTH

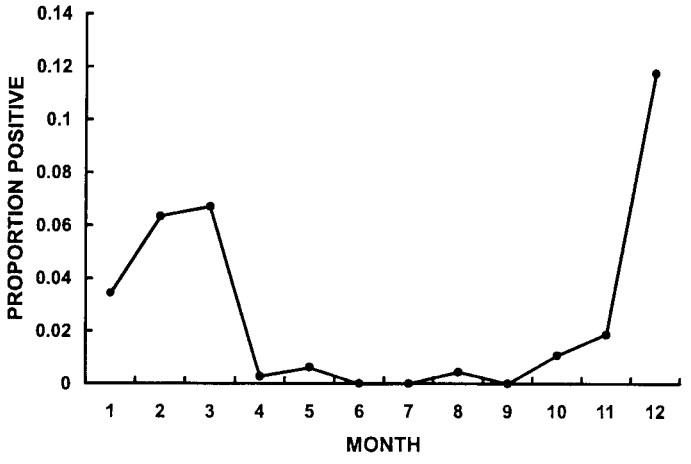

PROPORTION POSITIVE
YEAR

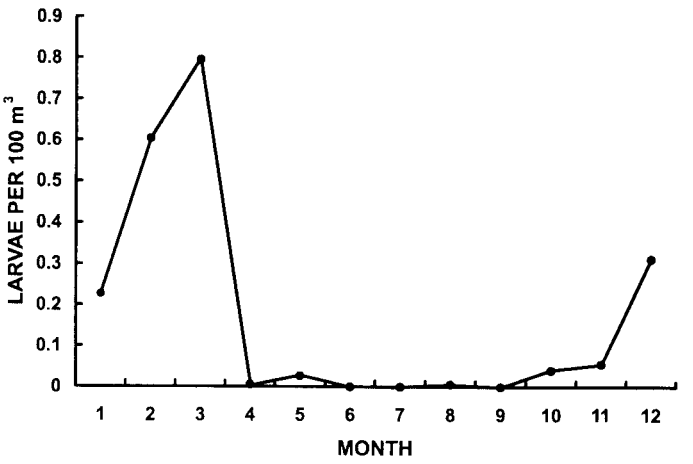

LARVAE PER 100 m³
YEAR

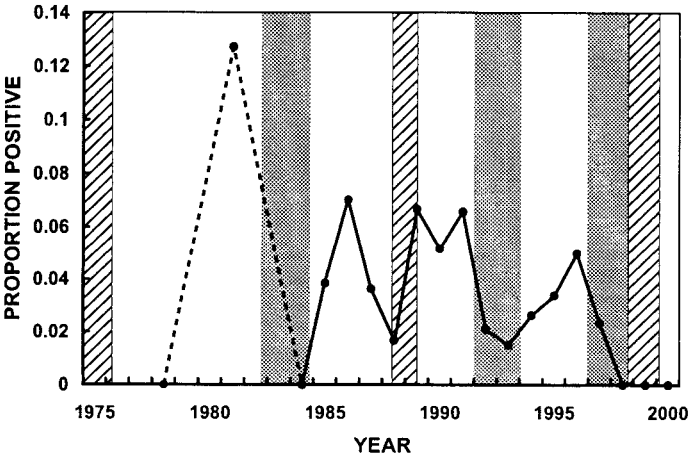
SCIAENIDAE White croaker ***Genyonemus lineatus***

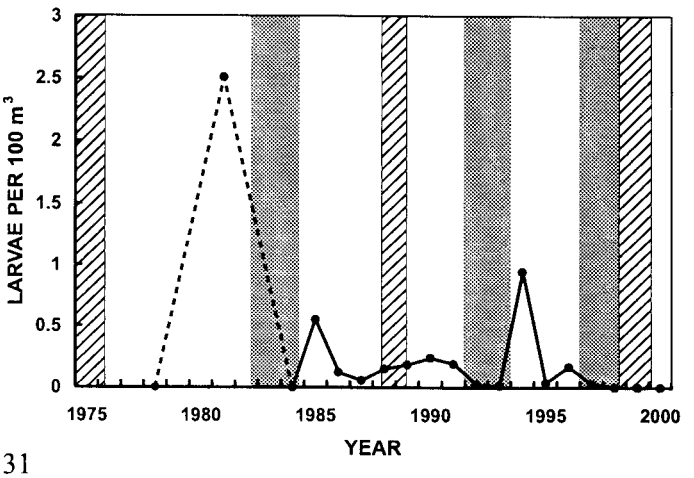


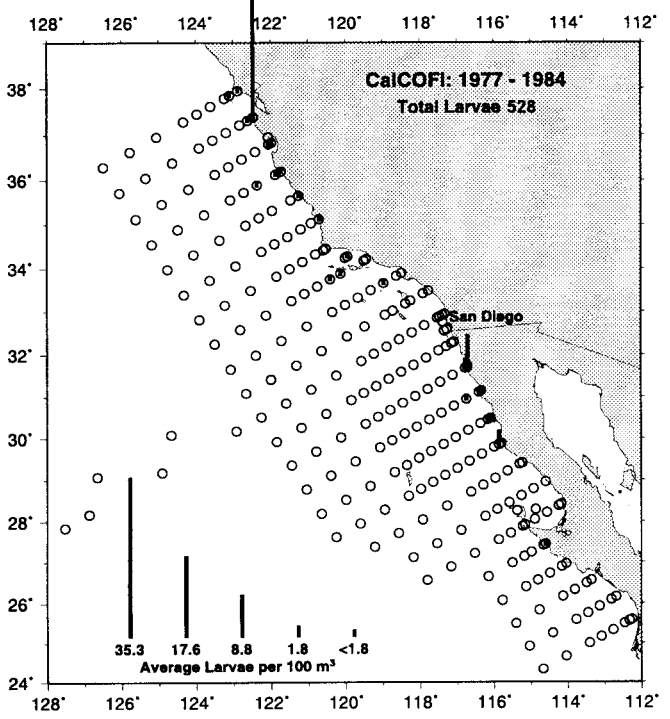



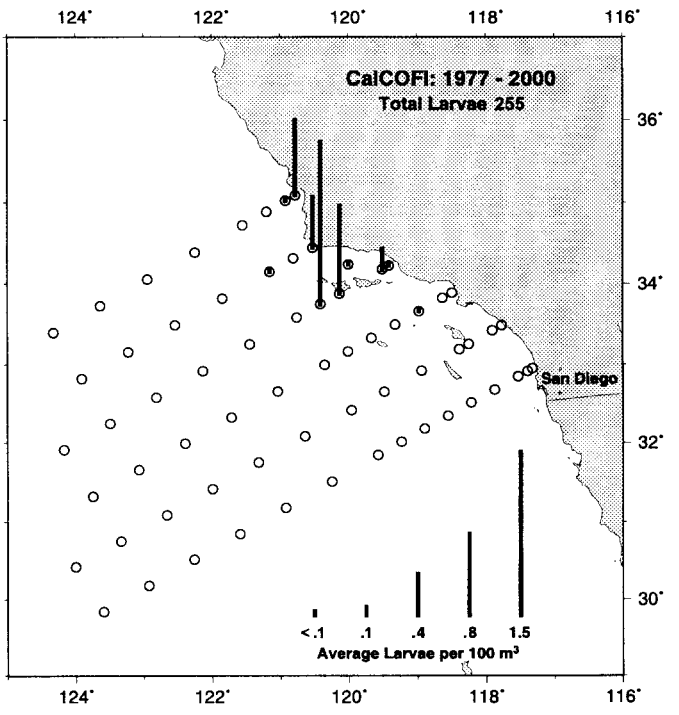



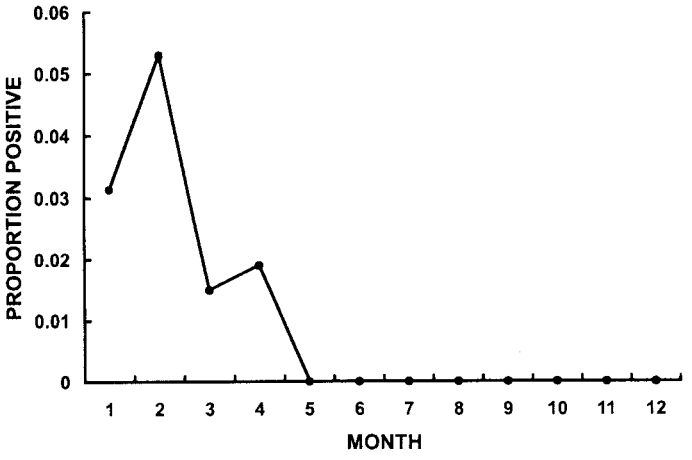



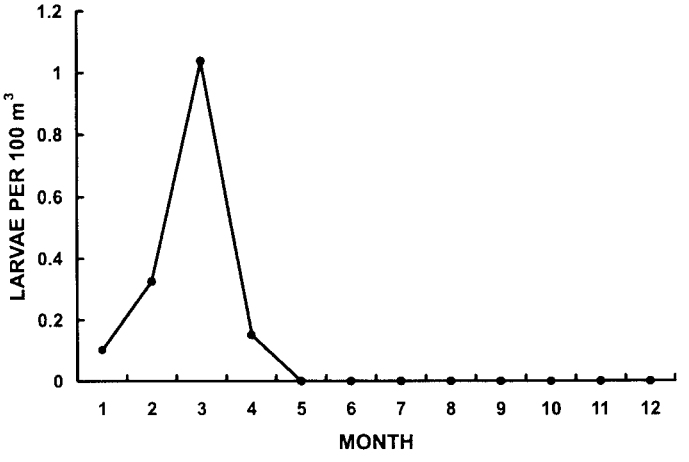



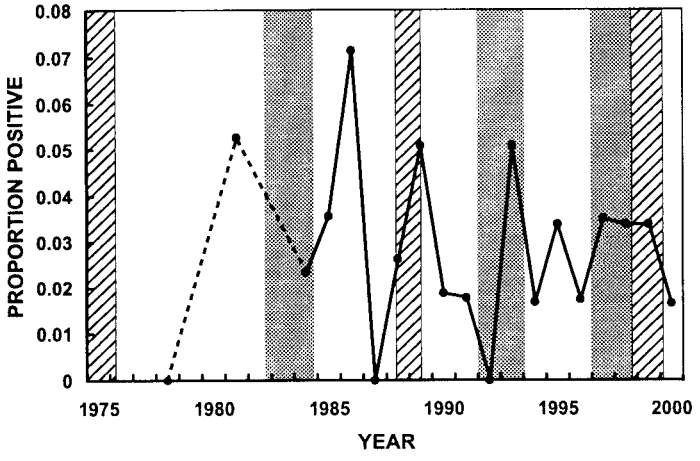
***Ophiodon elongatus*** Lingcod HEXAGRAMMIDAE

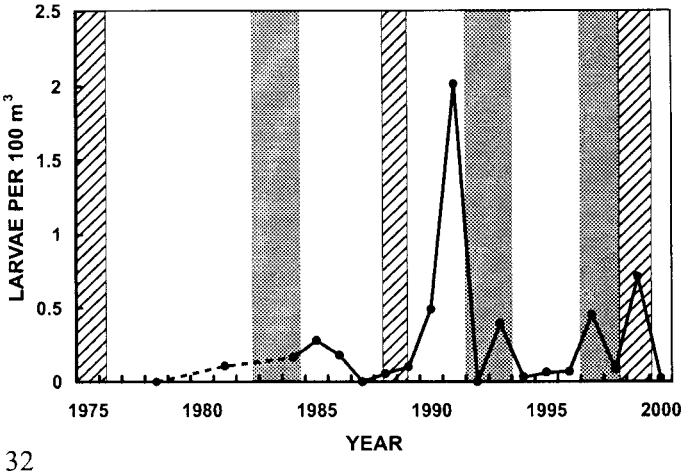


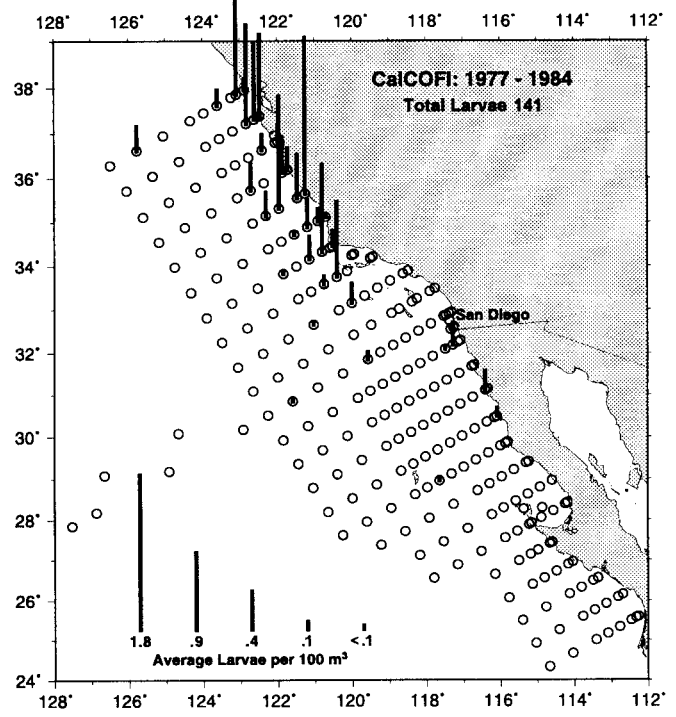



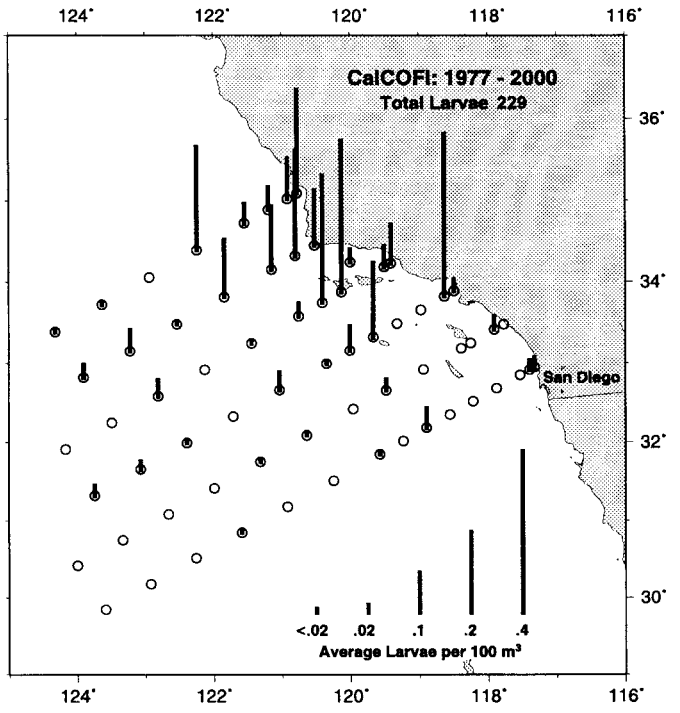



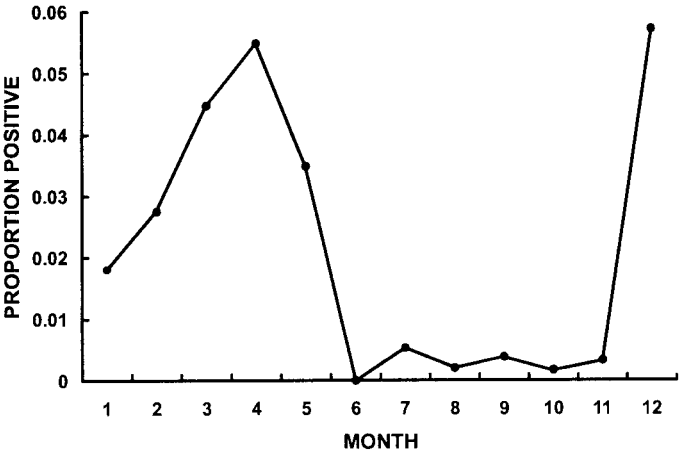



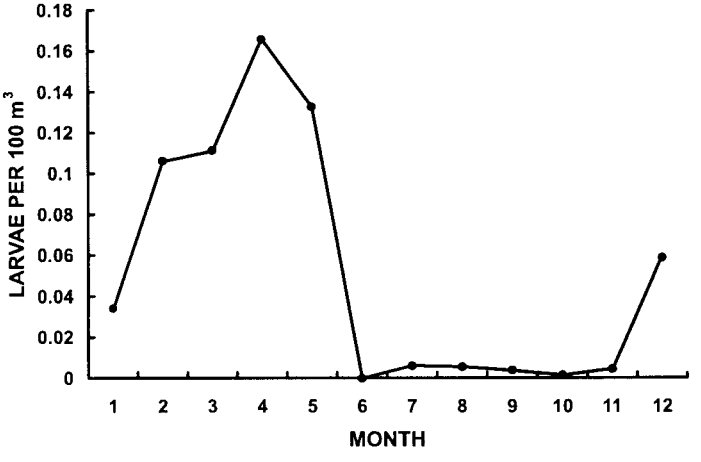



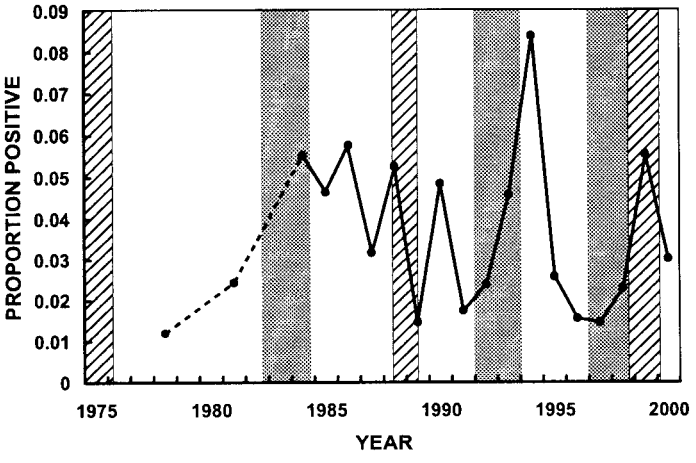
MYCTOPHIDAE Northern lampfish ***Stenobrachius leucopsarus***

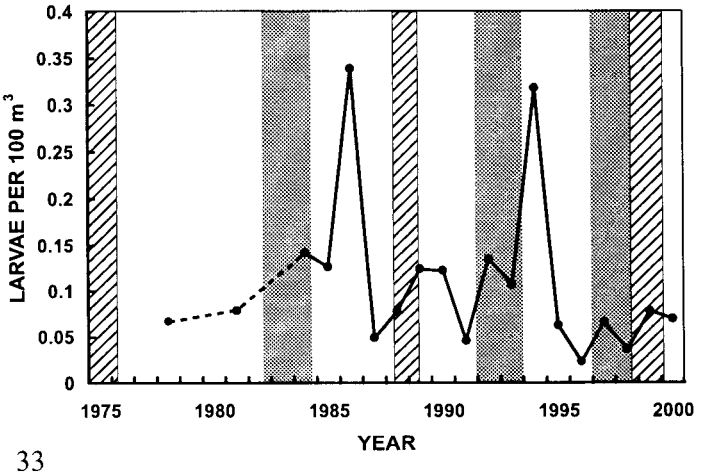


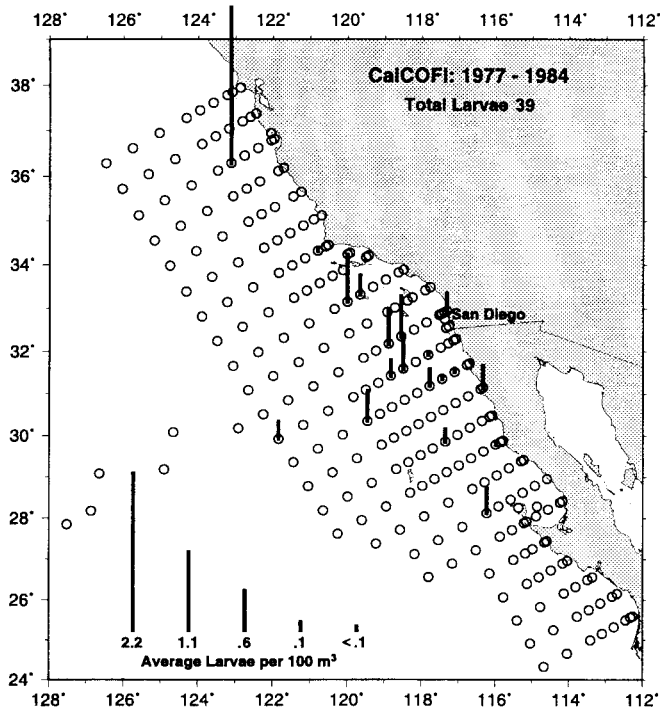



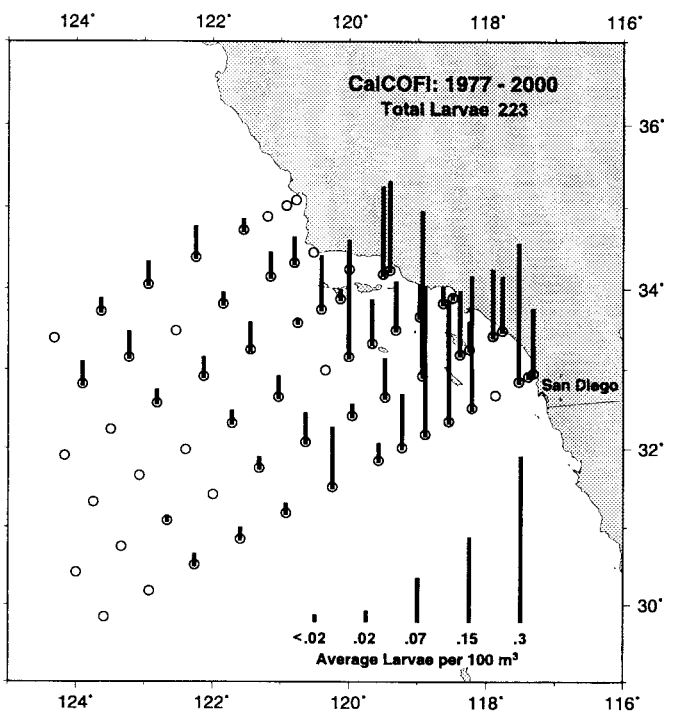



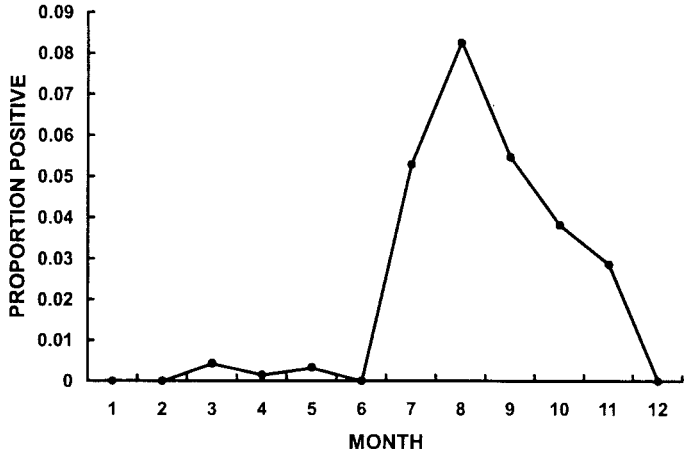



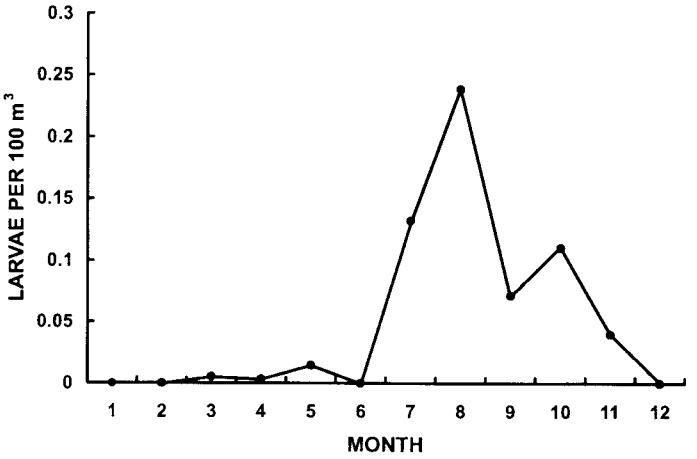



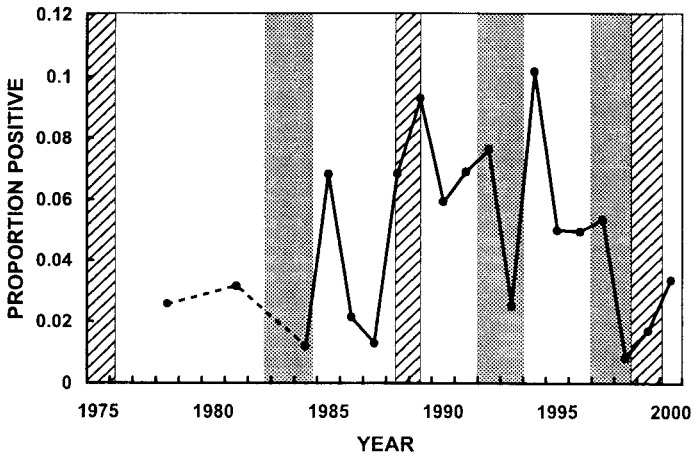
***Medialuna californiensis*** Halfmoon KYPHOSIDAE

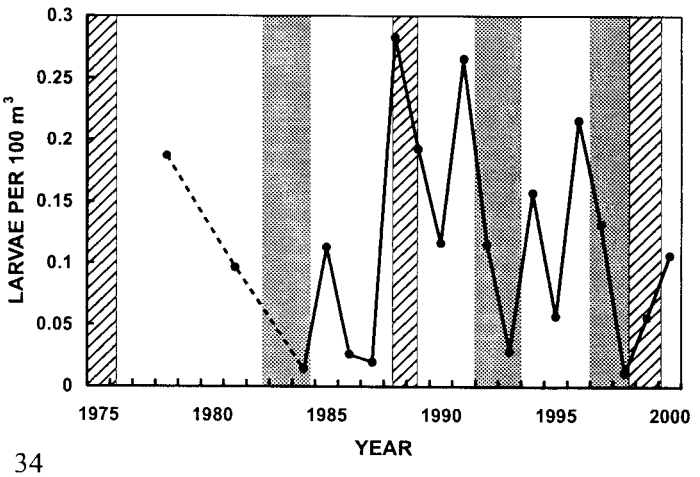


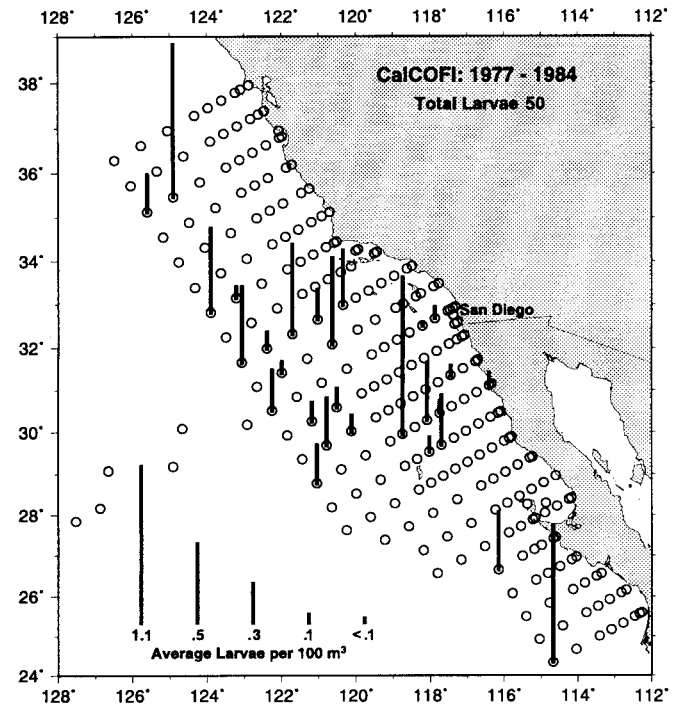



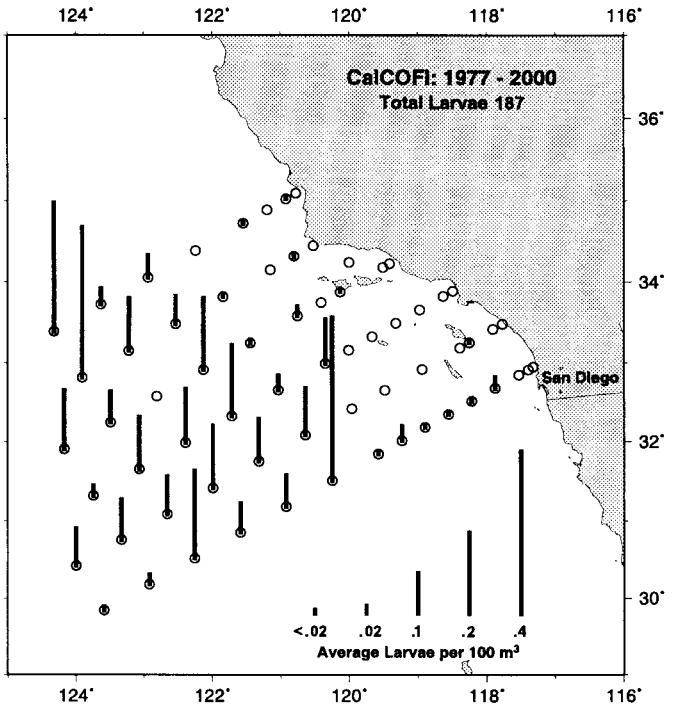



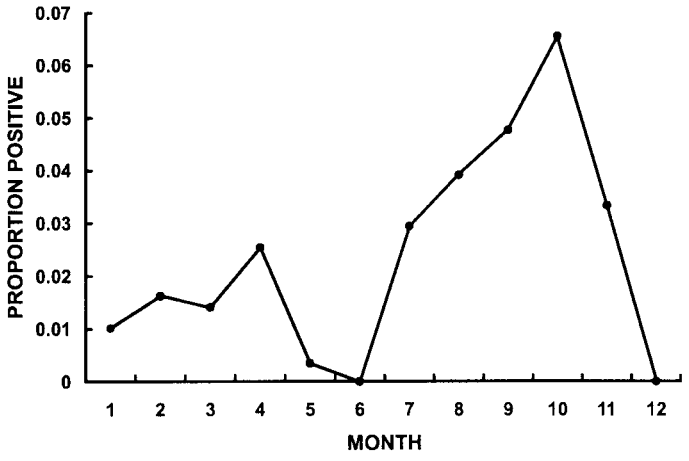



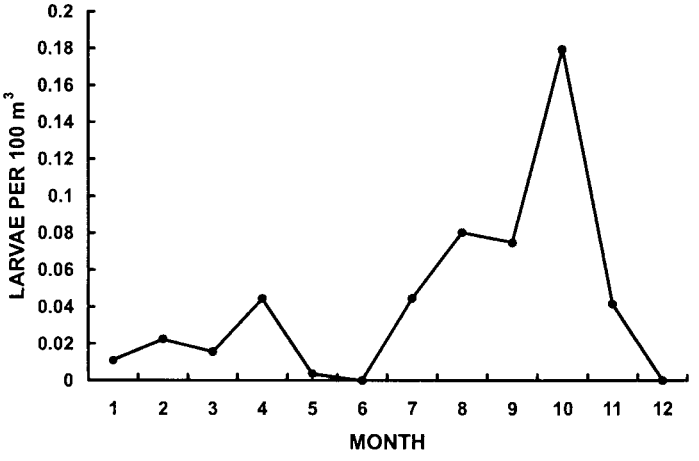



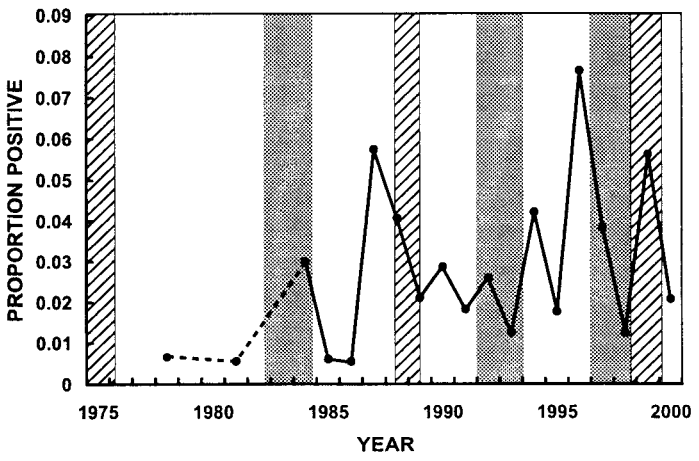



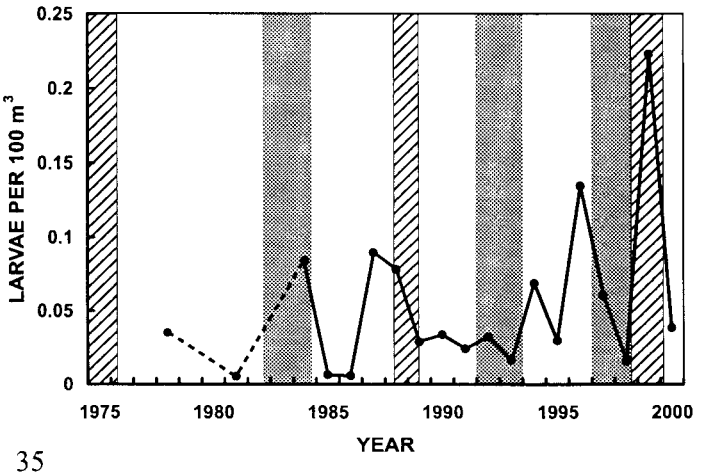

CalCOFI: 1977 - 1984
Total Larvae 50
San Diego
1.1 .5 .3 .1 <.1
Average Larvae per 100 m³

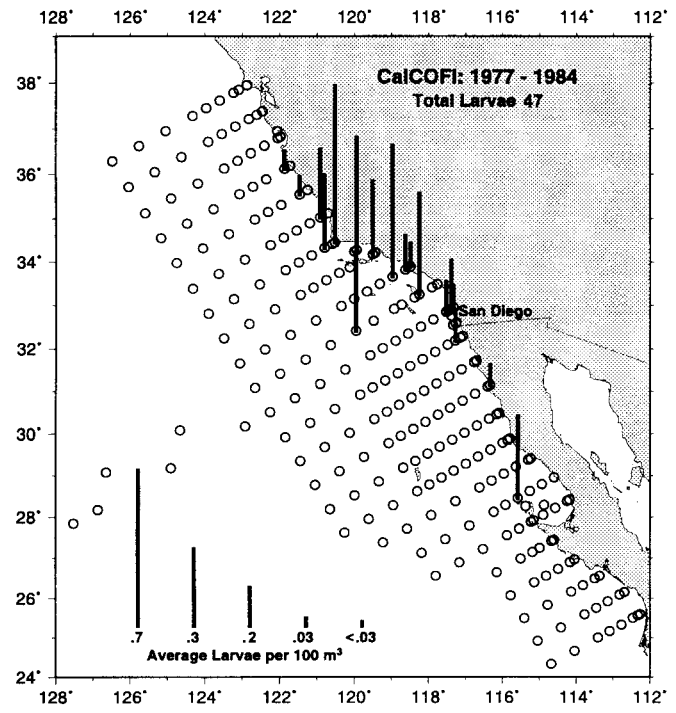

CalCOFI: 1977 - 2000
Total Larvae 187
San Diego
<.02 .02 .1 .2 .4
Average Larvae per 100 m³

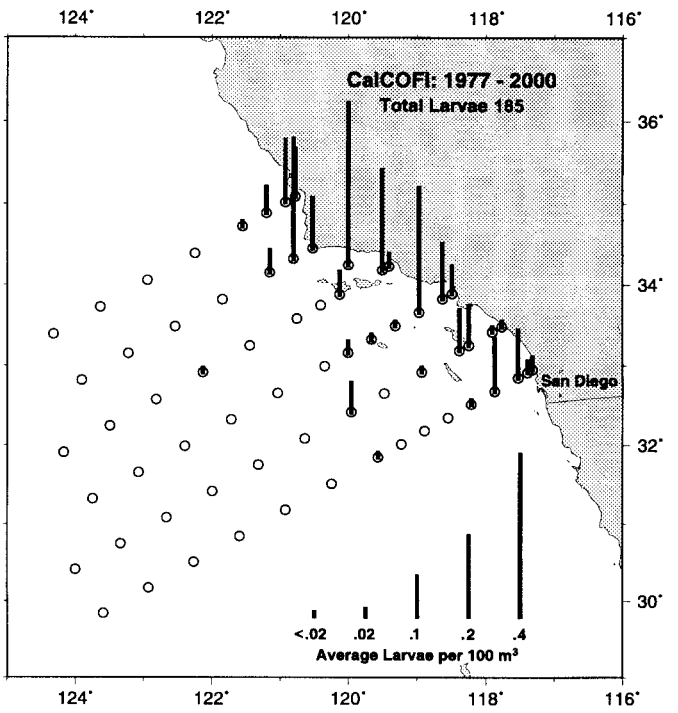

PROPORTION POSITIVE
MONTH

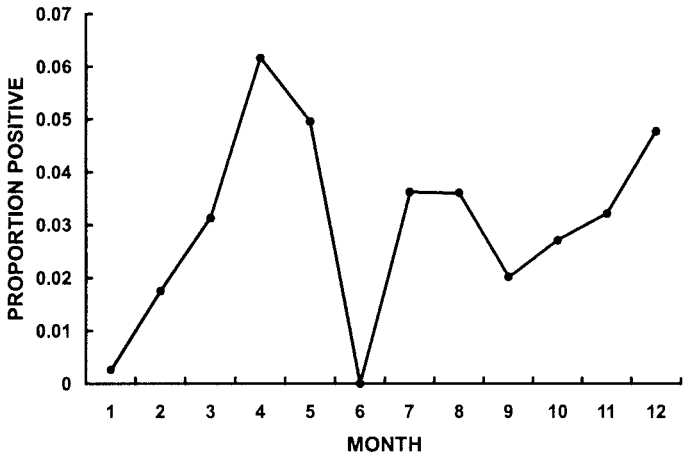

LARVAE PER 100 m³
MONTH

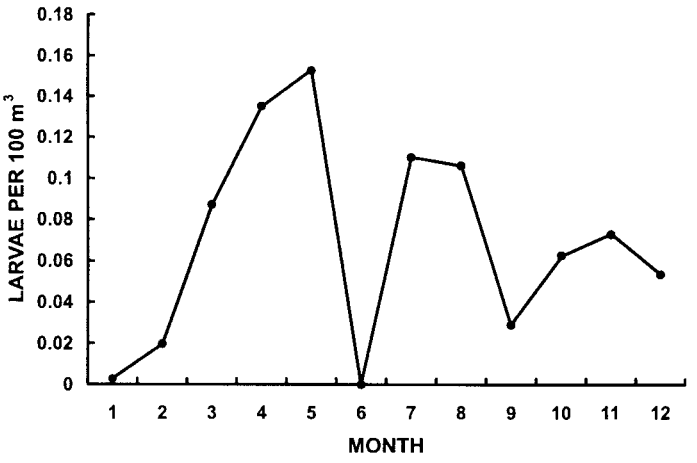

PROPORTION POSITIVE
YEAR

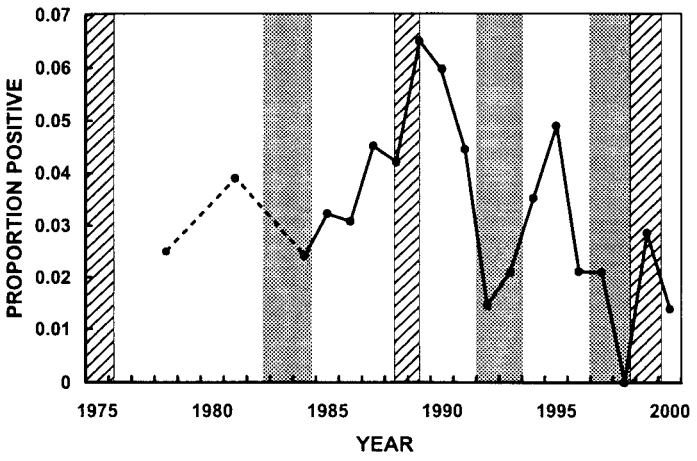

LARVAE PER 100 m³
YEAR

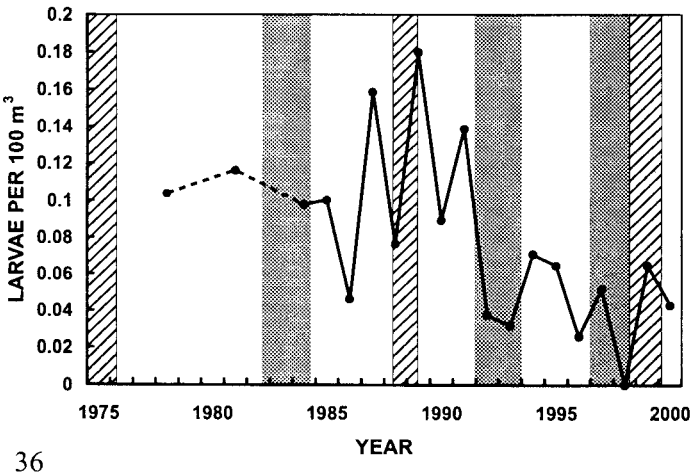

CalCOFI: 1977 - 1984
Total Larvae 47
San Diego
.7 .3 .2 .03 <.03
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 185
San Diego
<.02 .02 .1 .2 .4
Average Larvae per 100 m³

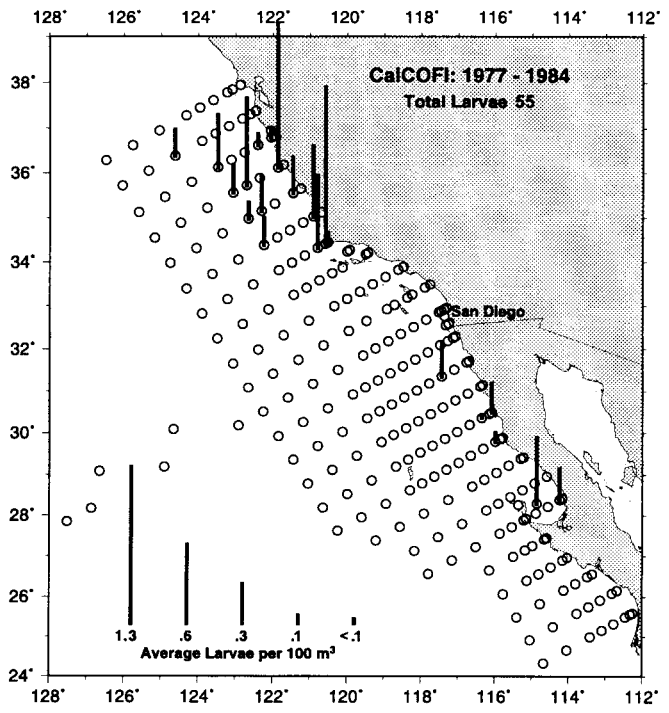

PROPORTION POSITIVE
MONTH

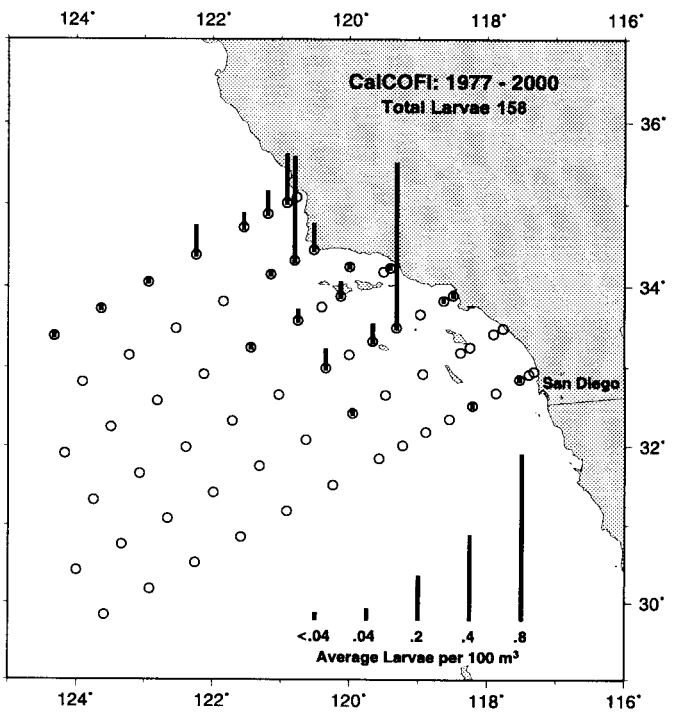

LARVAE PER 100 m³
MONTH

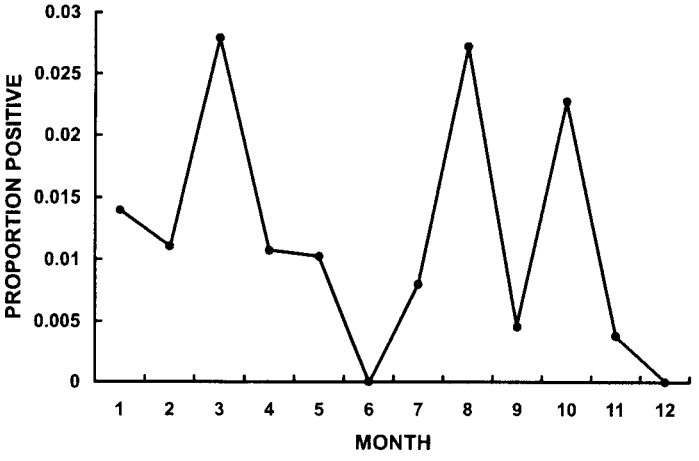

PROPORTION POSITIVE
YEAR

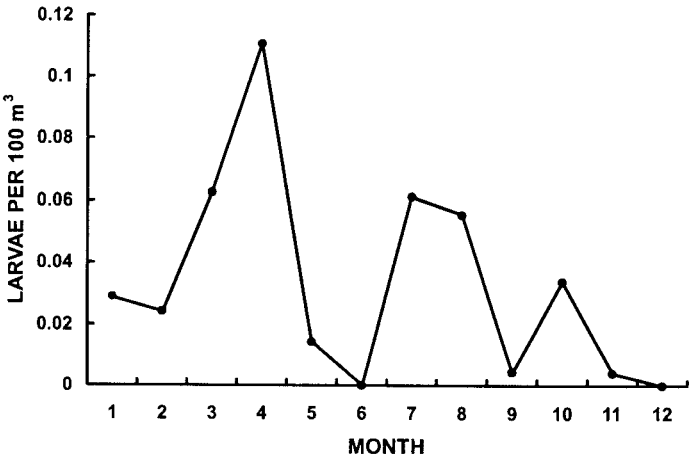

LARVAE PER 100 m³
YEAR

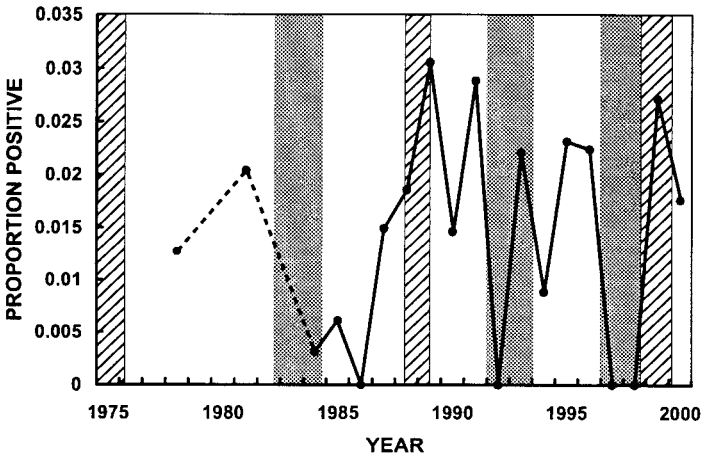
PARALICHTHYIDAE Speckled sanddab ***Citharichthys stigmaeus***

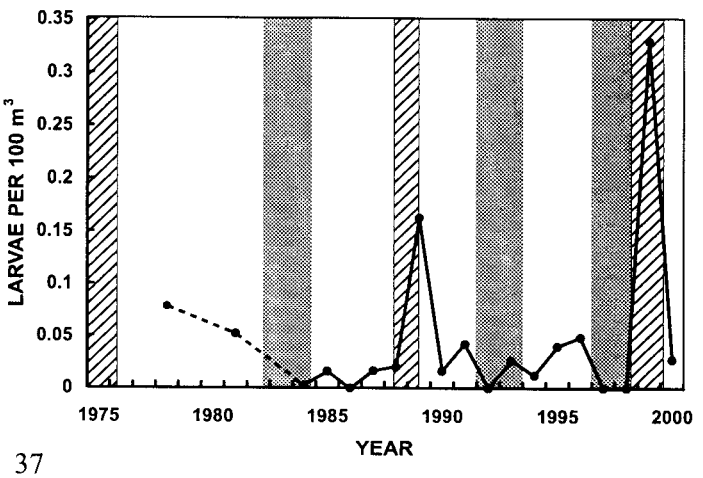


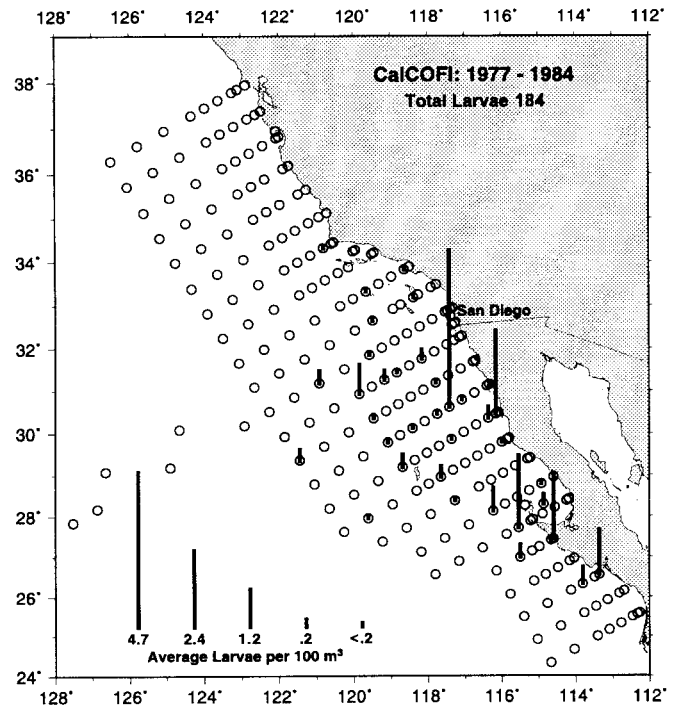



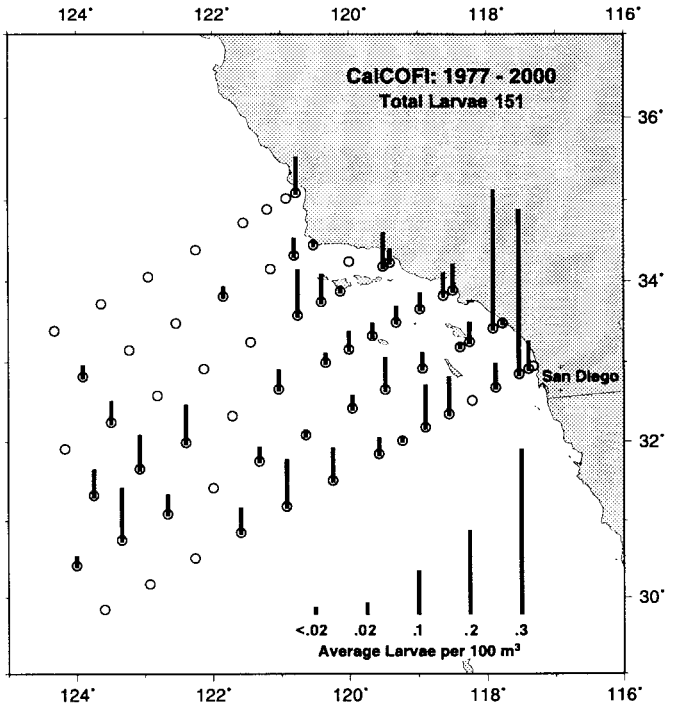



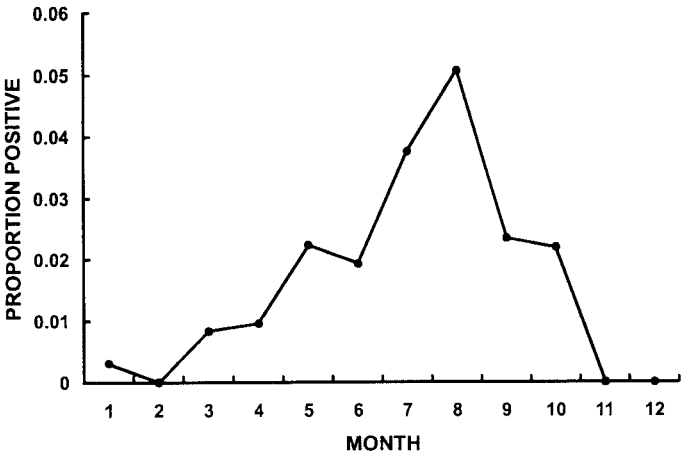



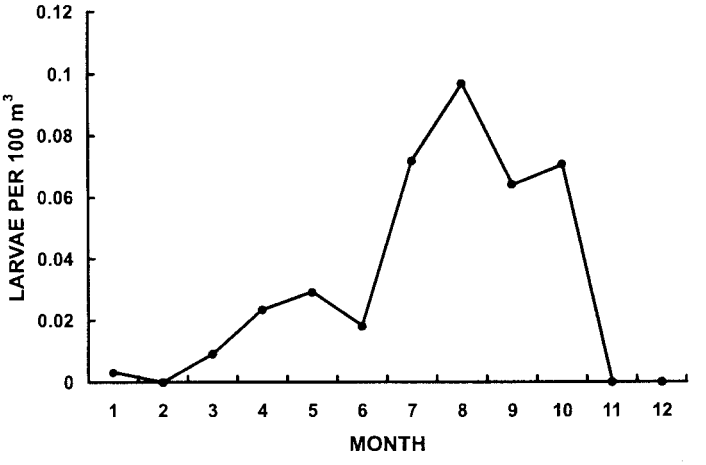



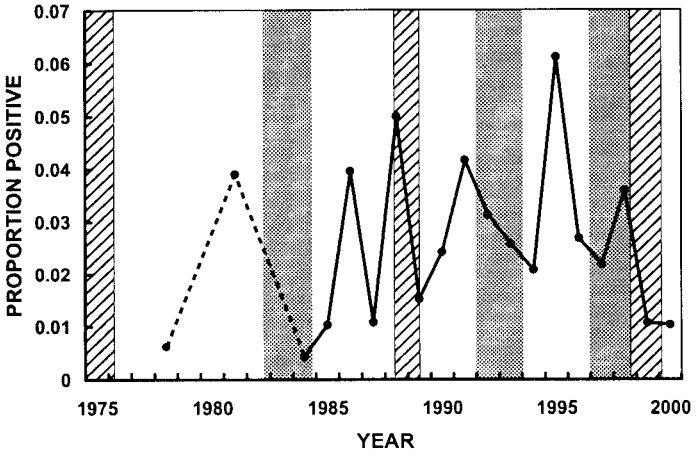



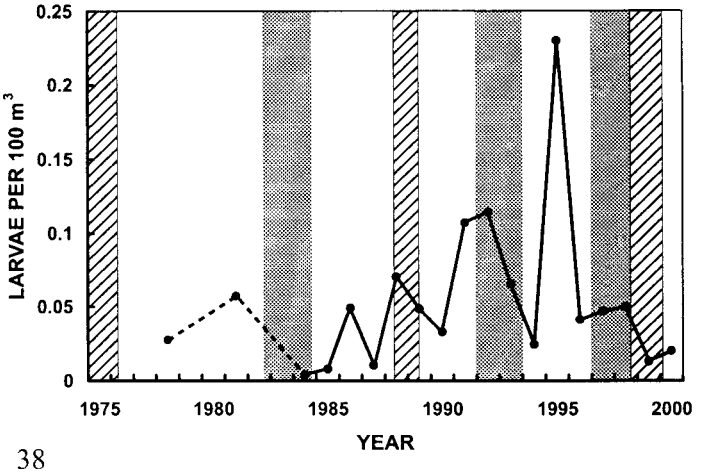

CalCOFI: 1977 - 1984
Total Larvae 184
San Diego
4.7 2.4 1.2 .2 <.2
Average Larvae per 100 m³

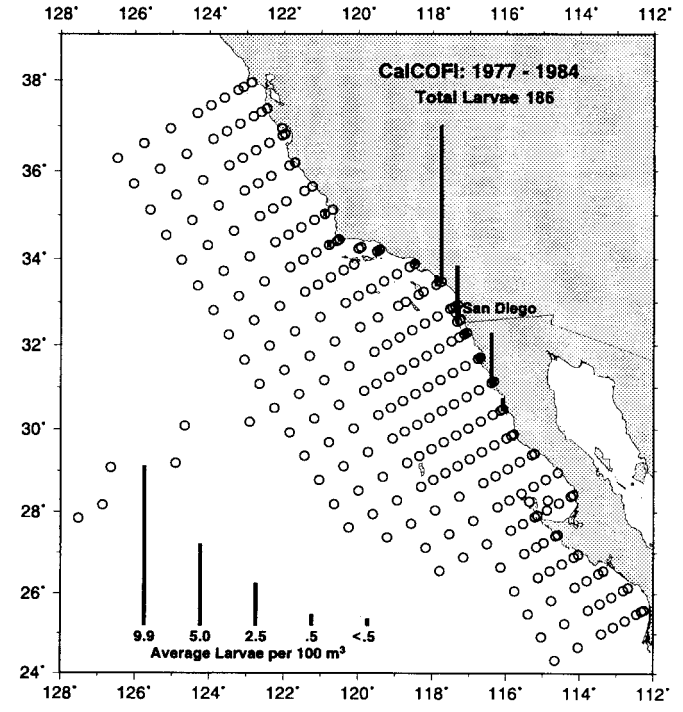

CalCOFI: 1977 - 2000
Total Larvae 151
San Diego
<.02 .02 .1 .2 .3
Average Larvae per 100 m³

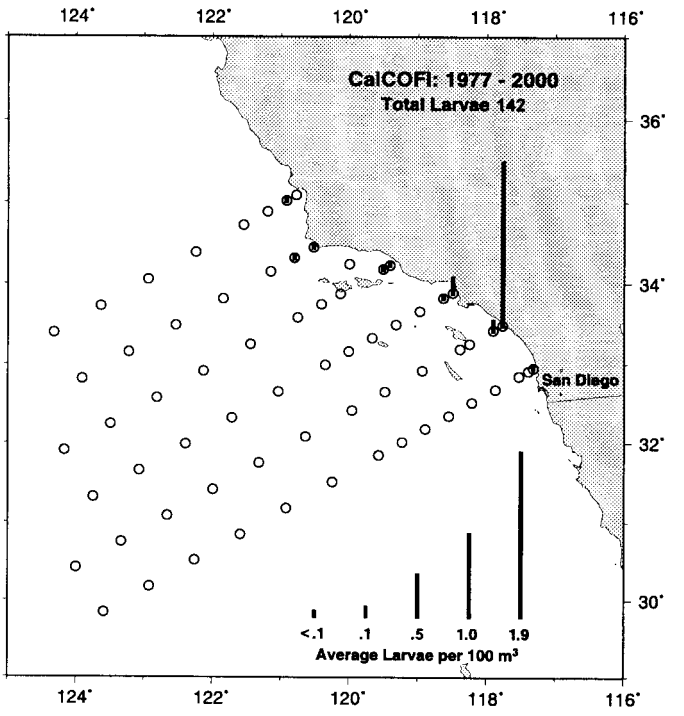

PROPORTION POSITIVE
MONTH

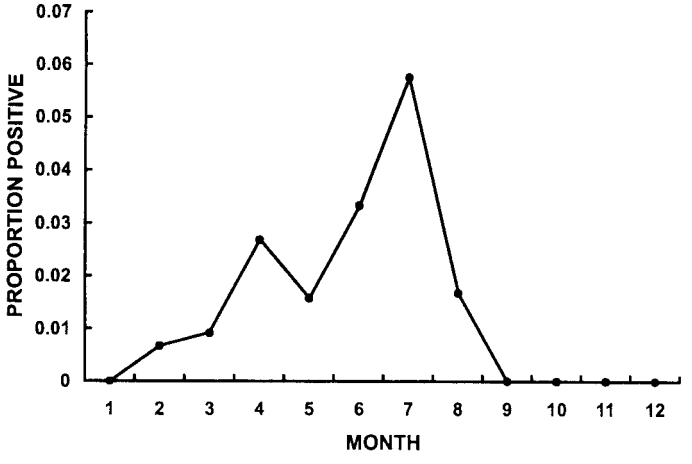

LARVAE PER 100 m³
MONTH

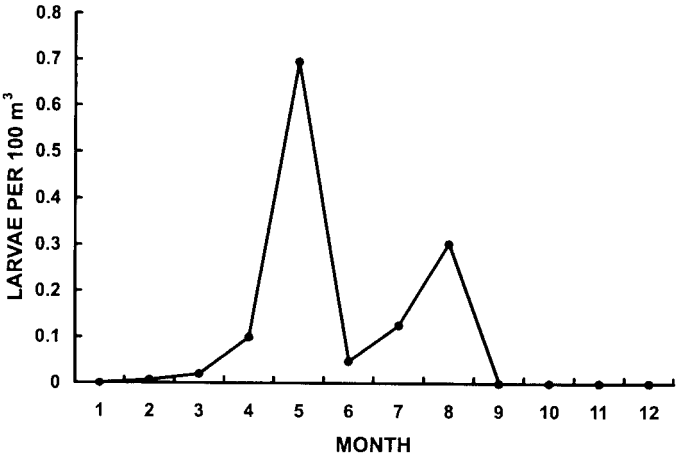

PROPORTION POSITIVE
YEAR

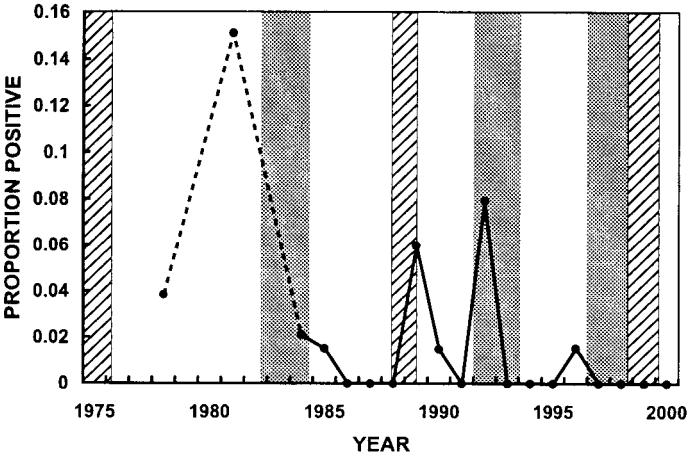

LARVAE PER 100 m³
YEAR

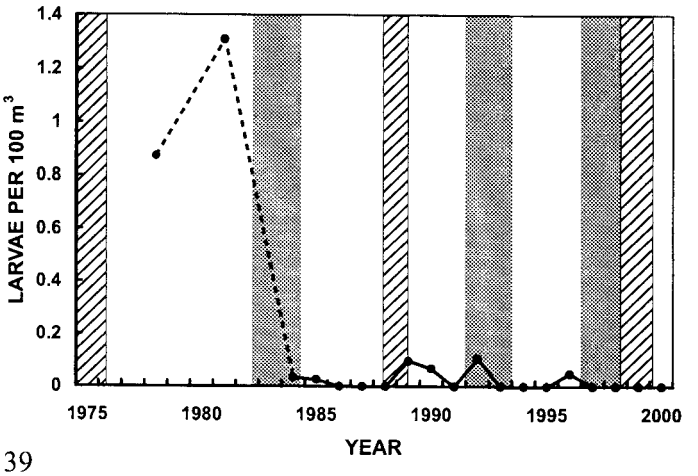

CalCOFI: 1977 - 1984
Total Larvae 186
San Diego
9.9 5.0 2.5 .5 <.5
Average Larvae per 100 m³

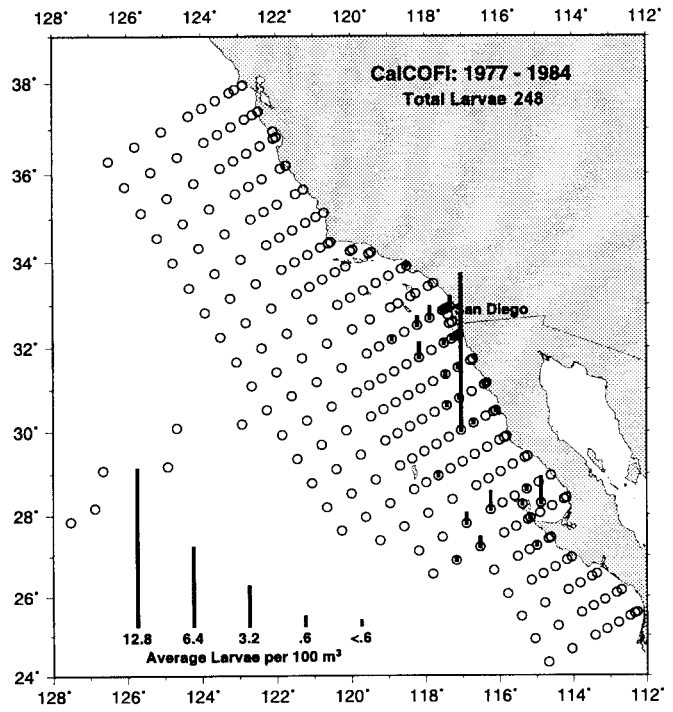

CalCOFI: 1977 - 2000
Total Larvae 142
San Diego
<.1 .1 .5 1.0 1.9
Average Larvae per 100 m³

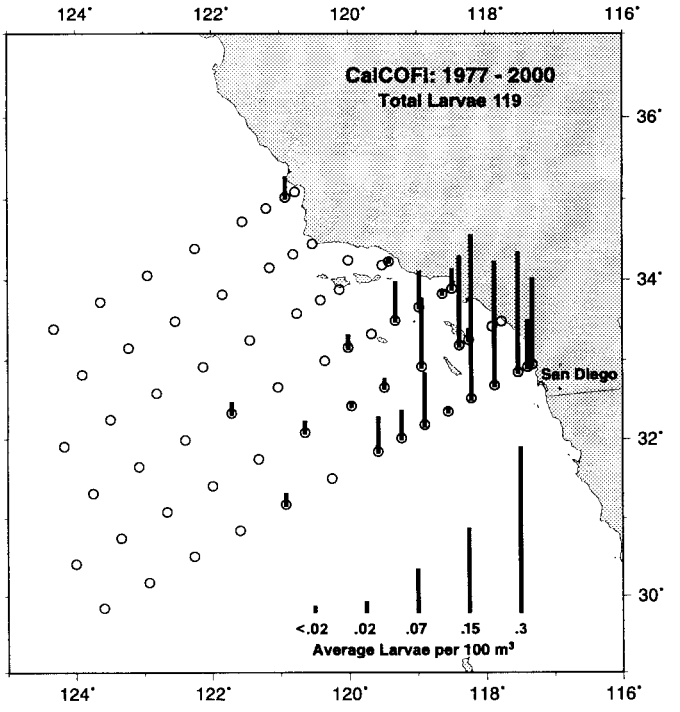

PROPORTION POSITIVE
MONTH

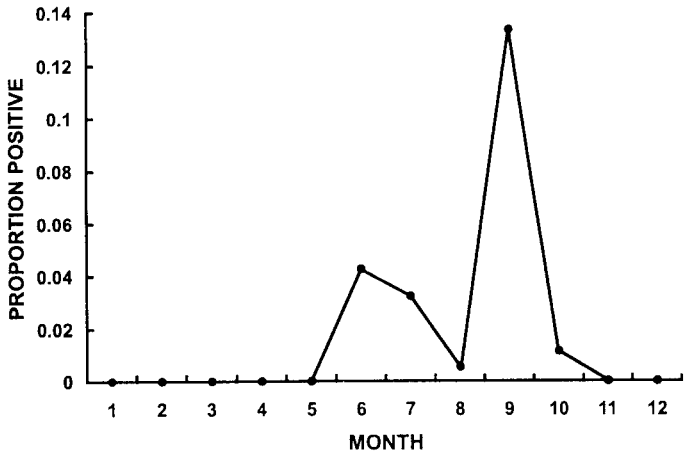

LARVAE PER 100 m³
MONTH

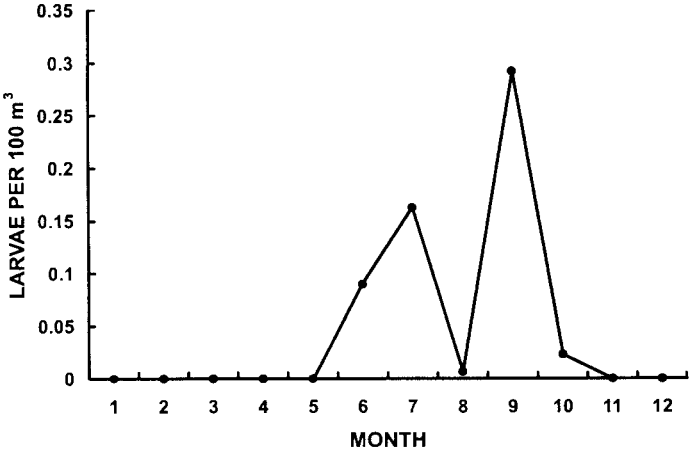

PROPORTION POSITIVE
YEAR

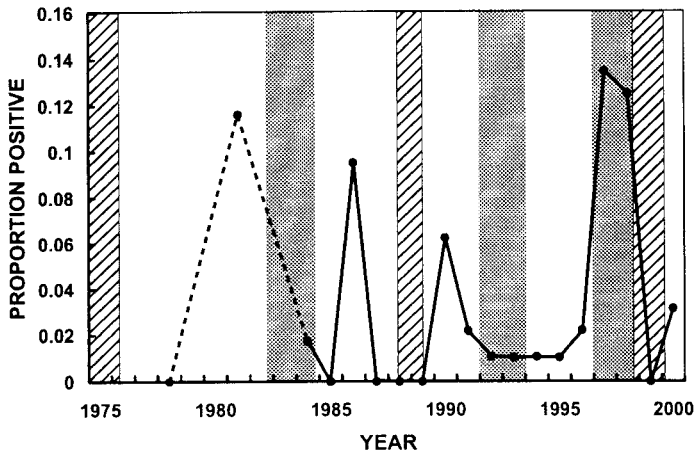

LARVAE PER 100 m³
YEAR

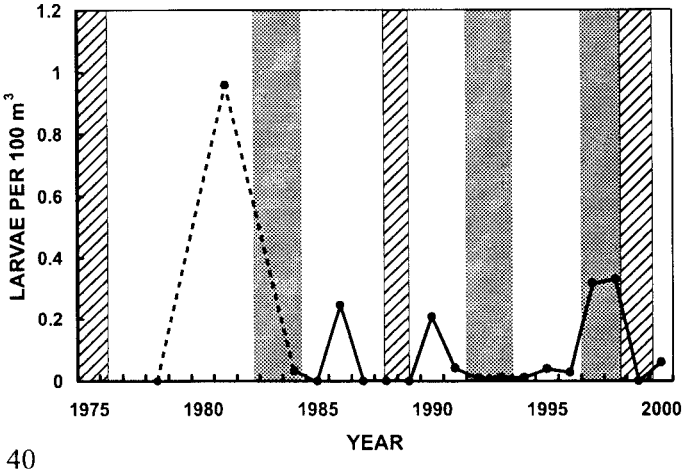

CalCOFI: 1977 - 1984
Total Larvae 248
San Diego
12.8 6.4 3.2 .6 <.6
Average Larvae per 100 m³

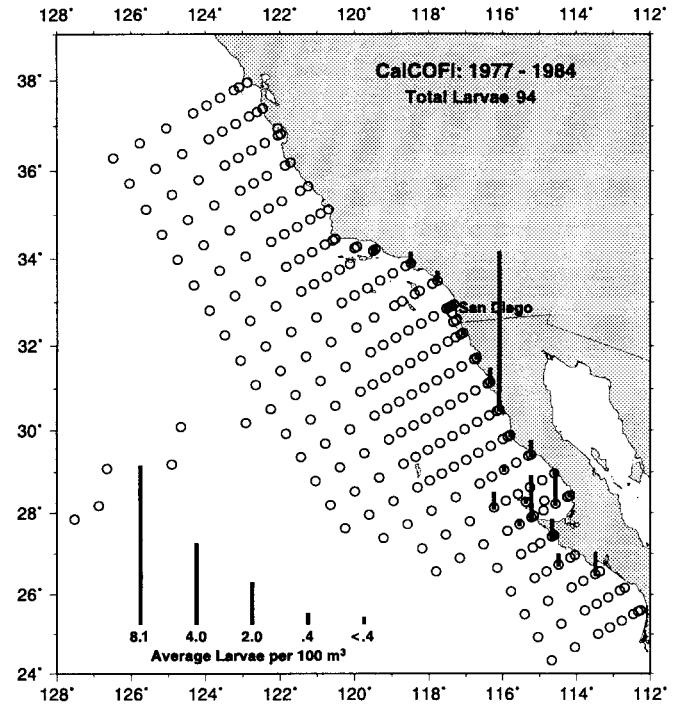

CalCOFI: 1977 - 2000
Total Larvae 119
San Diego
<.02 .02 .07 .15 .3
Average Larvae per 100 m³

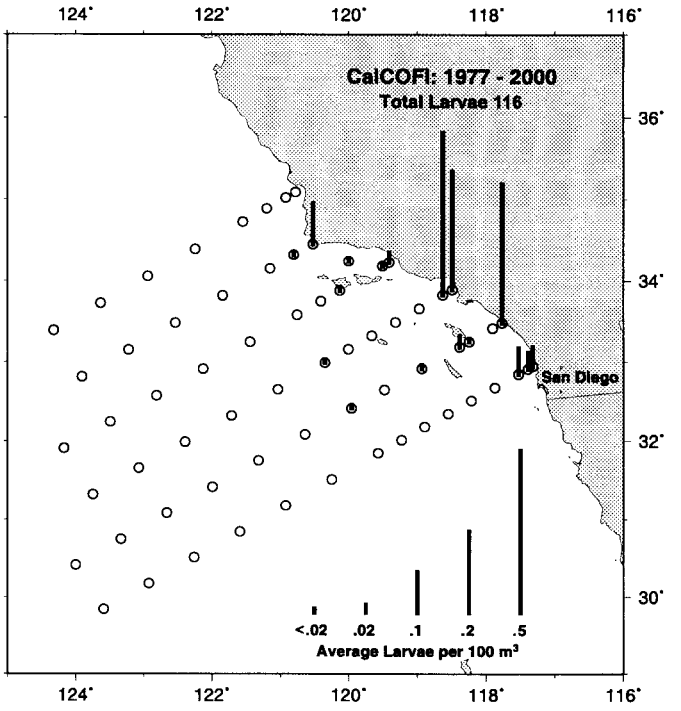

PROPORTION POSITIVE
MONTH

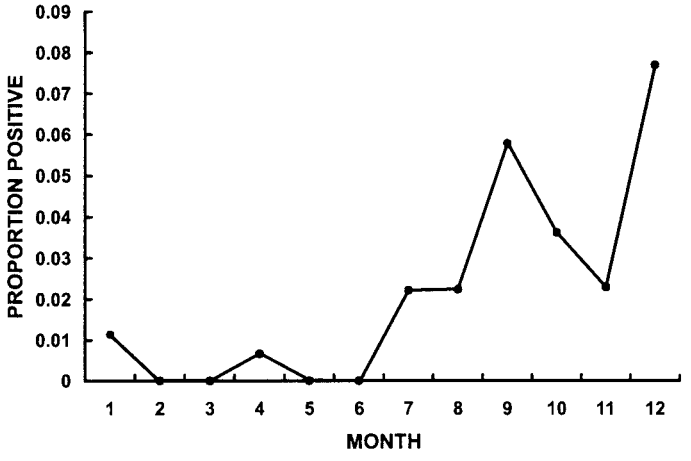

LARVAE PER 100 m³
MONTH

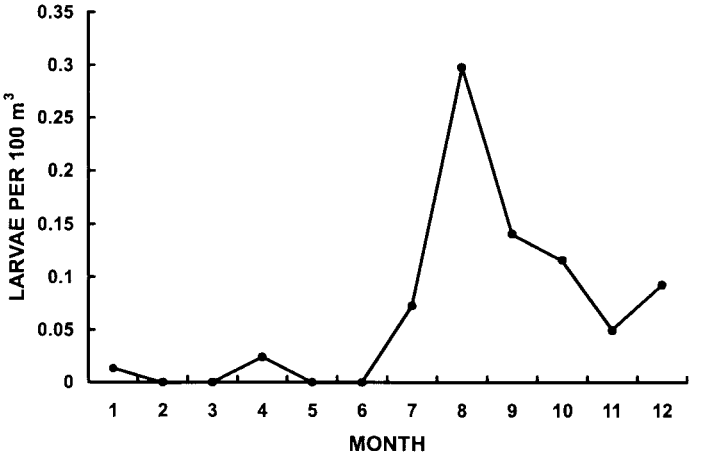

PROPORTION POSITIVE
YEAR

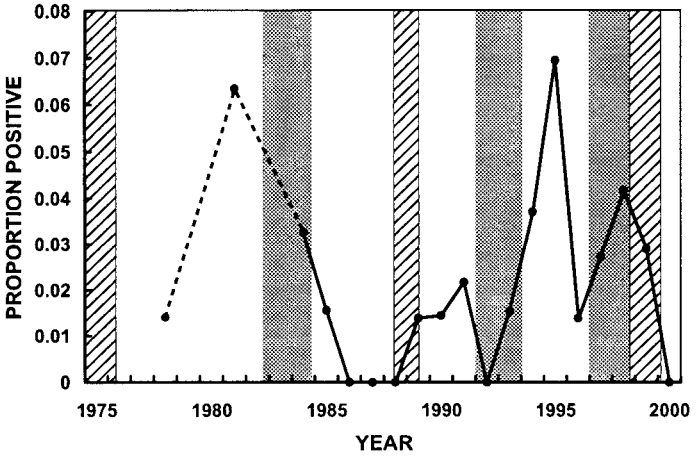

LARVAE PER 100 m³
YEAR

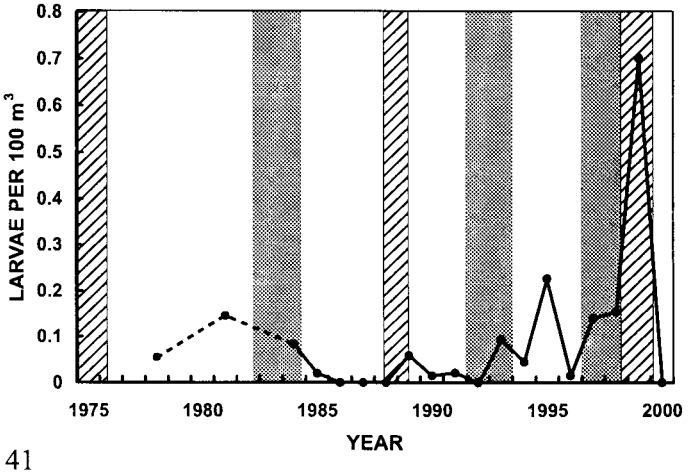

CalCOFI: 1977 - 1984
Total Larvae 94
San Diego
8.1 4.0 2.0 .4 <.4
Average Larvae per 100 m³

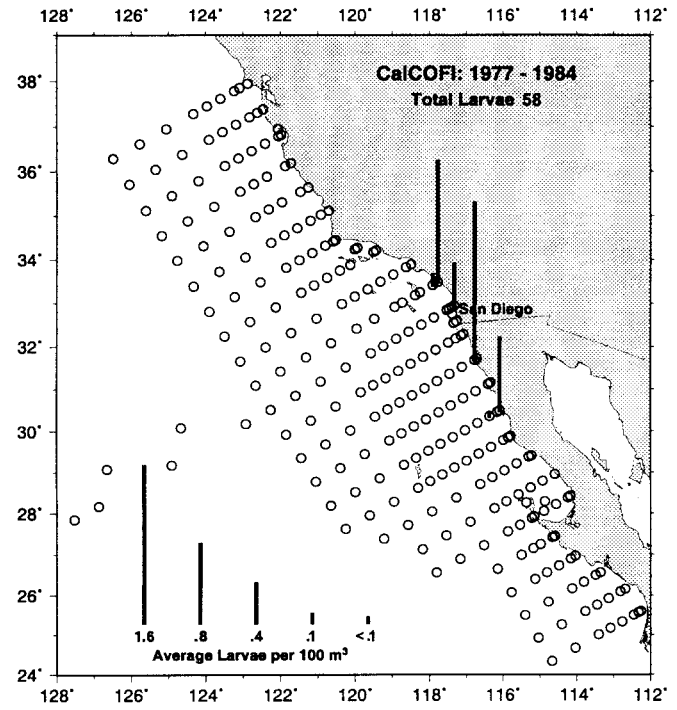

CalCOFI: 1977 - 2000
Total Larvae 116
San Diego
<.02 .02 .1 .2 .5
Average Larvae per 100 m³

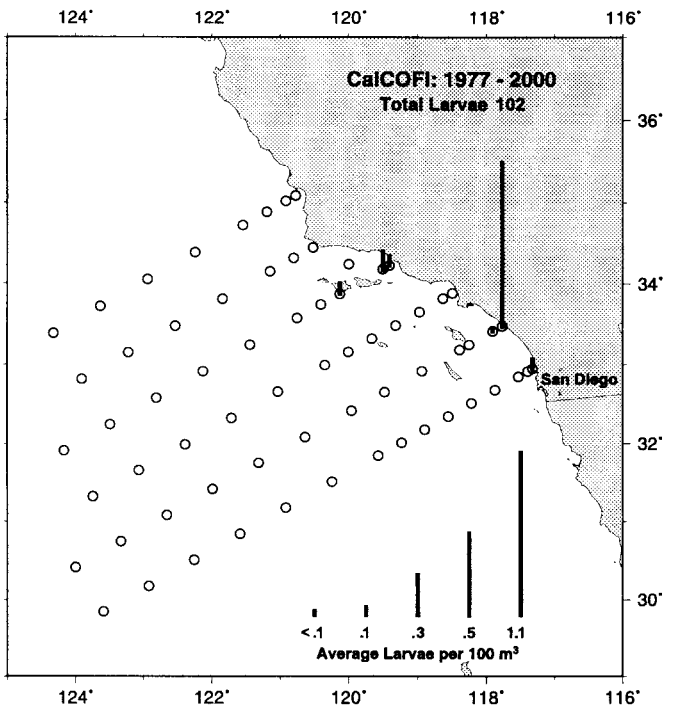

PROPORTION POSITIVE
MONTH

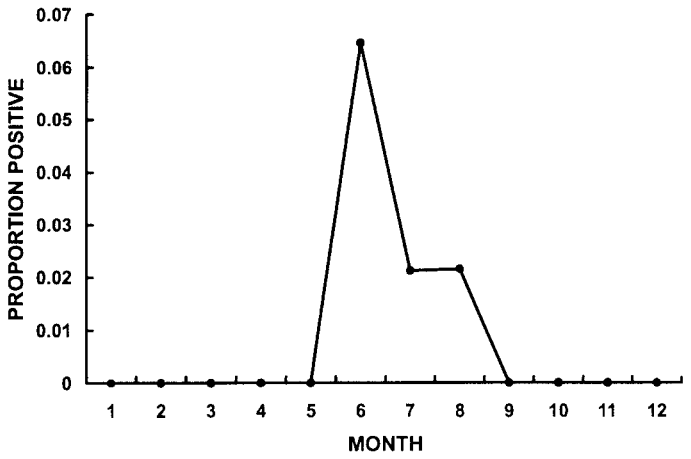

LARVAE PER 100 m³
MONTH

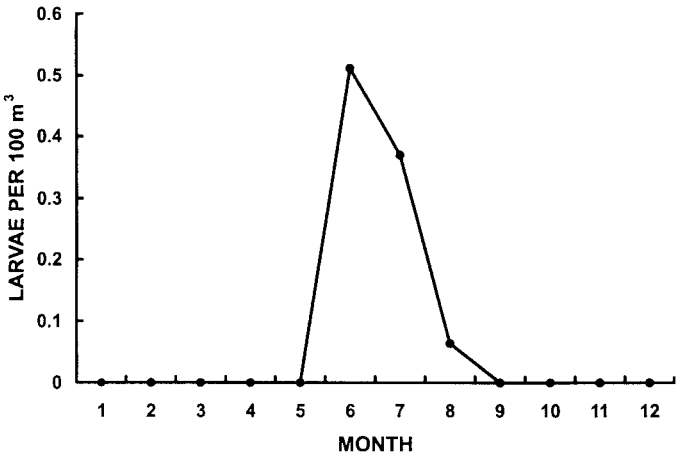

PROPORTION POSITIVE
YEAR

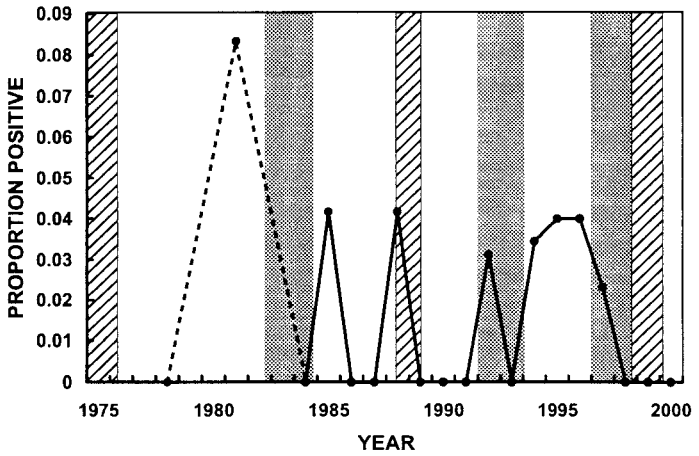

LARVAE PER 100 m³
YEAR

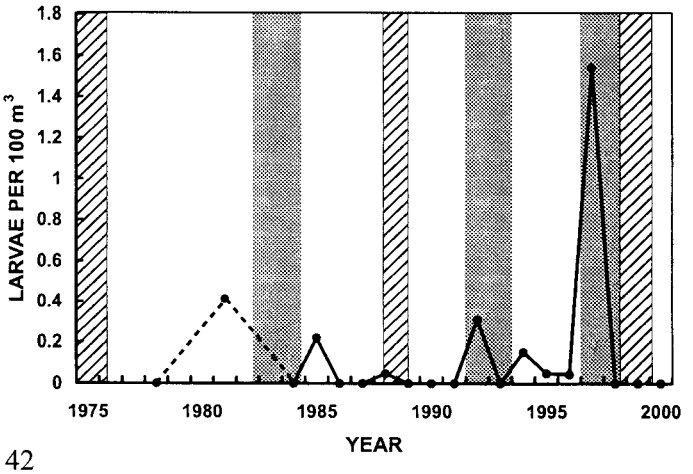

CalCOFI: 1977 - 1984
Total Larvae 58
San Diego
1.6 .8 .4 .1 <.1
Average Larvae per 100 m³

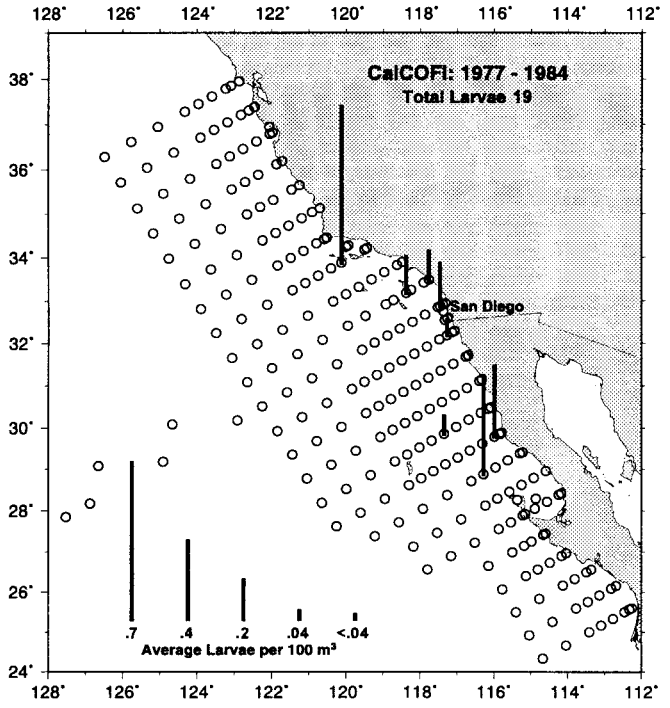

CalCOFI: 1977 - 2000
Total Larvae 102
San Diego
<.1 .1 .3 .5 1.1
Average Larvae per 100 m³

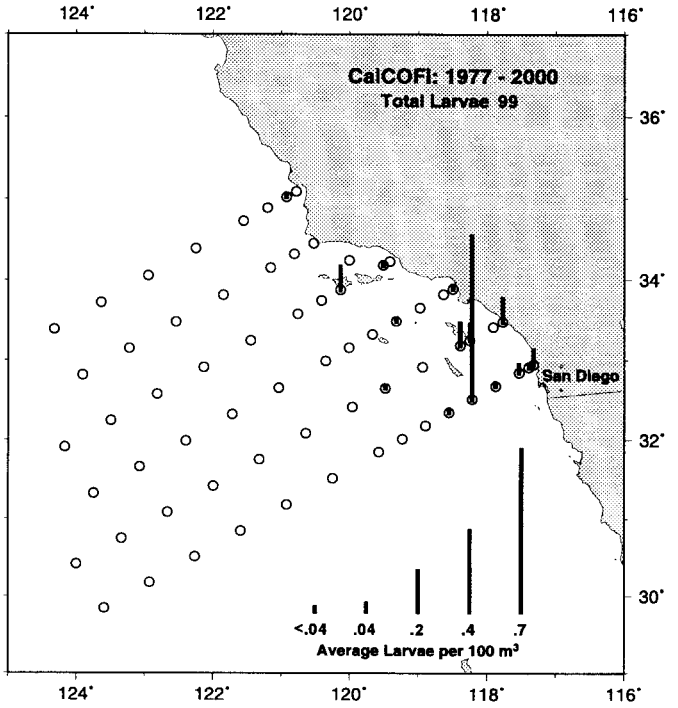

PROPORTION POSITIVE
MONTH

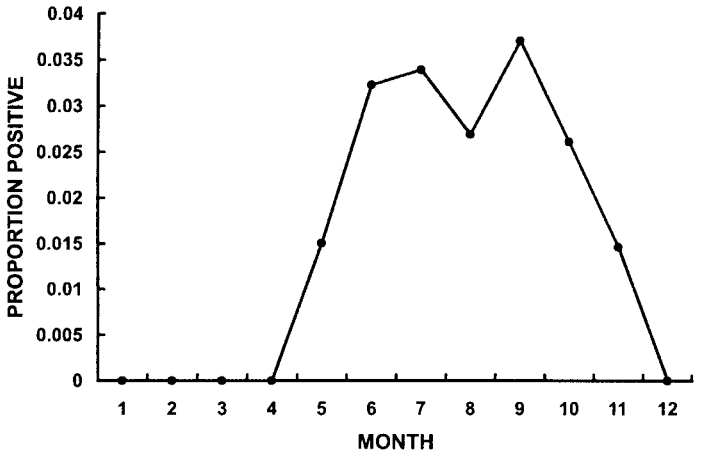

LARVAE PER 100 m³
MONTH

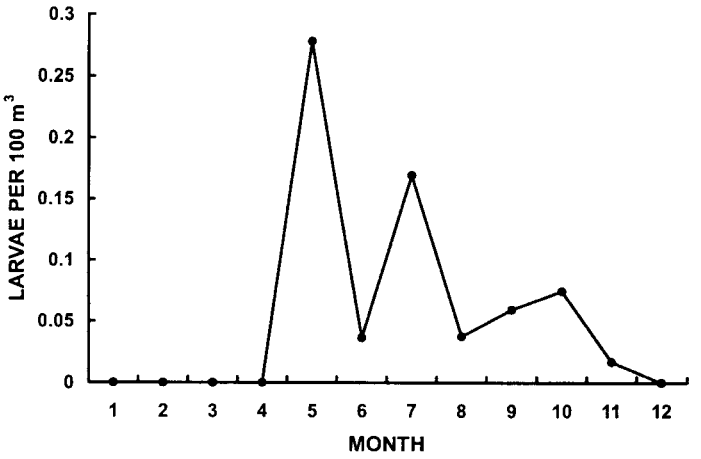

PROPORTION POSITIVE
YEAR

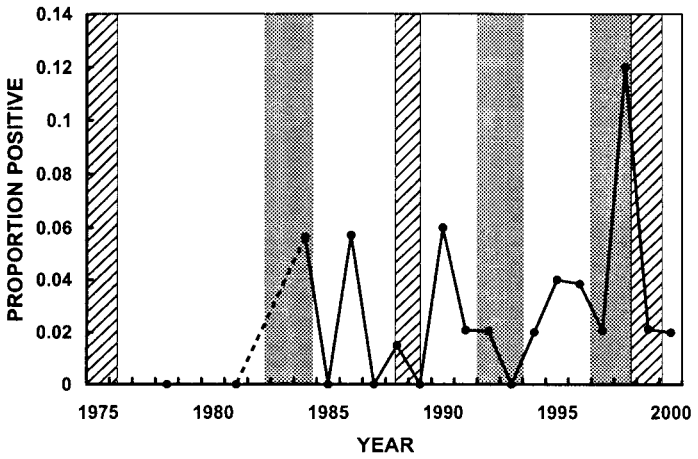

LARVAE PER 100 m³
YEAR

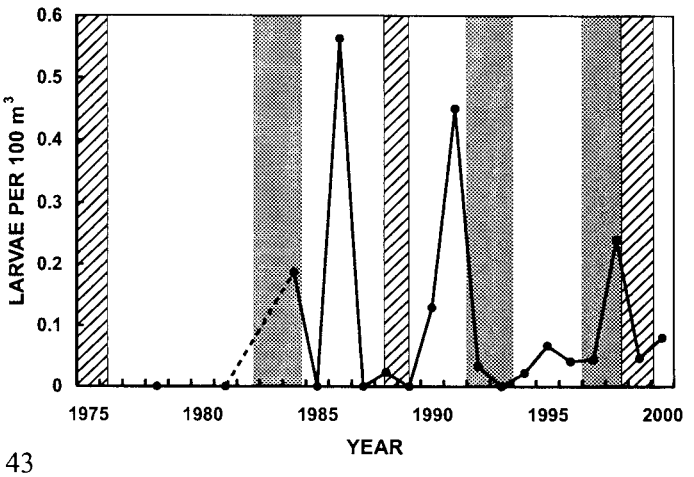

CalCOFI: 1977 - 1984
Total Larvae 19
San Diego
.7 .4 .2 .04 <.04
Average Larvae per 100 m³

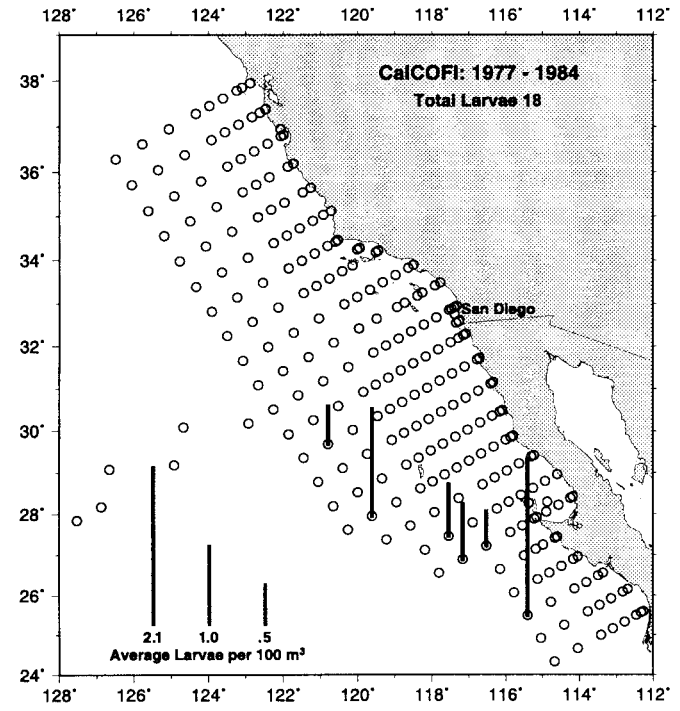

CalCOFI: 1977 - 2000
Total Larvae 99
San Diego
<.04 .04 .2 .4 .7
Average Larvae per 100 m³

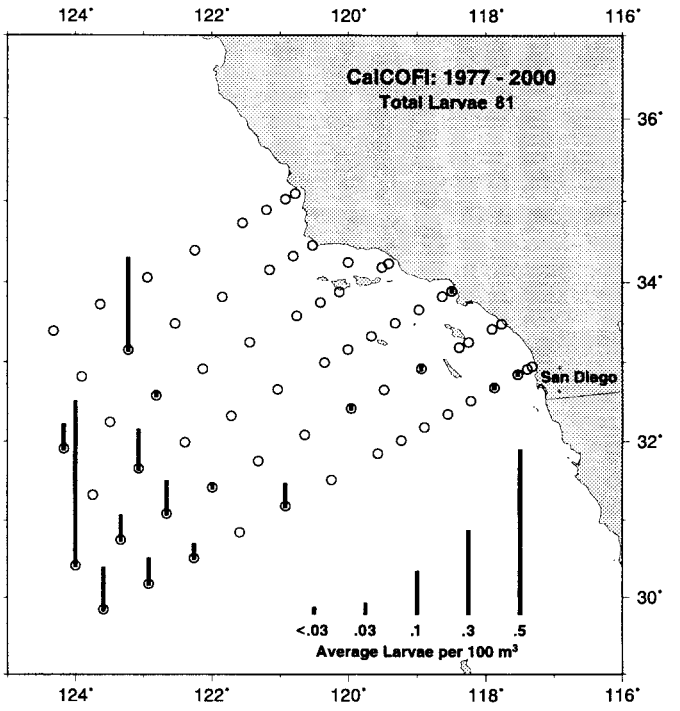

PROPORTION POSITIVE
MONTH

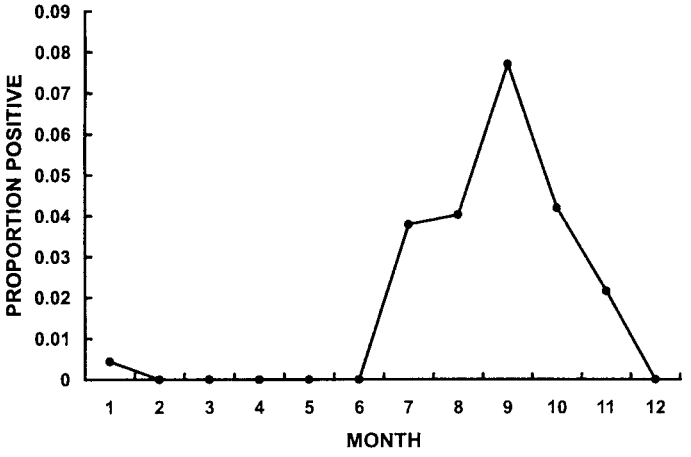

LARVAE PER 100 m³
MONTH

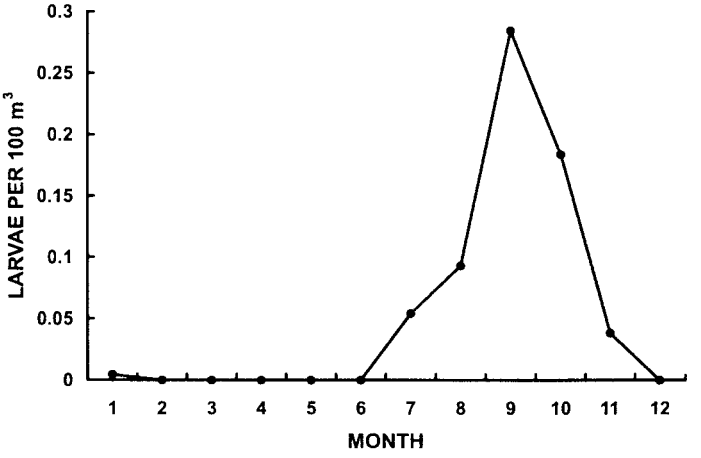

PROPORTION POSITIVE
YEAR

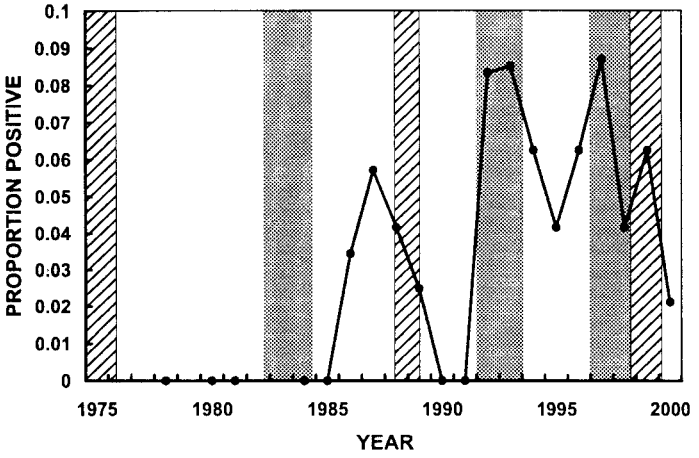

LARVAE PER 100 m³
YEAR

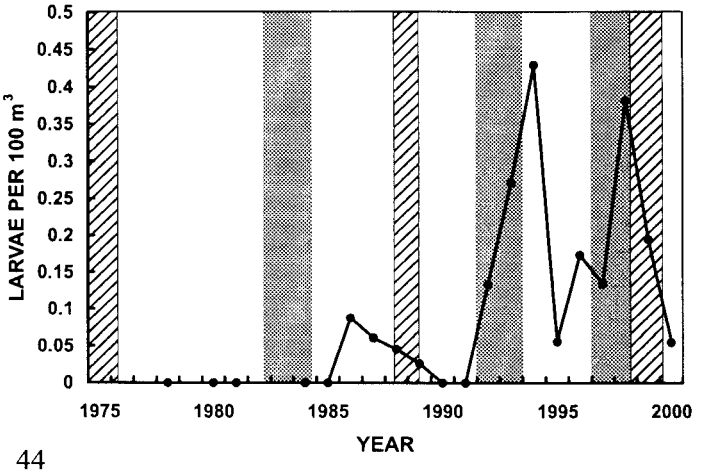

CalCOFI: 1977 - 1984
Total Larvae 18
San Diego
2.1
1.0
.5
Average Larvae per 100 m³

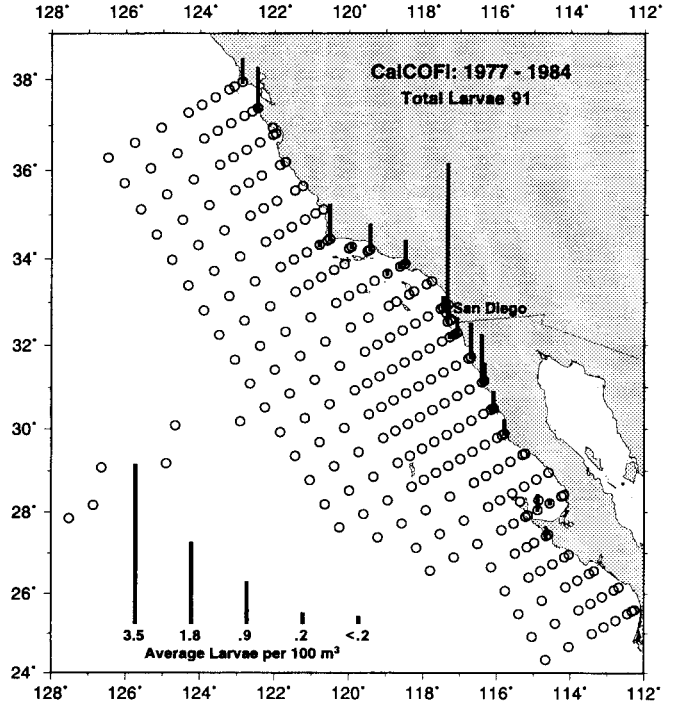

CalCOFI: 1977 - 2000
Total Larvae 81
San Diego
<.03
.03
.1
.3
.5
Average Larvae per 100 m³

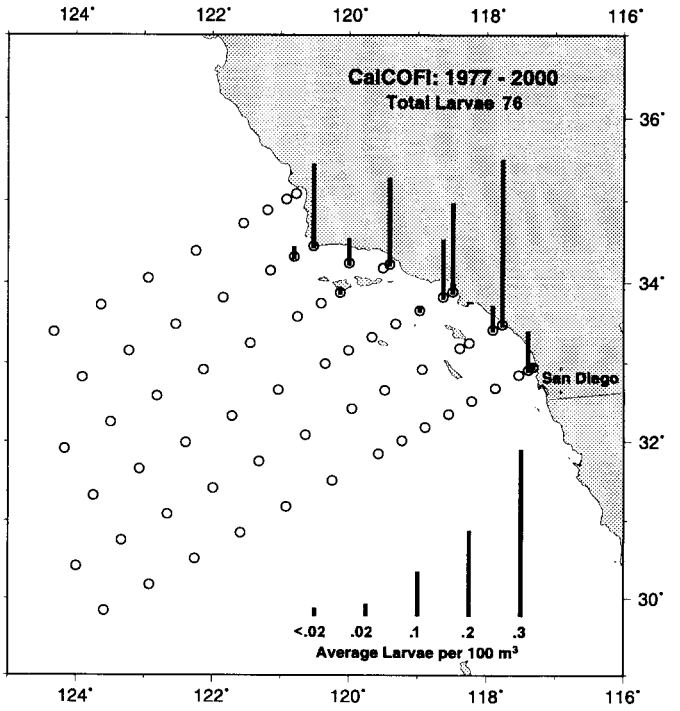

PROPORTION POSITIVE
MONTH

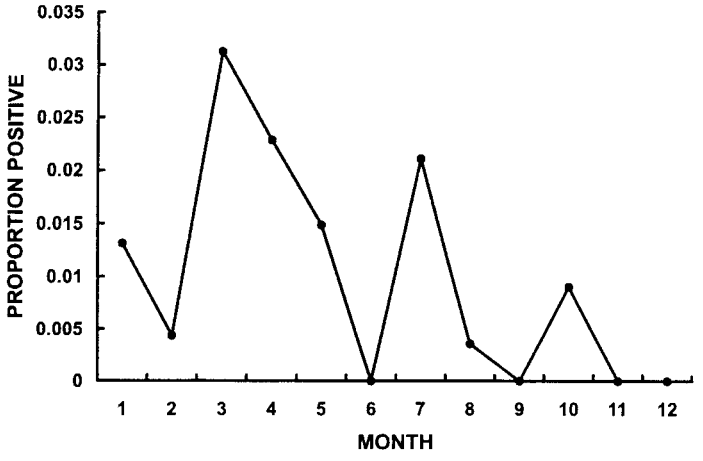

LARVAE PER 100 m³
MONTH

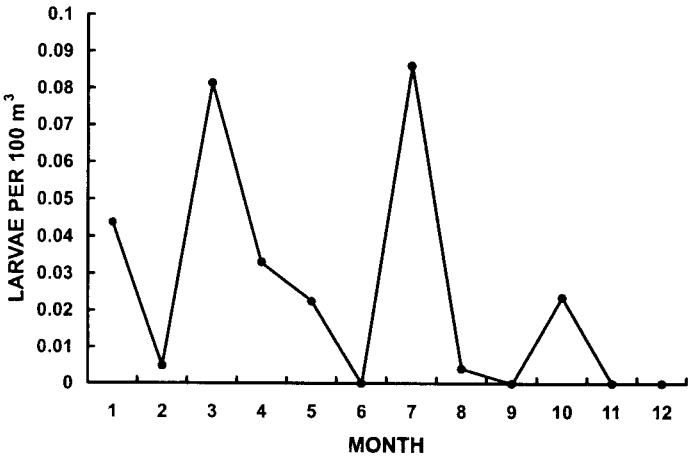

PROPORTION POSITIVE
YEAR

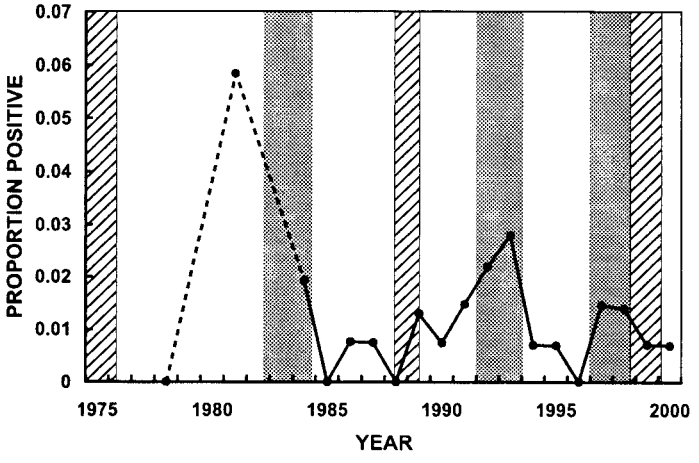

LARVAE PER 100 m³
YEAR

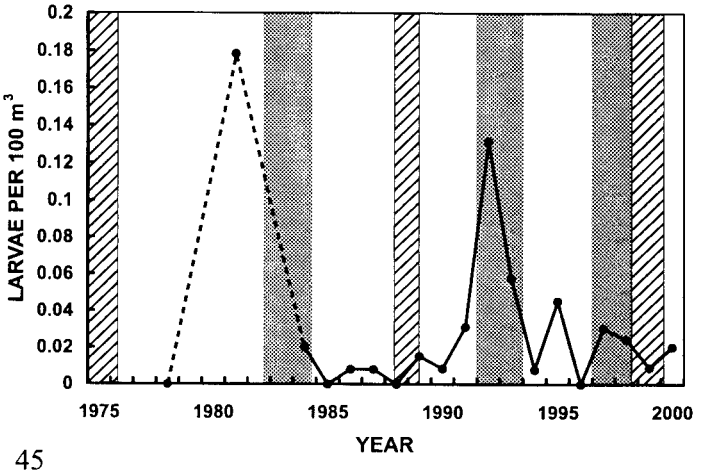

CalCOFI: 1977 - 1984
Total Larvae 91
San Diego
3.5 1.8 .9 .2 <.2
Average Larvae per 100 m³

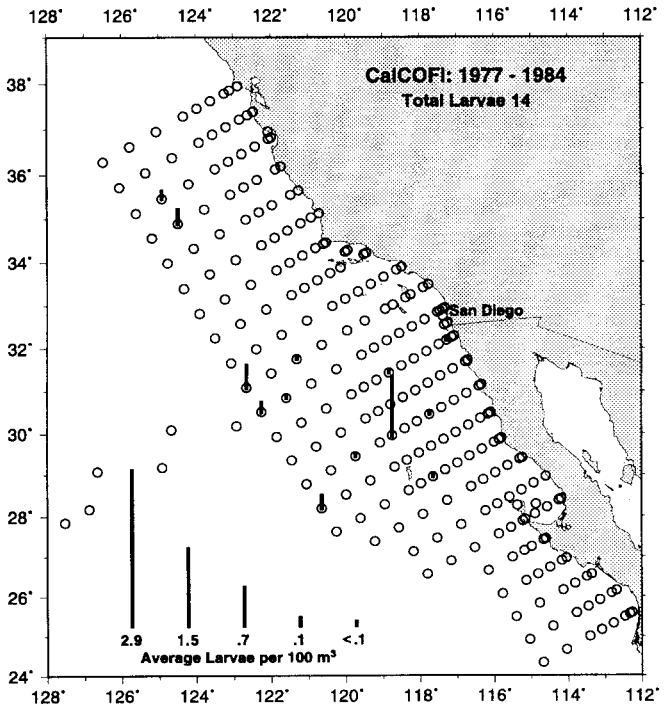

CalCOFI: 1977 - 2000
Total Larvae 76
San Diego
<.02 .02 .1 .2 .3
Average Larvae per 100 m³

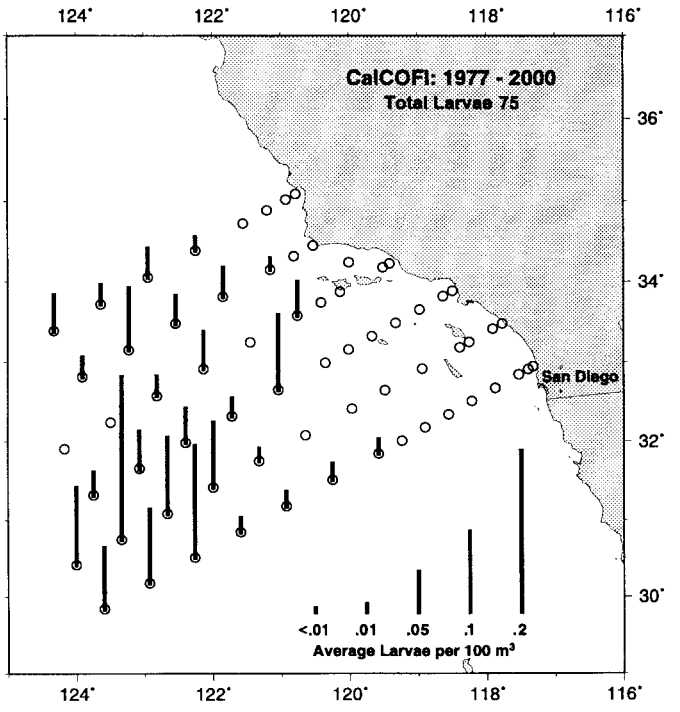

PROPORTION POSITIVE
MONTH

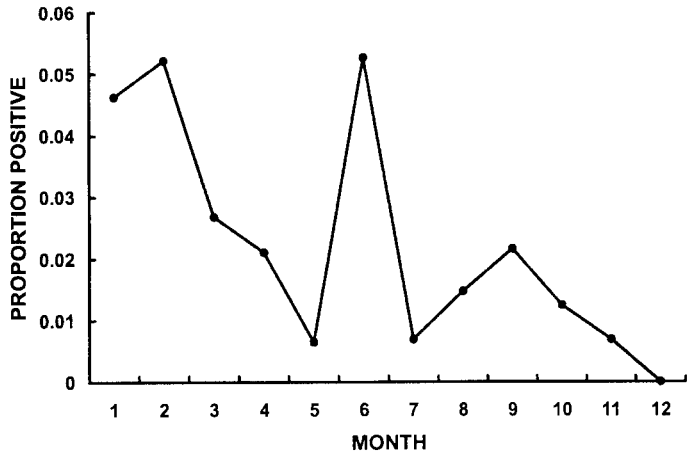

LARVAE PER 100 m³
MONTH

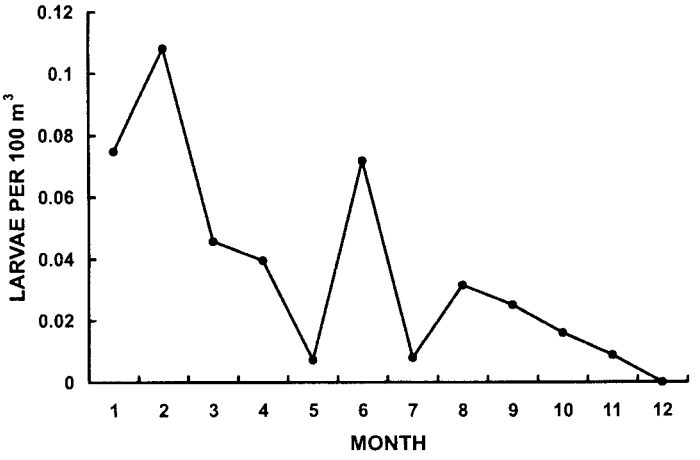

PROPORTION POSITIVE
YEAR

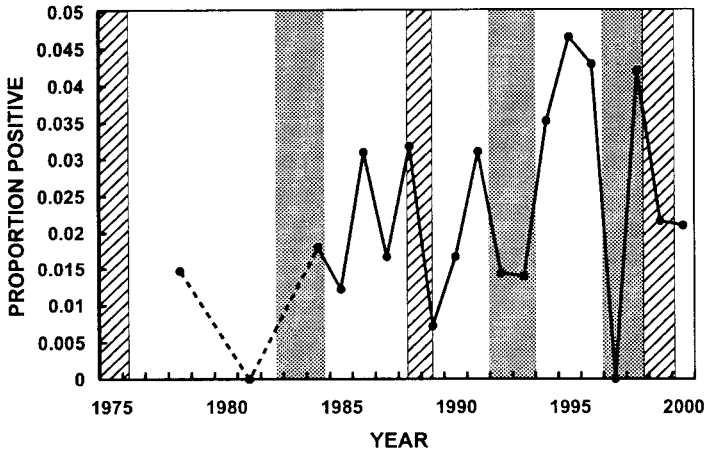

LARVAE PER 100 m³
YEAR

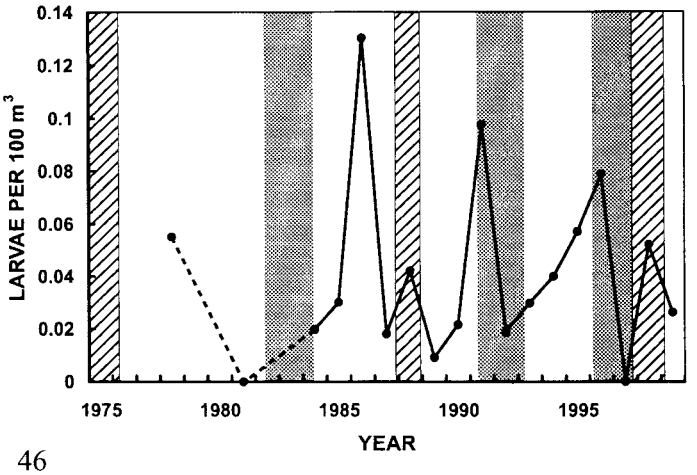

CalCOFI: 1977 - 1984
Total Larvae 14
San Diego
2.9 1.5 .7 .1 <.1
Average Larvae per 100 m³

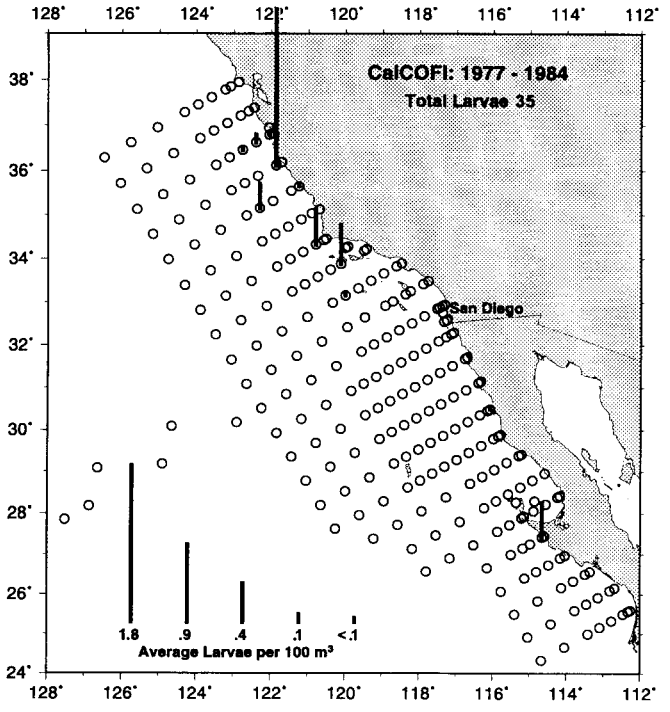

CalCOFI: 1977 - 2000
Total Larvae 75
San Diego
<.01 .01 .05 .1 .2
Average Larvae per 100 m³

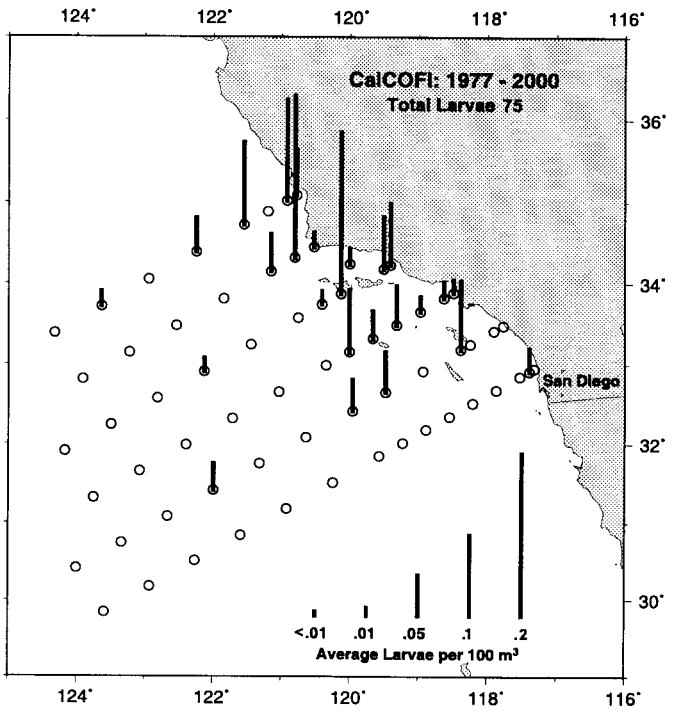

PROPORTION POSITIVE
MONTH

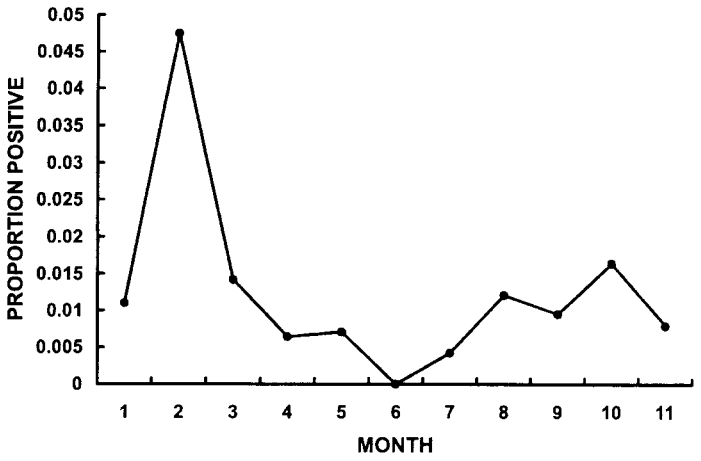

LARVAE PER 100 m³
MONTH

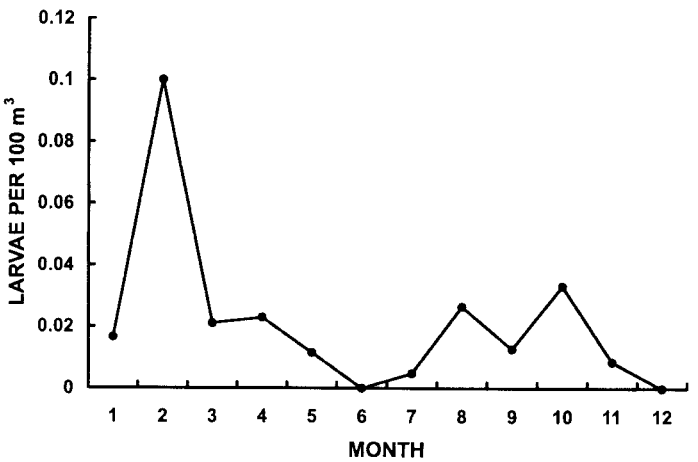

PROPORTION POSITIVE
YEAR

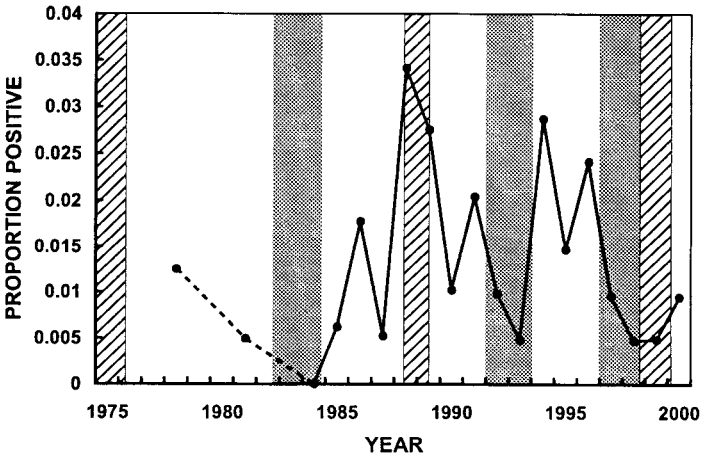

LARVAE PER 100 m³
YEAR

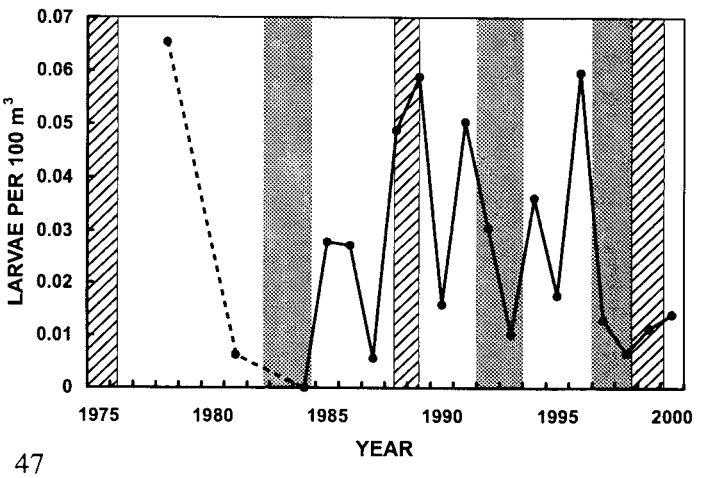

CalCOFI: 1977 - 1984
Total Larvae 35
San Diego
1.8 .9 .4 .1 <.1
Average Larvae per 100 m³

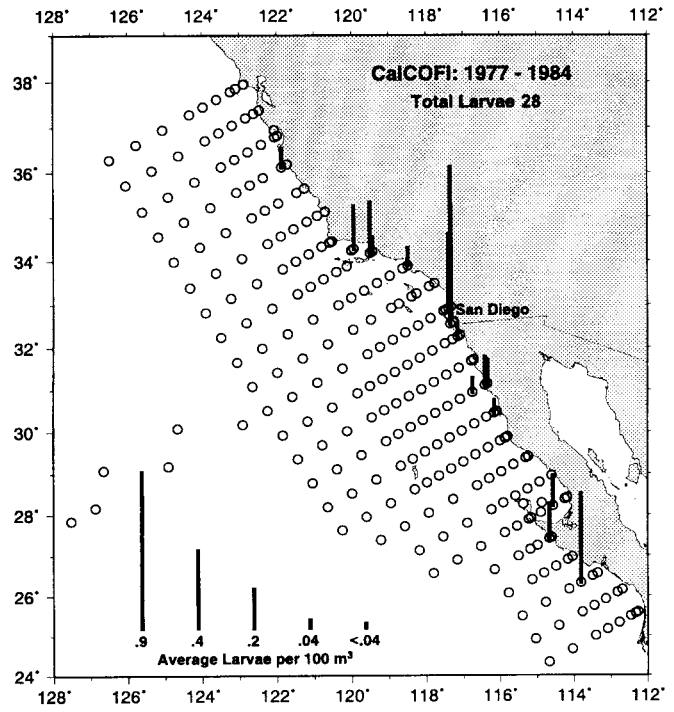

CalCOFI: 1977 - 2000
Total Larvae 75
San Diego
<.01 .01 .05 .1 .2
Average Larvae per 100 m³

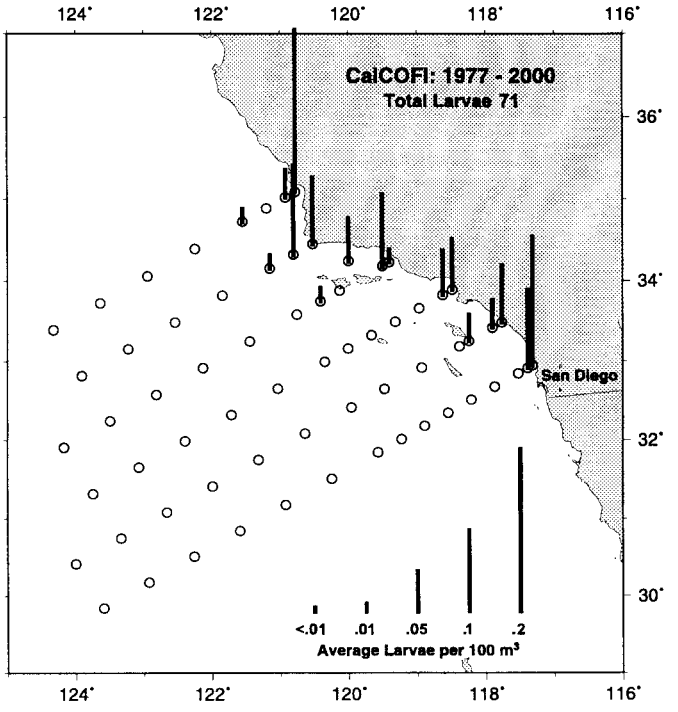

PROPORTION POSITIVE
MONTH

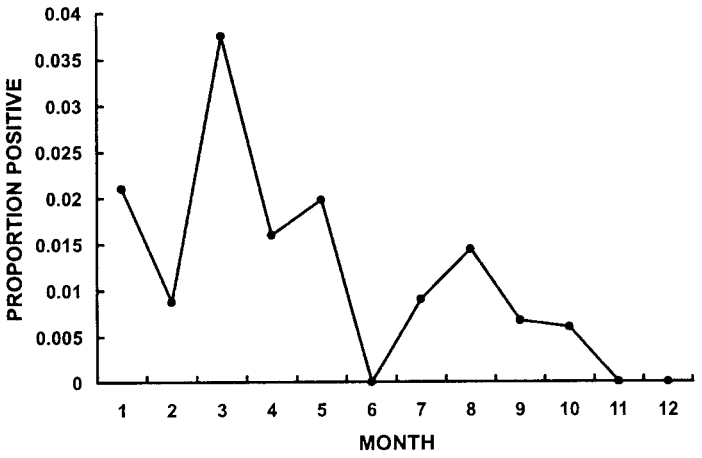

LARVAE PER 100 m³
MONTH

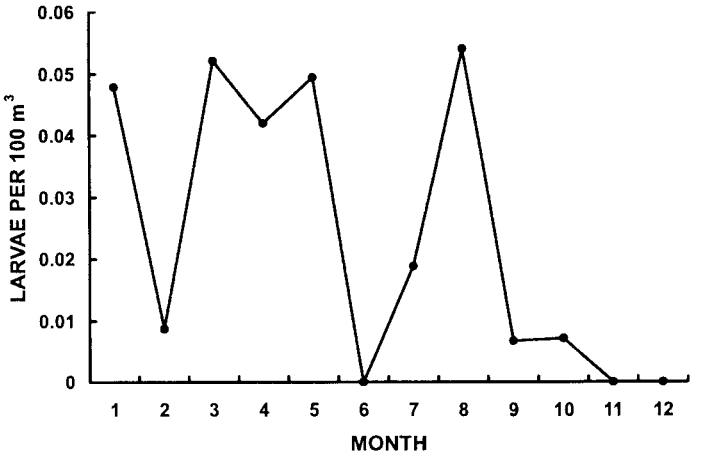

PROPORTION POSITIVE
YEAR

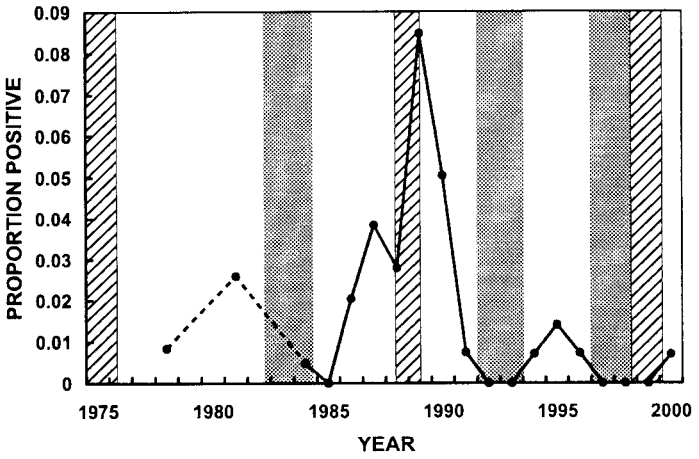

LARVAE PER 100 m³
YEAR

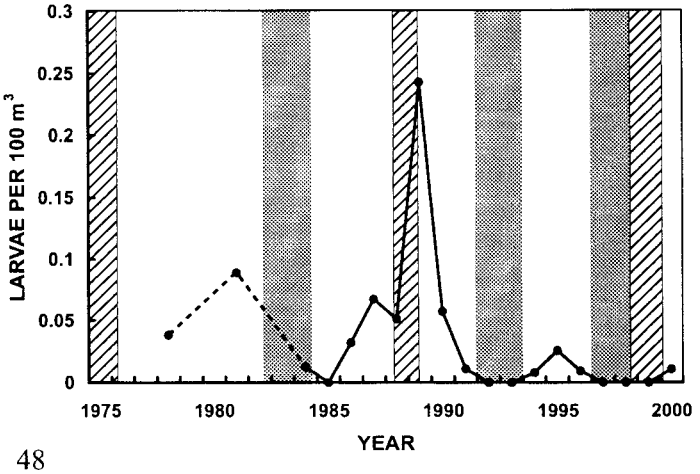

CalCOFI: 1977 - 1984
Total Larvae 28
San Diego
.9 .4 .2 .04 <.04
Average Larvae per 100 m³

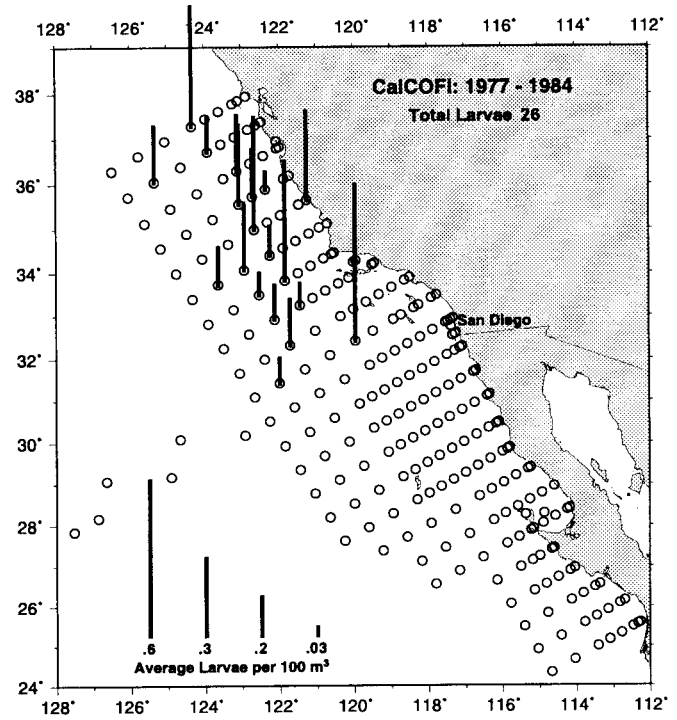

CalCOFI: 1977 - 2000
Total Larvae 71
San Diego
<.01 .01 .05 .1 .2
Average Larvae per 100 m³

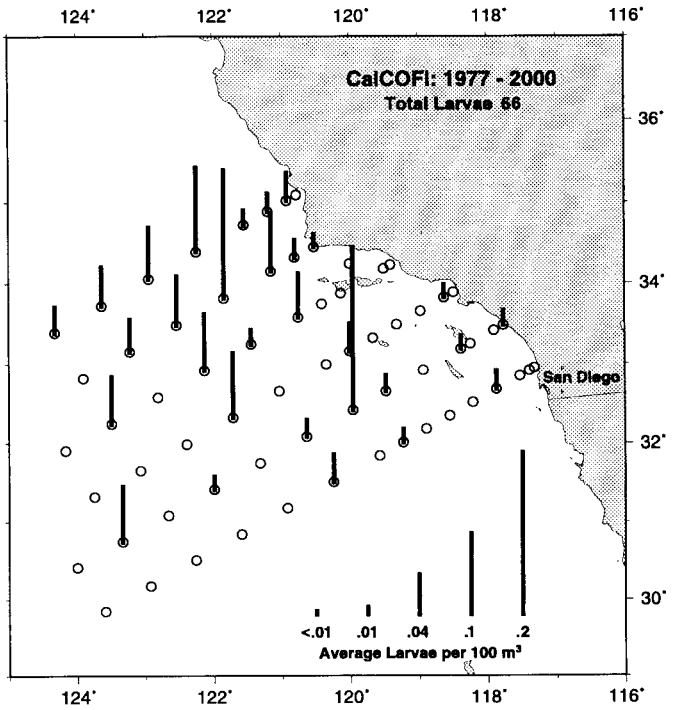

PROPORTION POSITIVE
MONTH

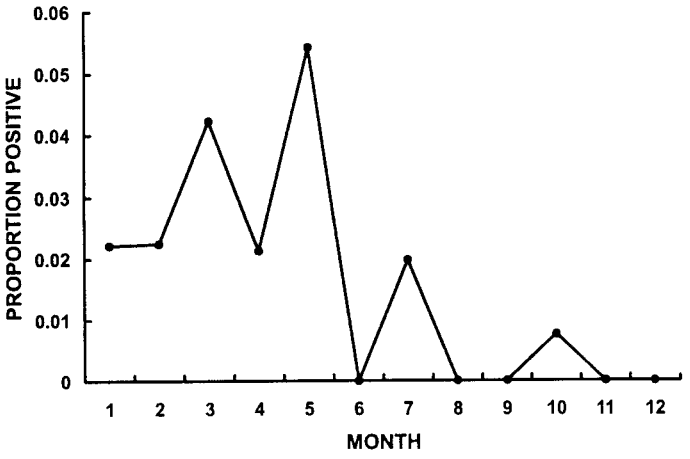

LARVAE PER 100 m³
MONTH

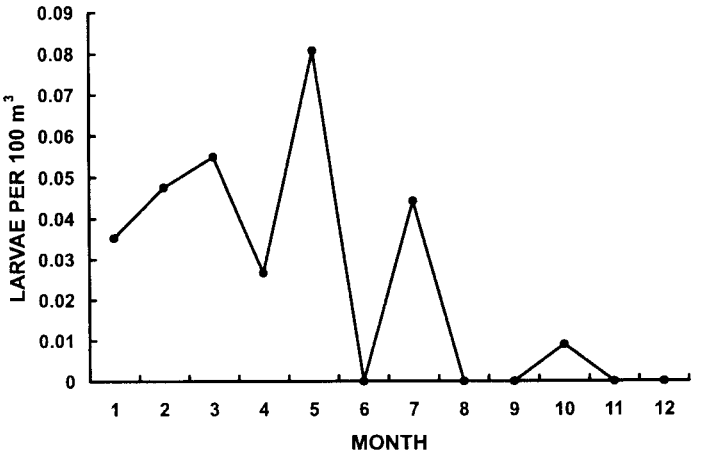

PROPORTION POSITIVE
YEAR

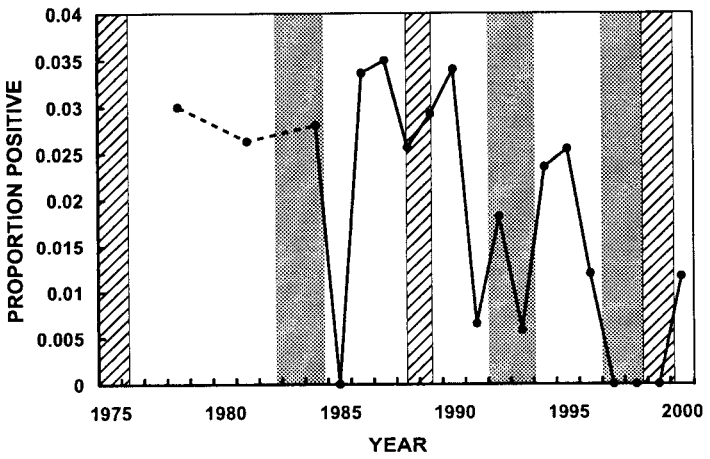

LARVAE PER 100 m³
YEAR

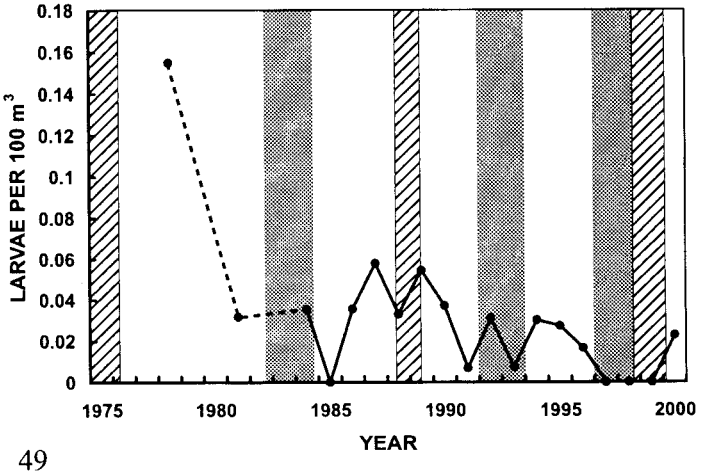

CalCOFI: 1977 - 1984
Total Larvae 26
San Diego
.6 .3 .2 .03
Average Larvae per 100 m³

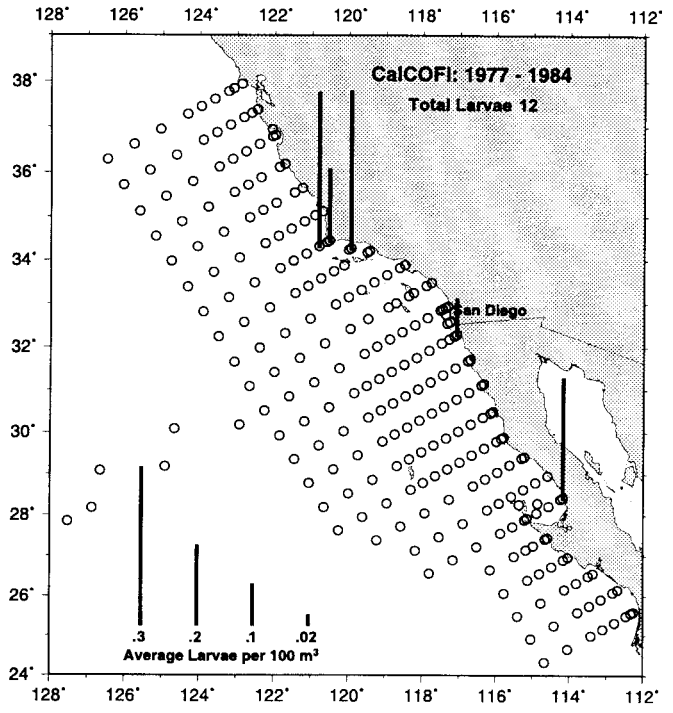

CalCOFI: 1977 - 2000
Total Larvae 66
San Diego
<.01 .01 .04 .1 .2
Average Larvae per 100 m³

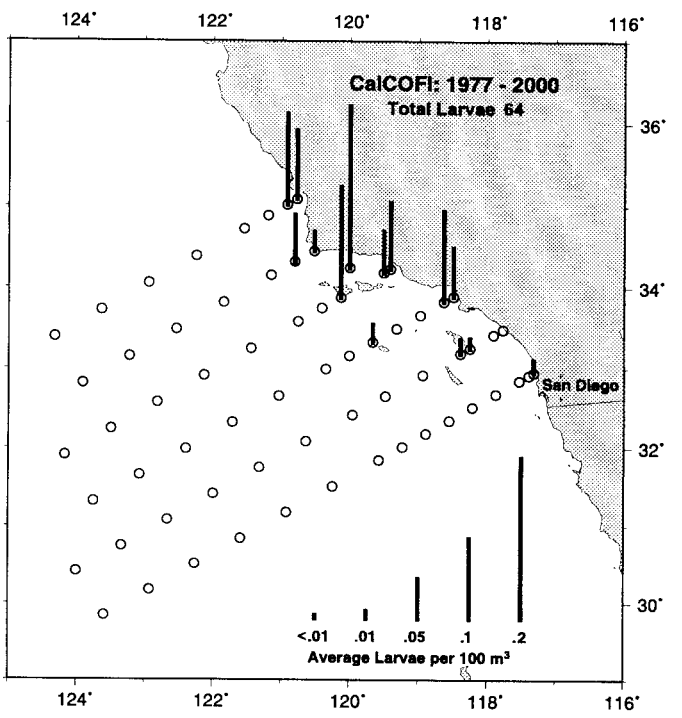

PROPORTION POSITIVE
MONTH

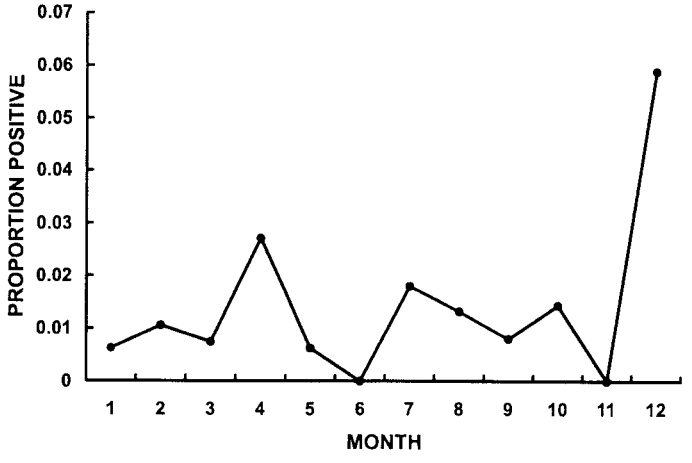

LARVAE PER 100 m³
MONTH

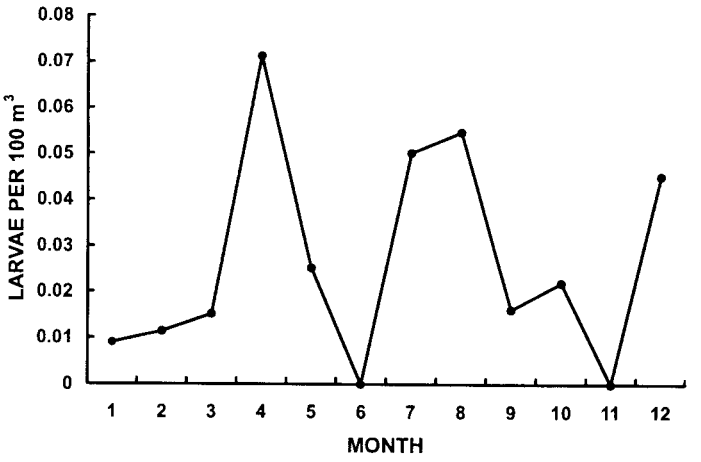

PROPORTION POSITIVE
YEAR

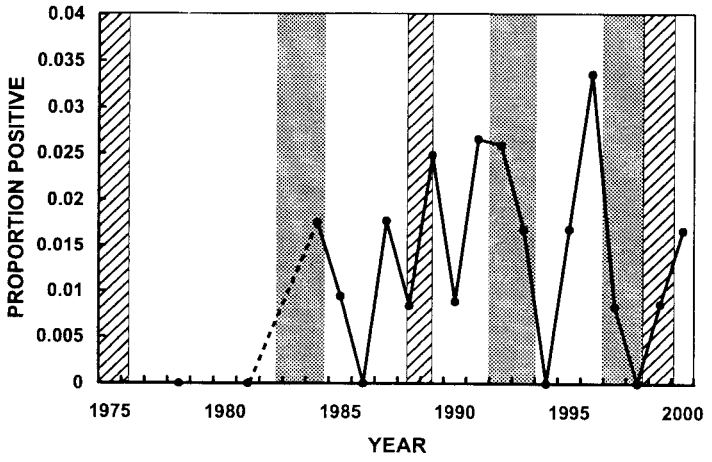

LARVAE PER 100 m³
YEAR

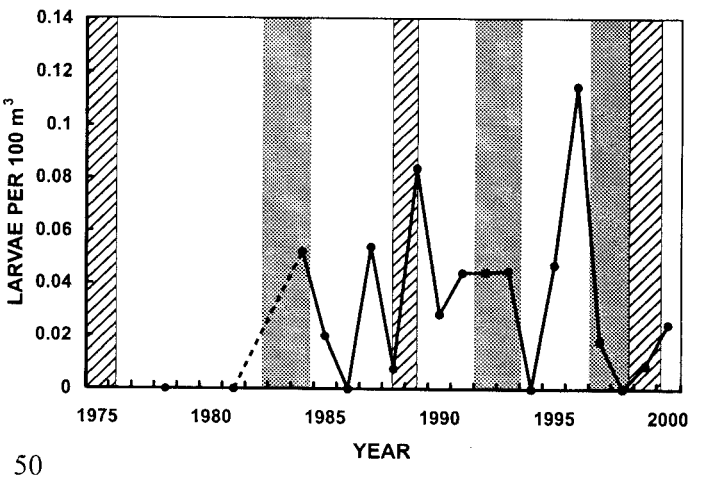

CalCOFI: 1977 - 1984
Total Larvae 12
San Diego
.3 .2 .1 .02
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 64
San Diego
<.01 .01 .05 .1 .2
Average Larvae per 100 m³

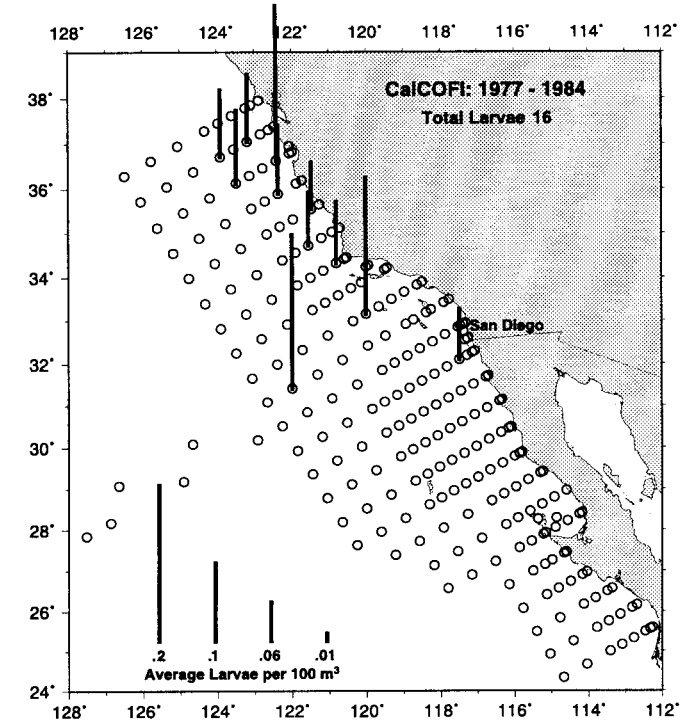

PROPORTION POSITIVE
MONTH

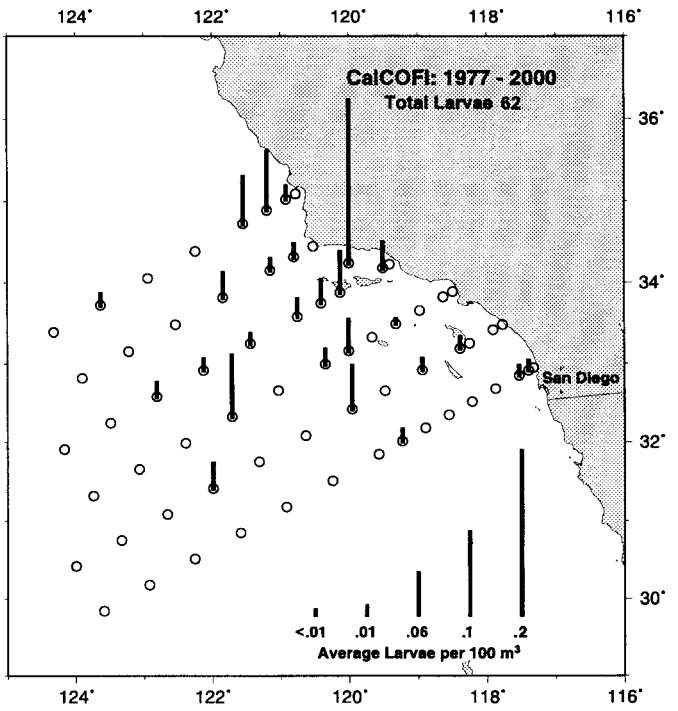

LARVAE PER 100 m³
MONTH

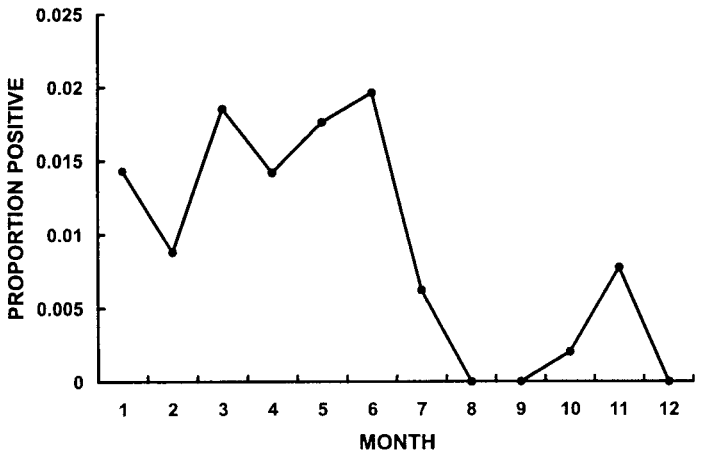

PROPORTION POSITIVE
YEAR

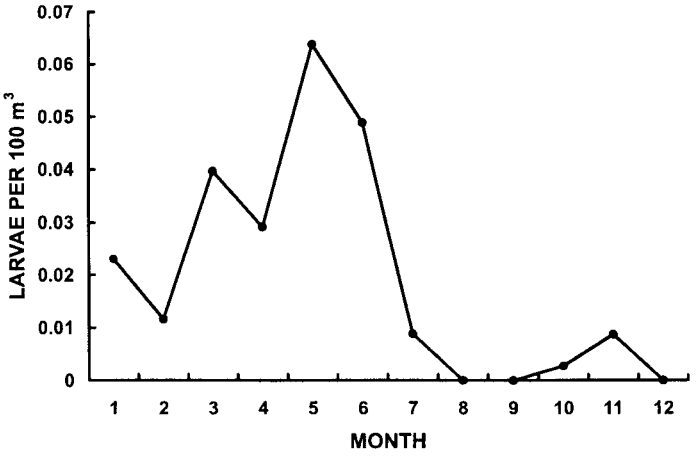

LARVAE PER 100 m³
YEAR

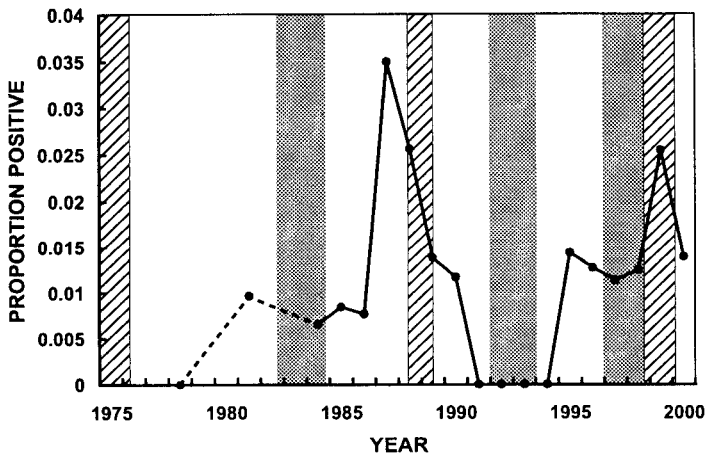
HEXAGRAMMIDAE Painted greenling ***Oxylebius pictus***

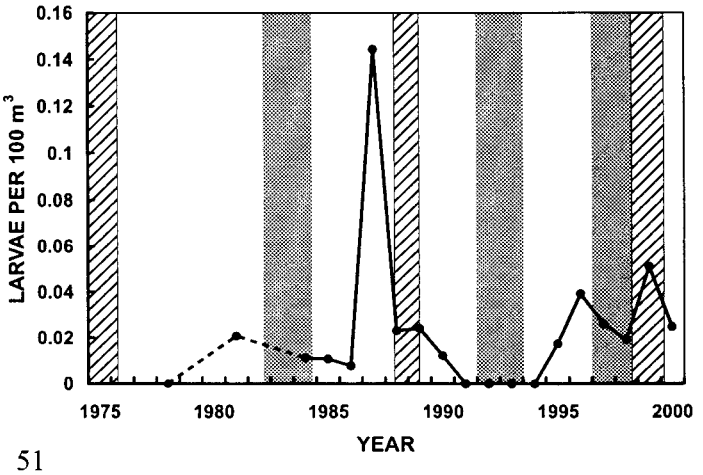


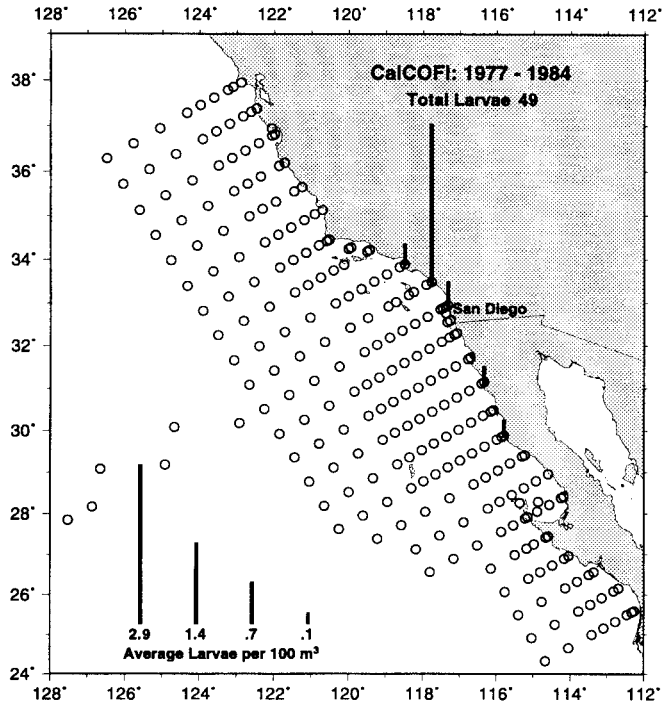



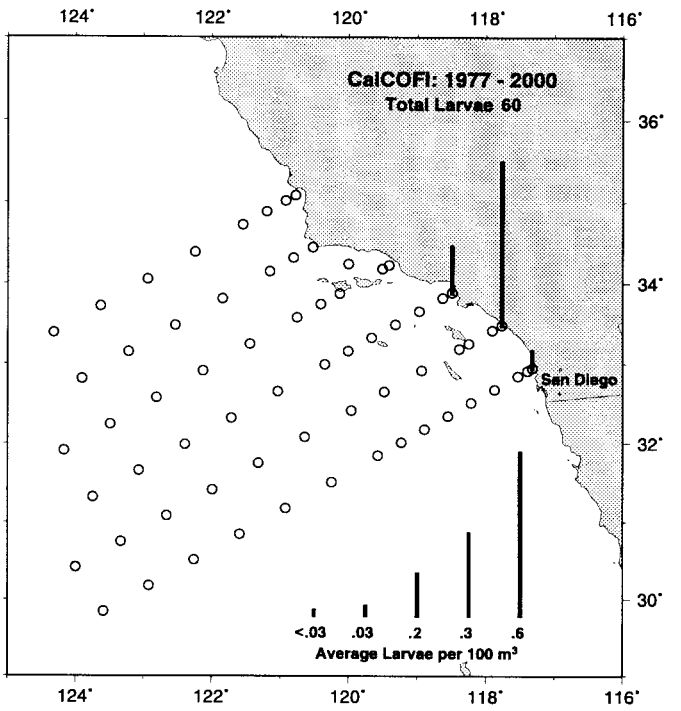



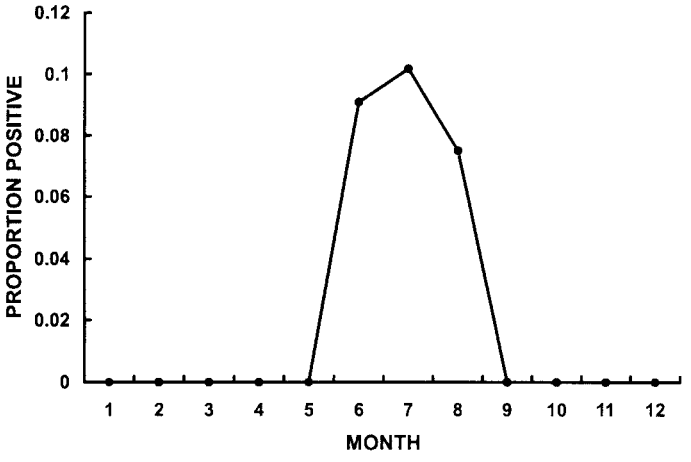



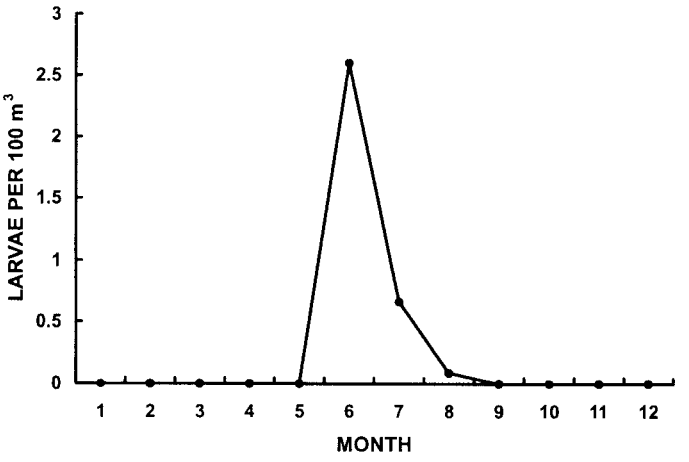



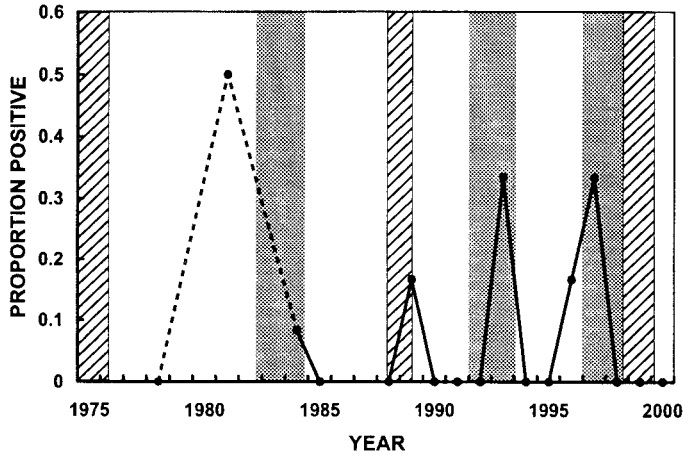
## *Anisotremus davidsoni* Sargo HAEMULIDAE

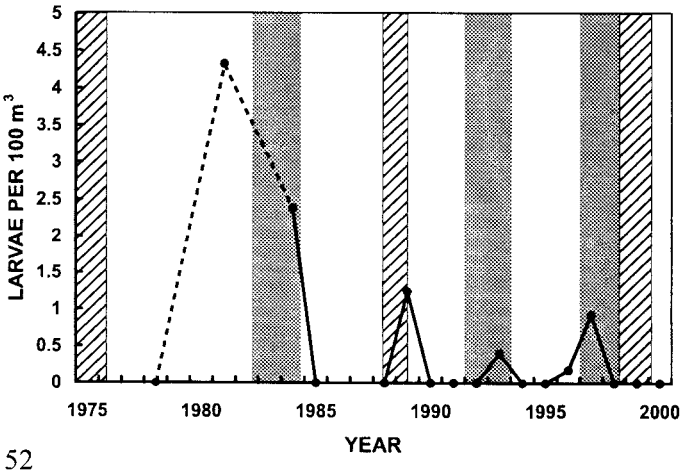


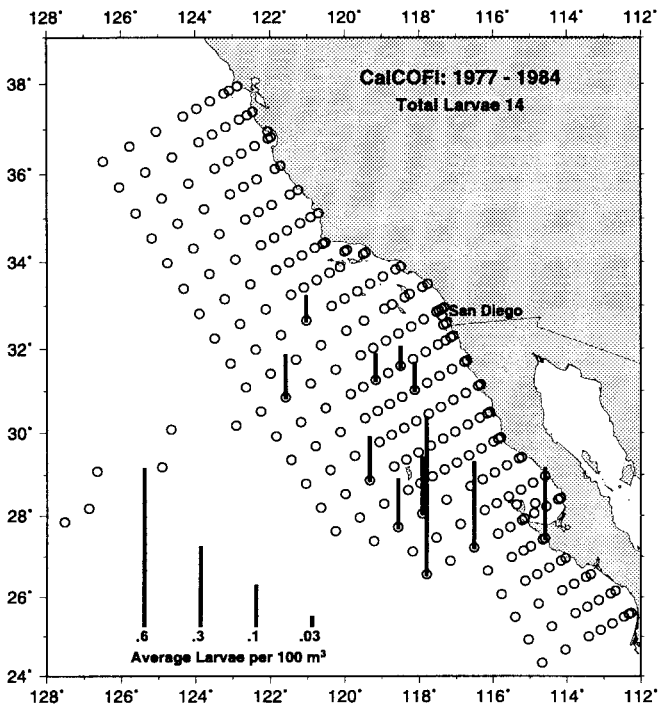



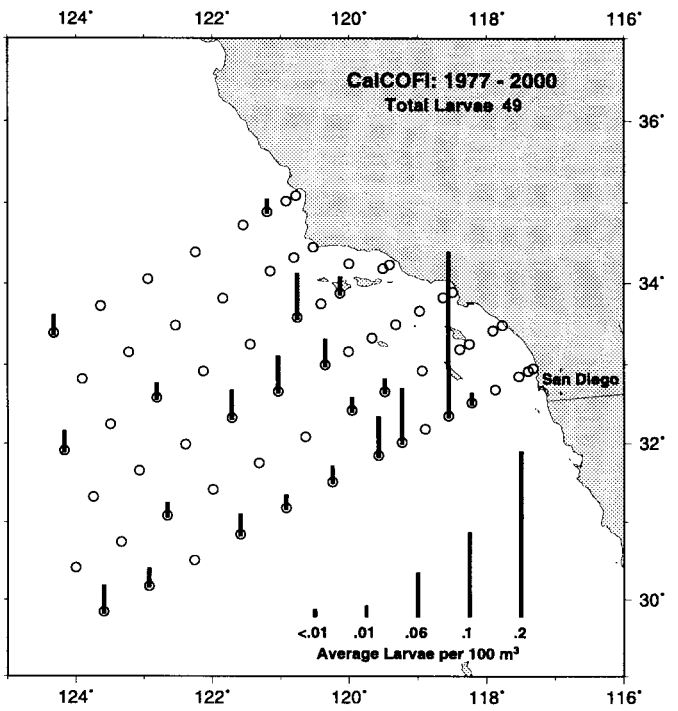



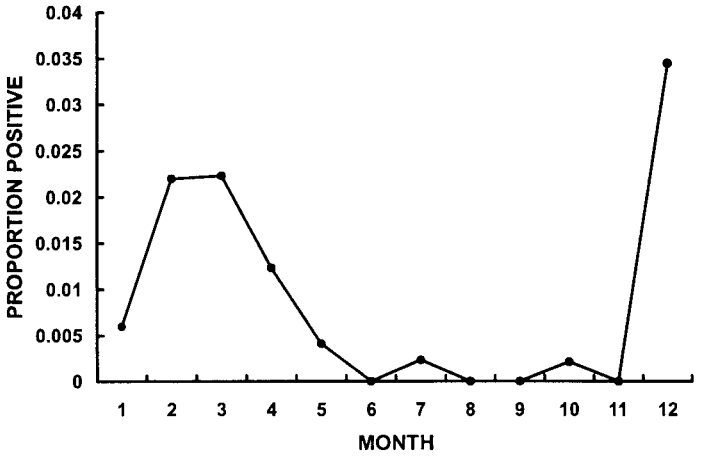



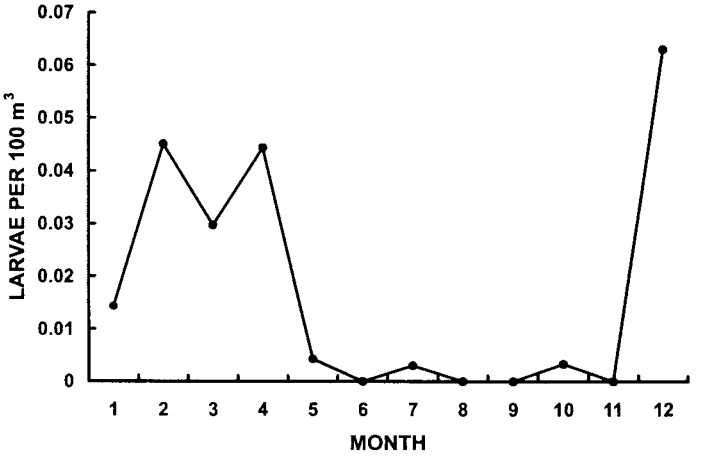



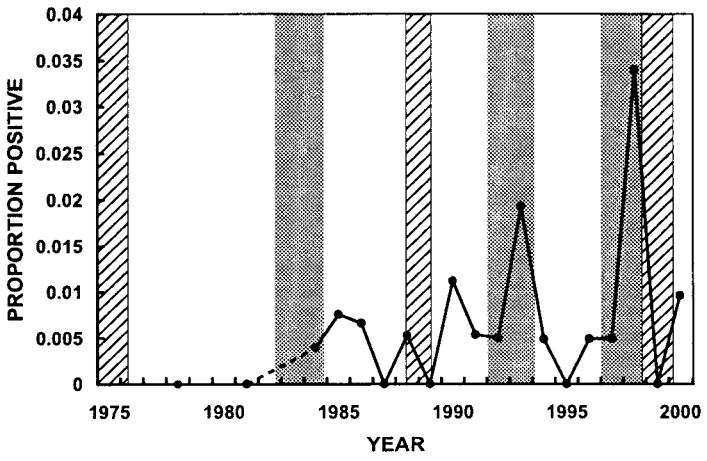



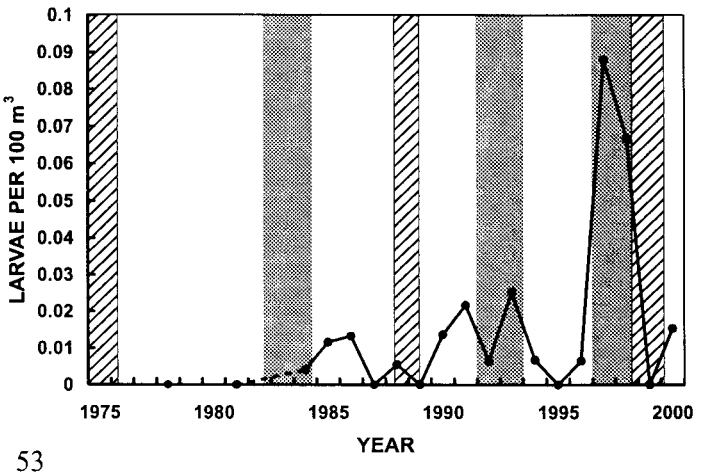

CalCOFI: 1977 - 1984
Total Larvae 14
San Diego
.6 .3 .1 .03
Average Larvae per 100 m³

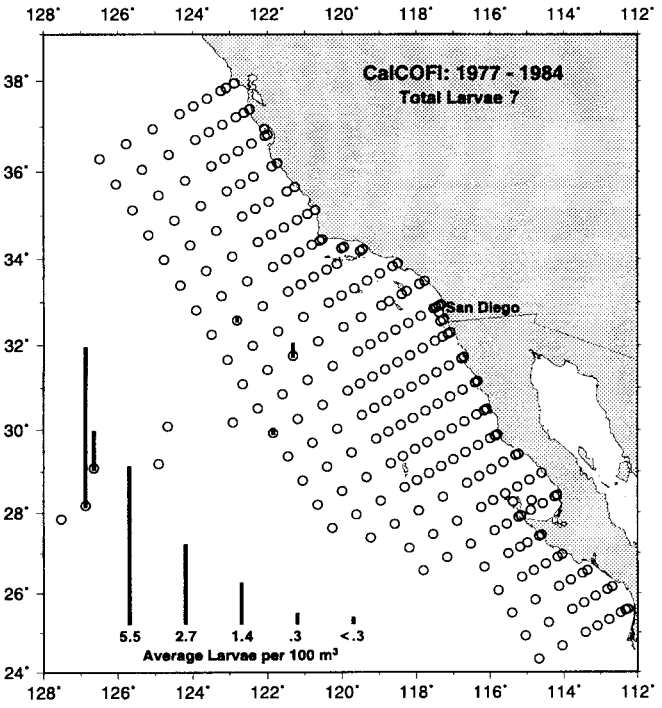

CalCOFI: 1977 - 2000
Total Larvae 49
San Diego
<.01 .01 .06 .1 .2
Average Larvae per 100 m³

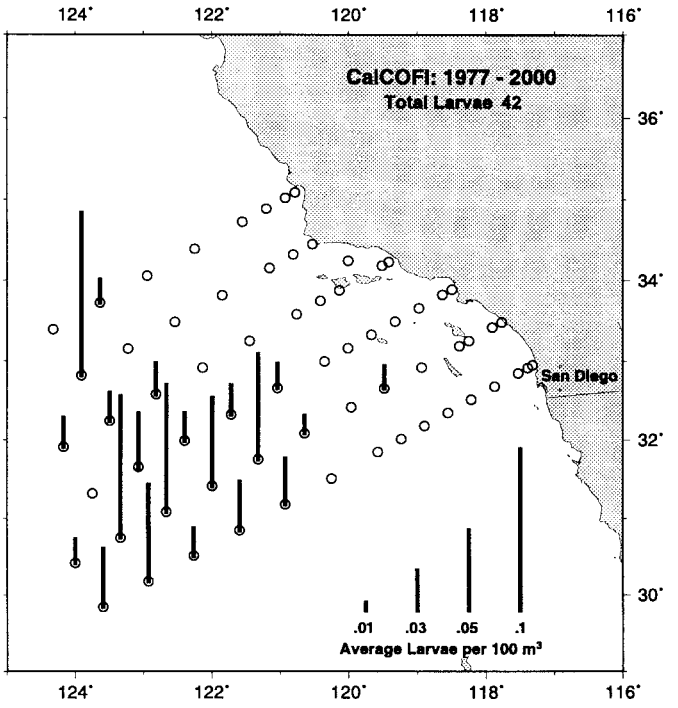

PROPORTION POSITIVE
MONTH

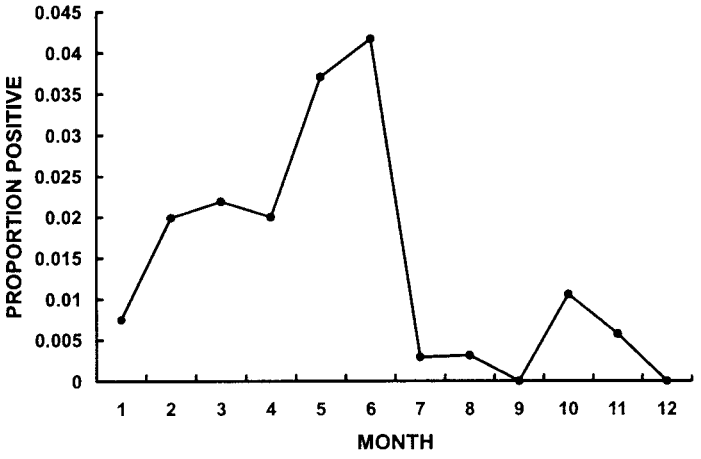

LARVAE PER 100 m³
MONTH

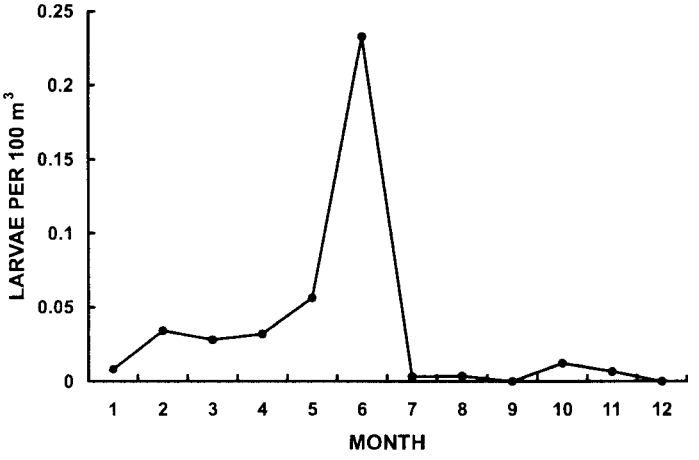

PROPORTION POSITIVE
YEAR

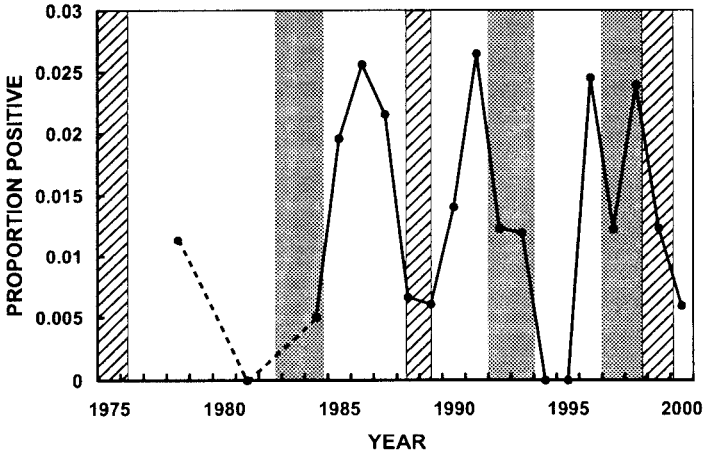

LARVAE PER 100 m³
YEAR

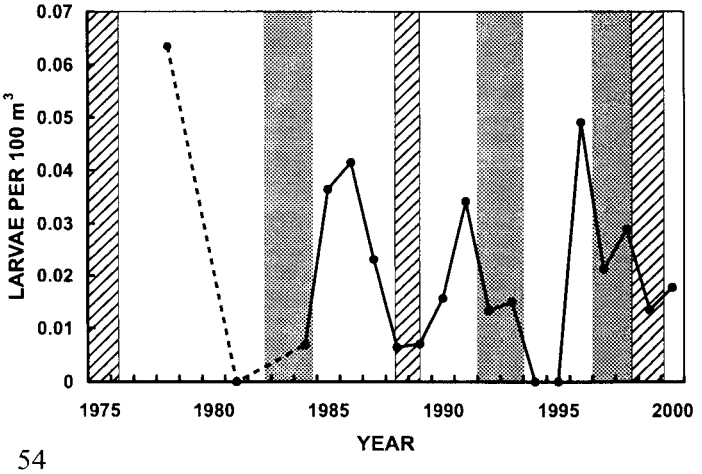

CalCOFI: 1977 - 1984
Total Larvae 7
San Diego
5.5 2.7 1.4 .3 <.3
Average Larvae per 100 m³

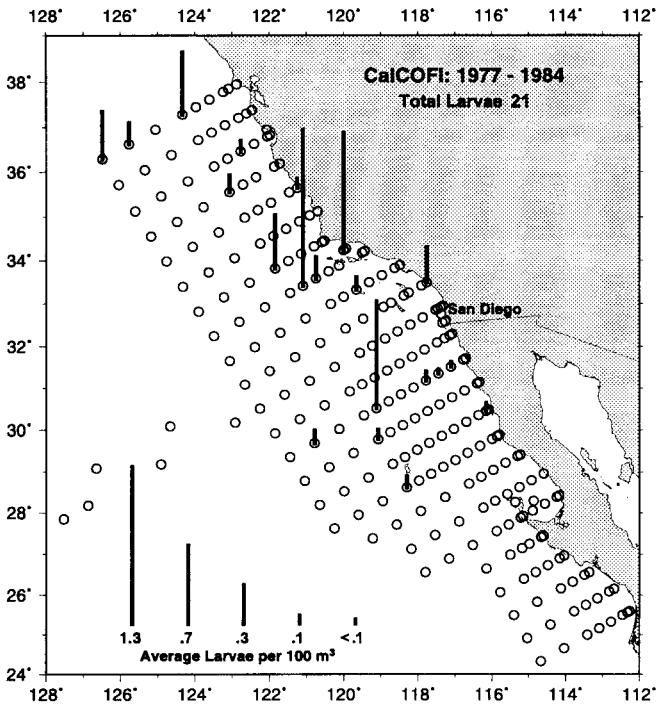

CalCOFI: 1977 - 2000
Total Larvae 42
San Diego
.01 .03 .05 .1
Average Larvae per 100 m³

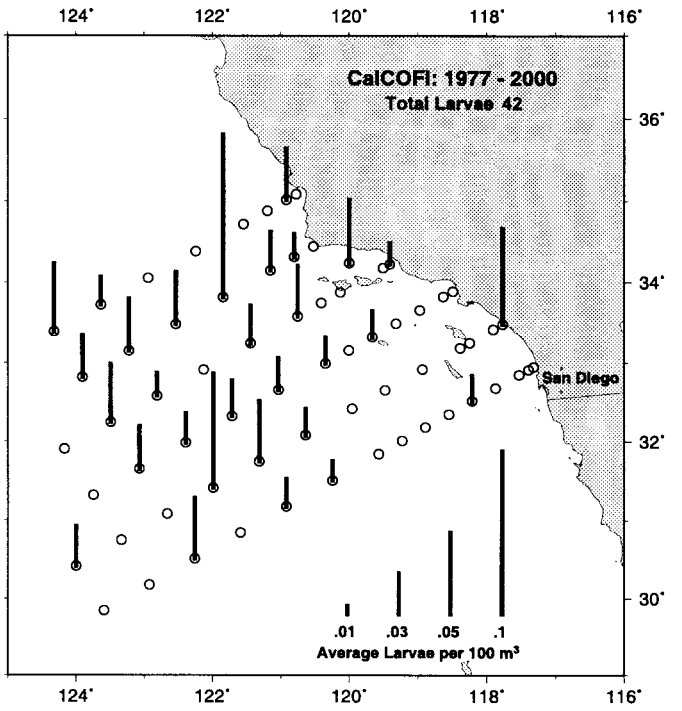

PROPORTION POSITIVE
MONTH

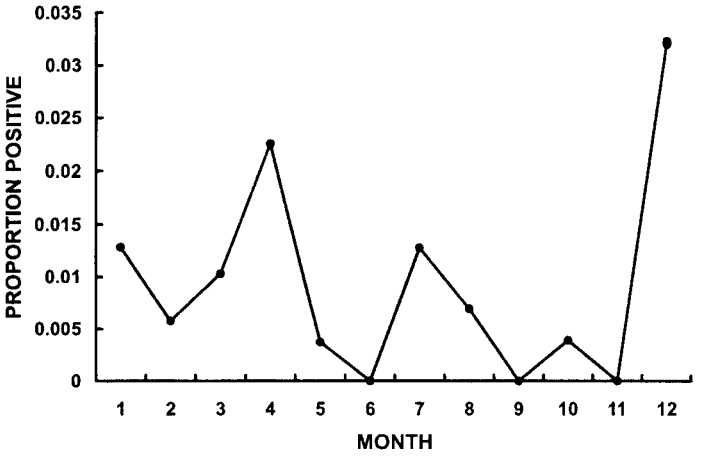

LARVAE PER 100 m³
MONTH

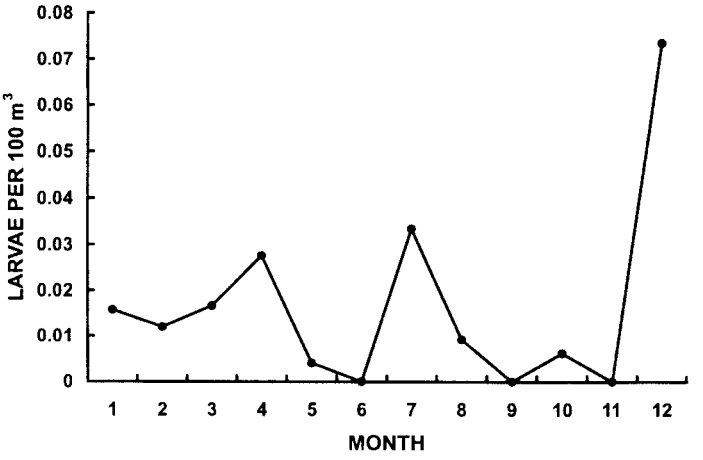

PROPORTION POSITIVE
YEAR

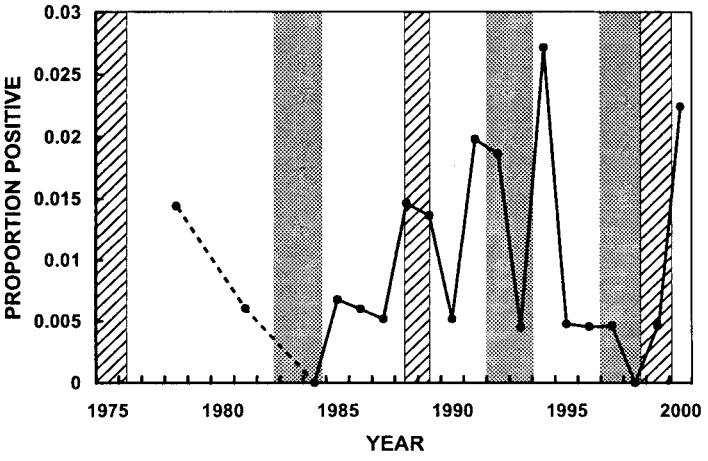

LARVAE PER 100 m³
YEAR

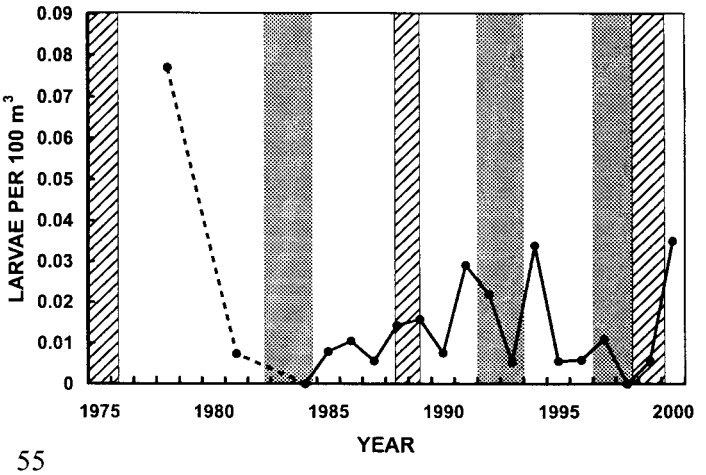

CalCOFI: 1977 - 1984
Total Larvae 21
San Diego
1.3 .7 .3 .1 <.1
Average Larvae per 100 m³

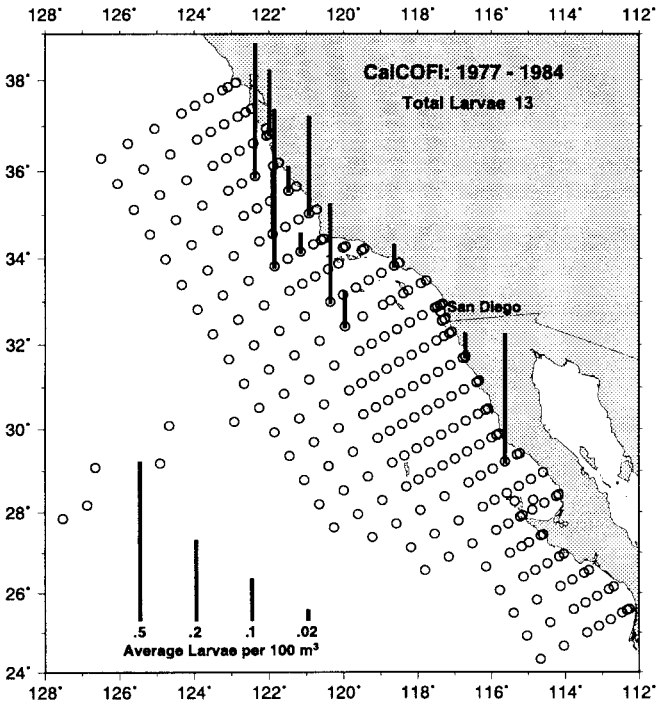

CalCOFI: 1977 - 2000
Total Larvae 42
San Diego
.01 .03 .05 .1
Average Larvae per 100 m³

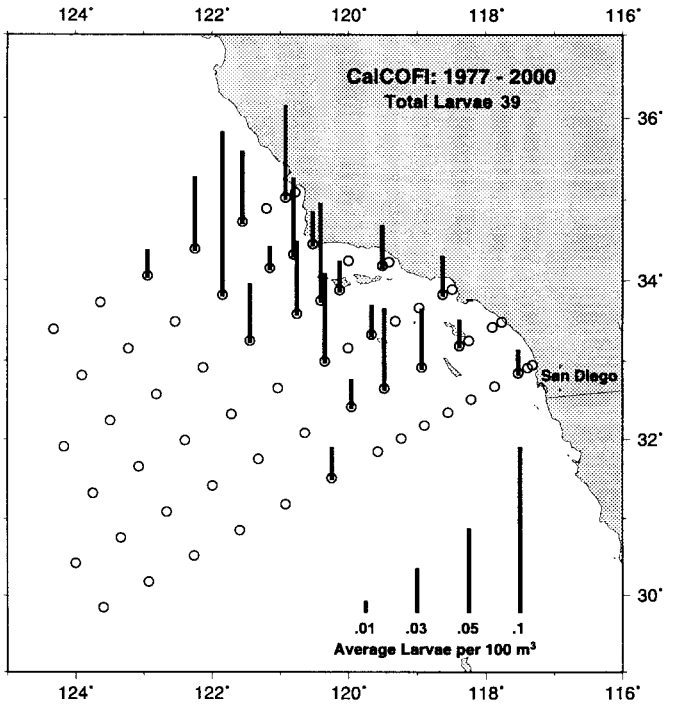

PROPORTION POSITIVE
MONTH

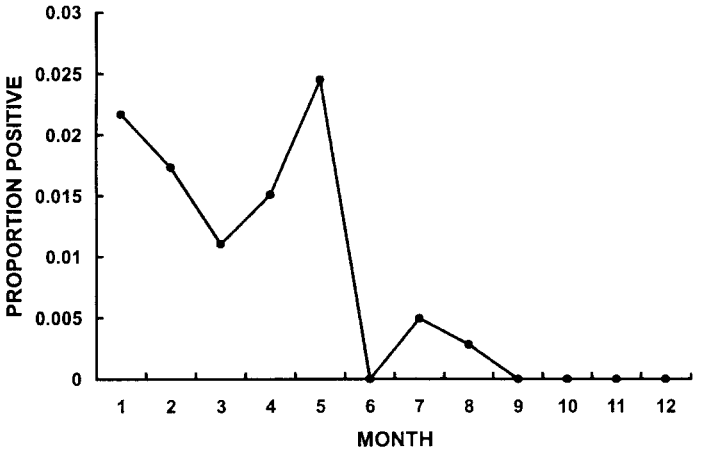

LARVAE PER 100 m³
MONTH

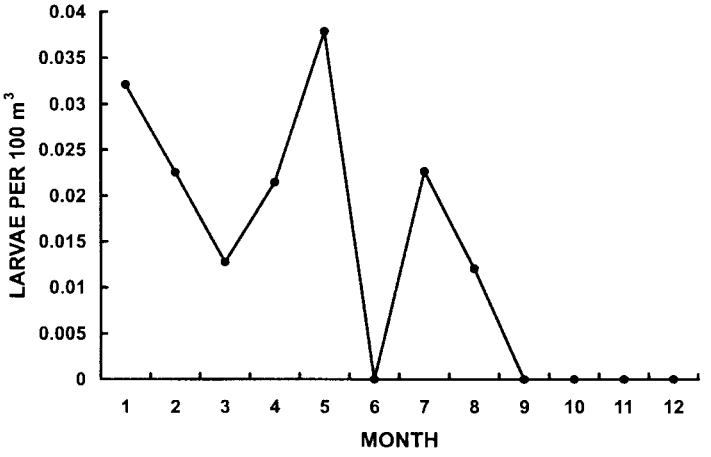

PROPORTION POSITIVE
YEAR

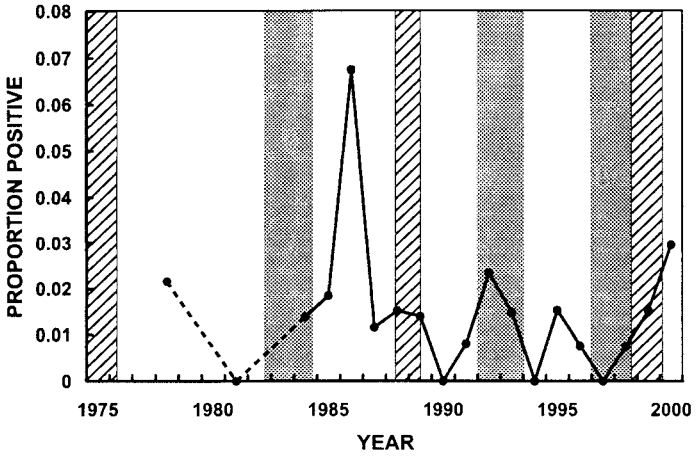

LARVAE PER 100 m³
YEAR

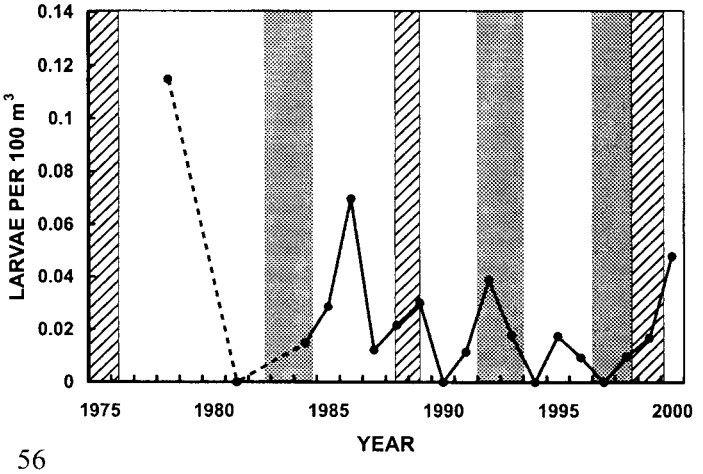

CalCOFI: 1977 - 1984
Total Larvae 13
San Diego
.5 .2 .1 .02
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 39
San Diego
.01 .03 .05 .1
Average Larvae per 100 m³

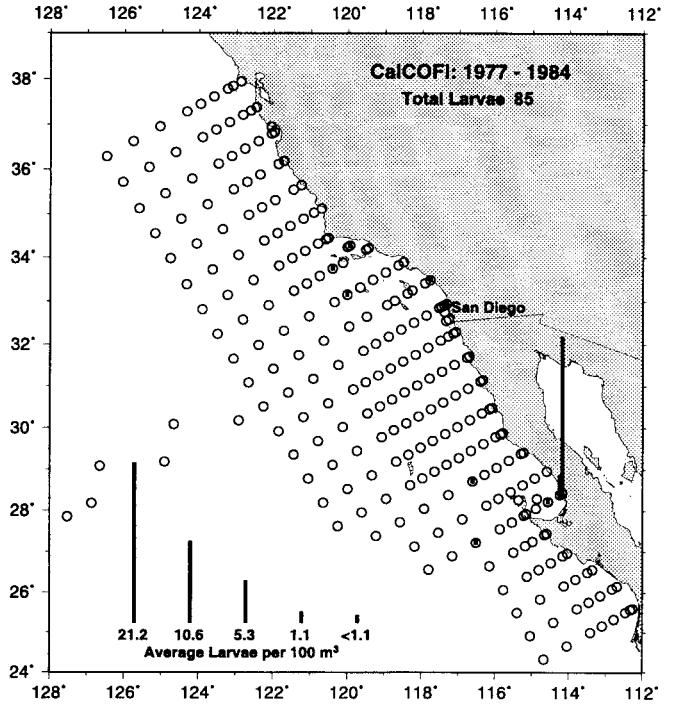

PROPORTION POSITIVE
MONTH

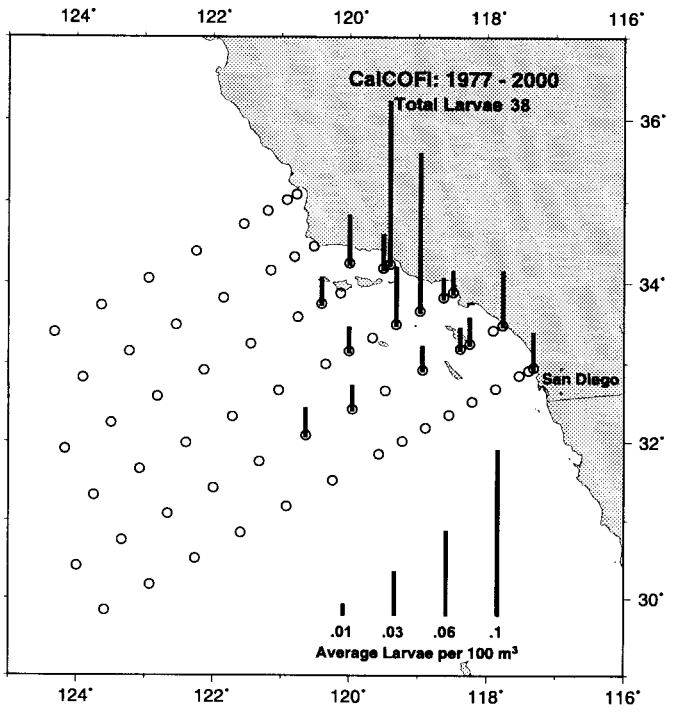

LARVAE PER 100 m³
MONTH

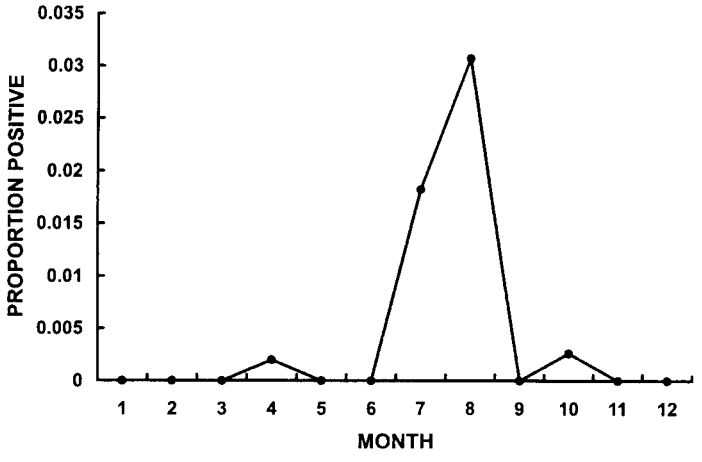

PROPORTION POSITIVE
YEAR

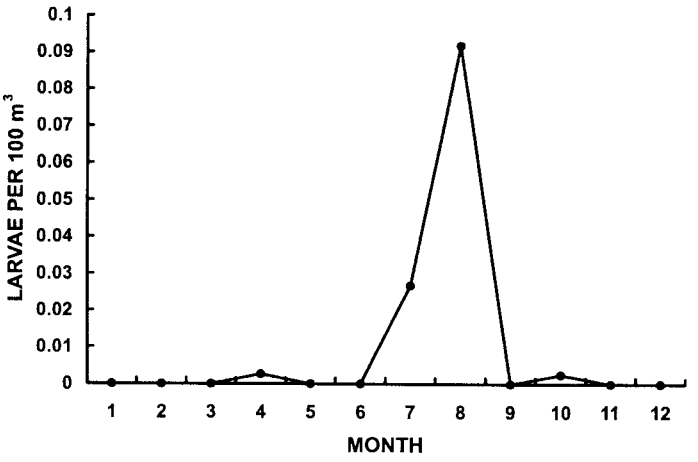

LARVAE PER 100 m³
YEAR

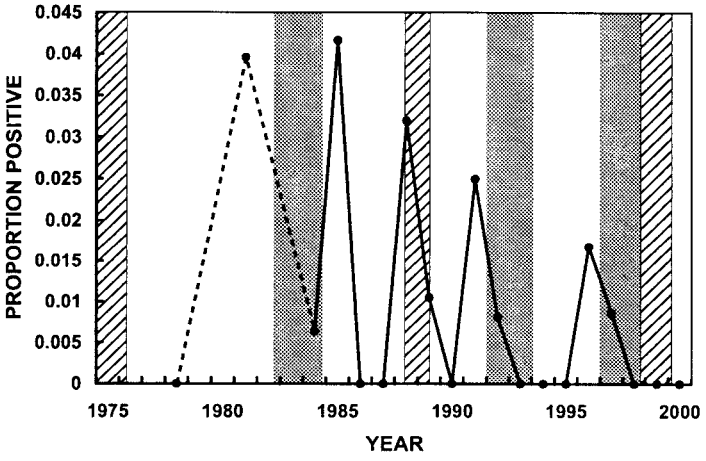
LABRIDAE Rock wrasse ***Halichoeres semicinctus***

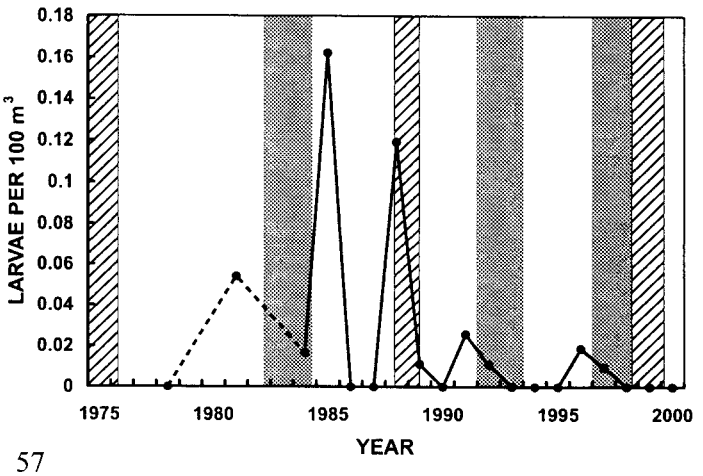


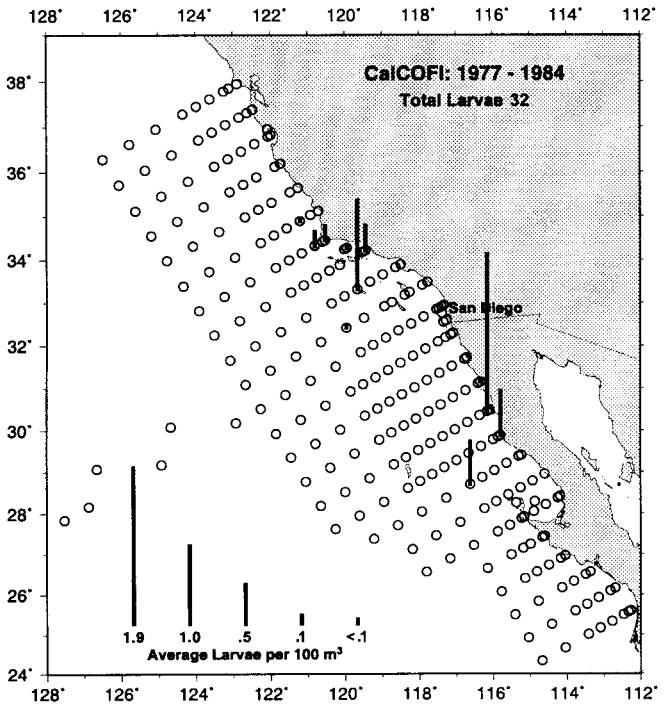



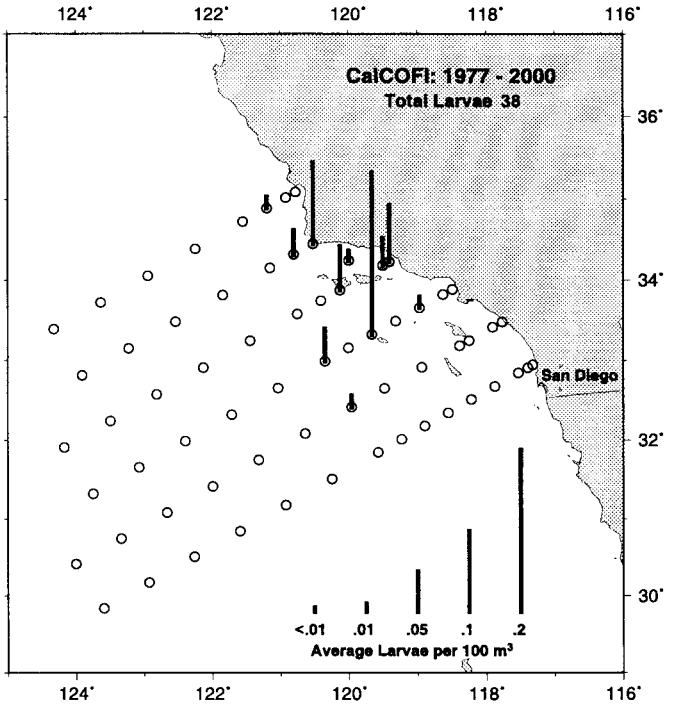



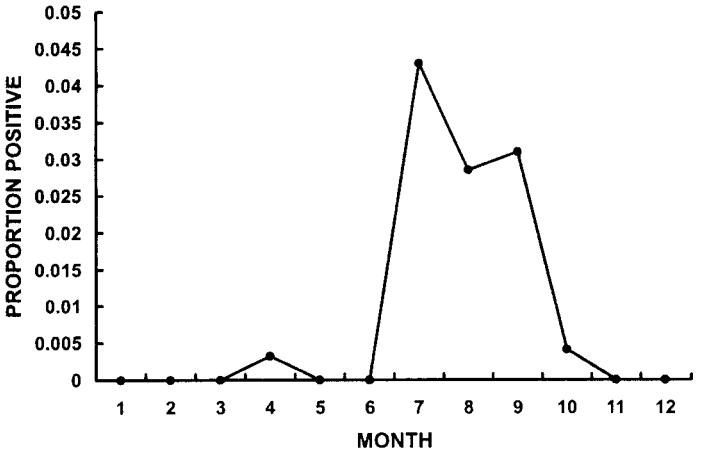



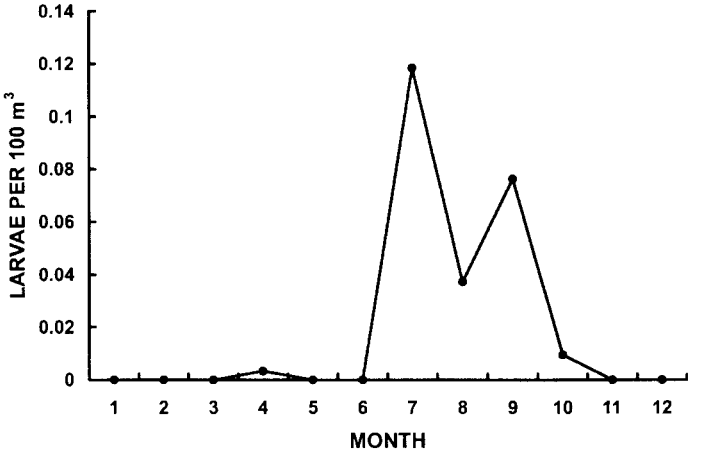



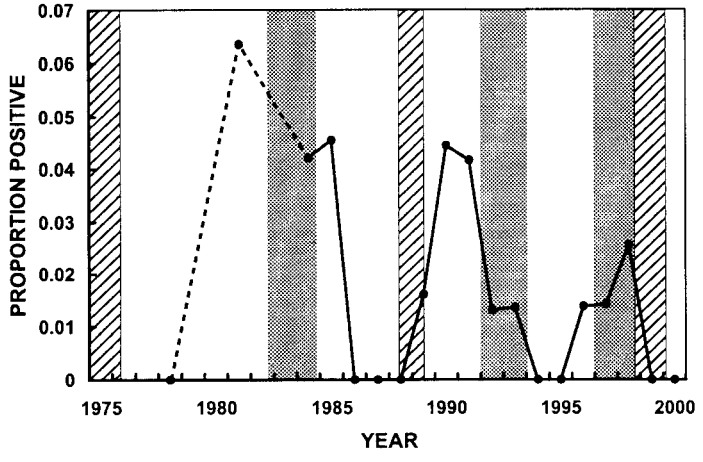
***Semicossyphus pulcher*** Sheephead LABRIDAE

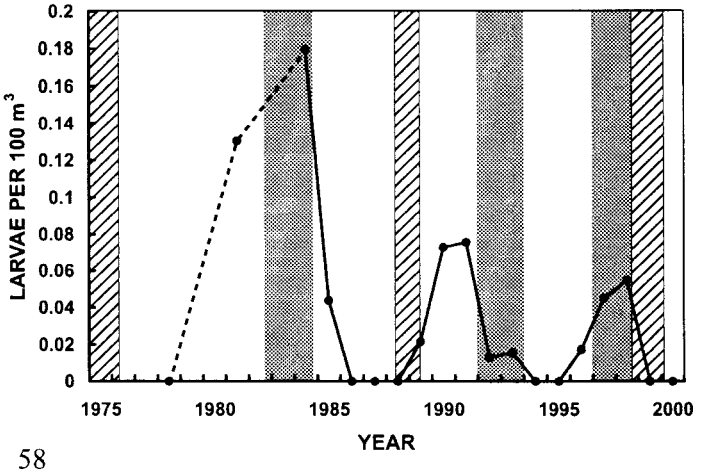


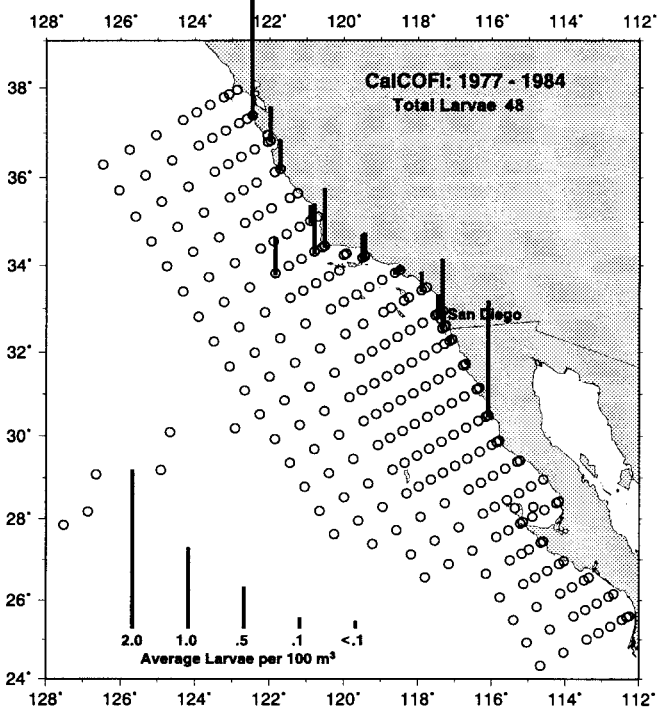



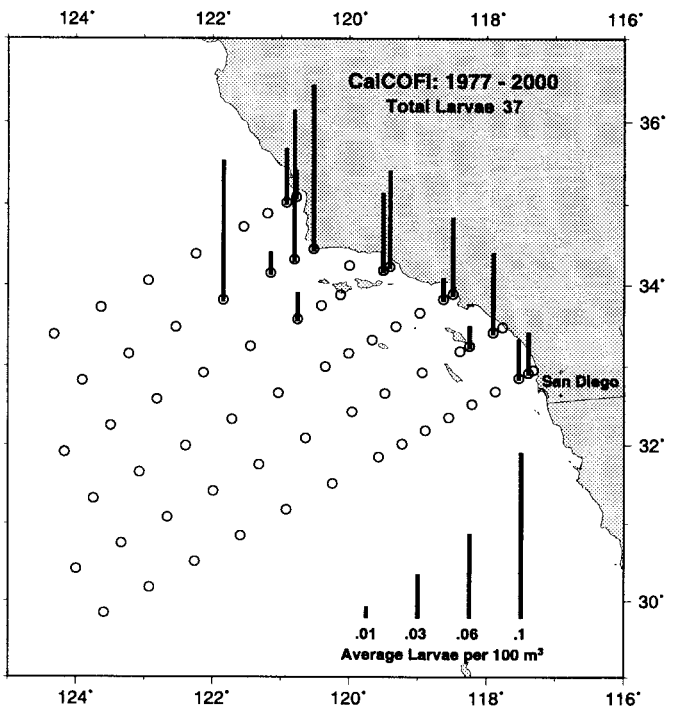



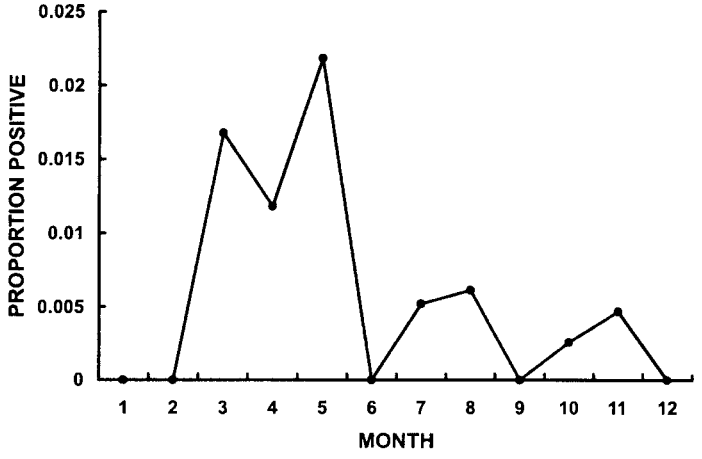



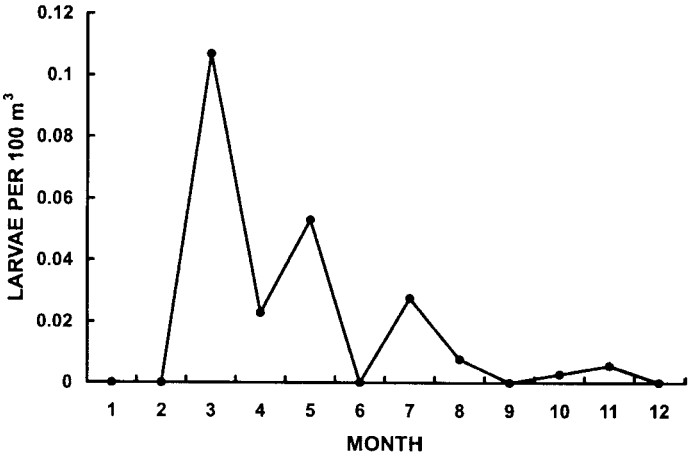



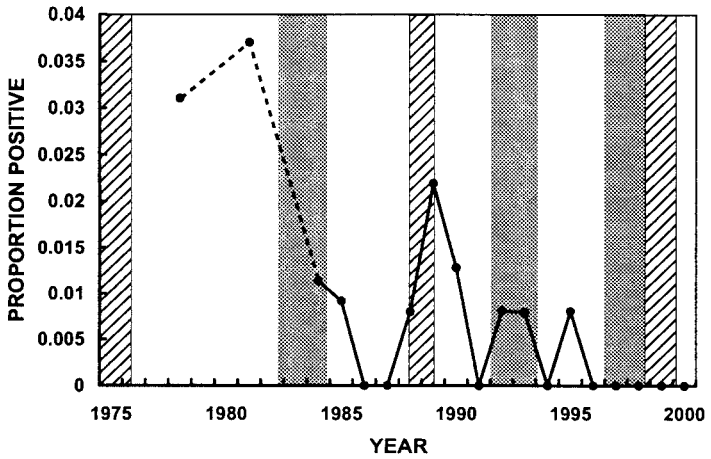
STROMATEIDAE Pacific butterfish ***Peprilus simillimus***

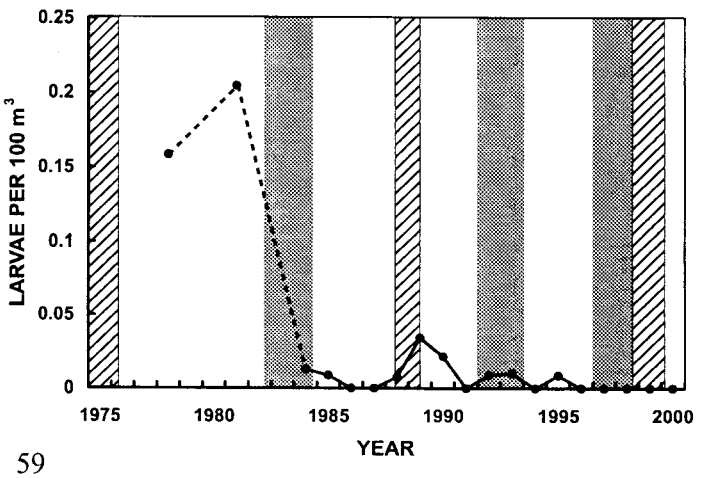


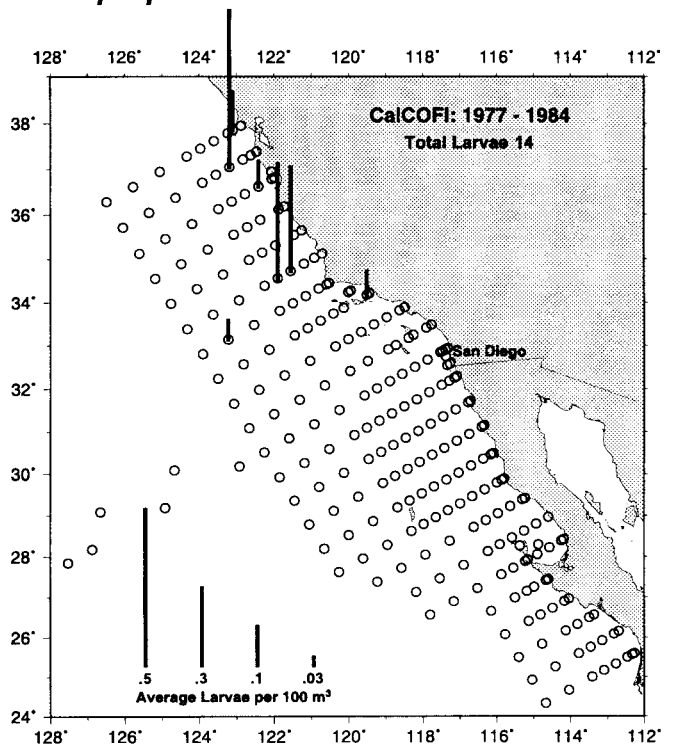



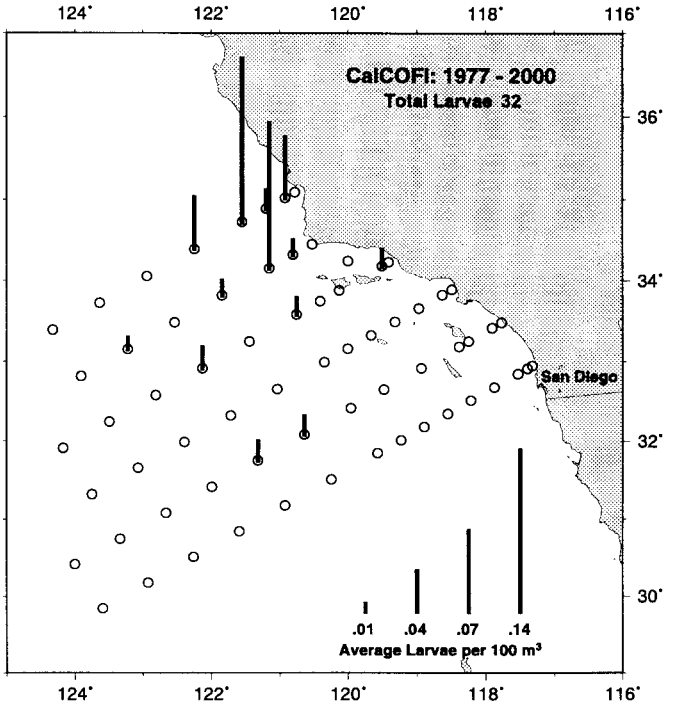



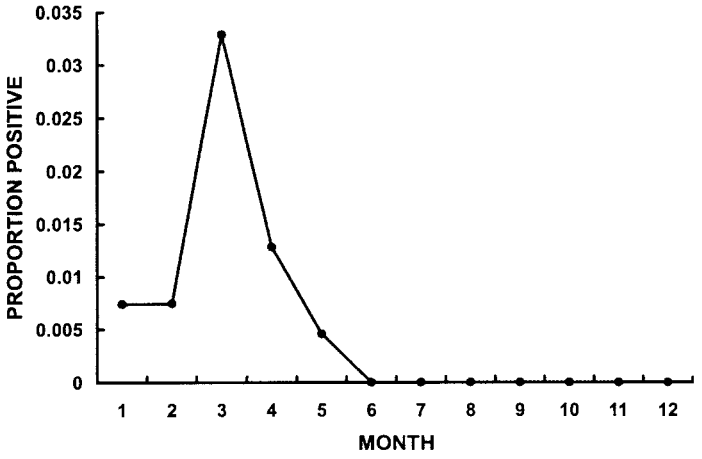



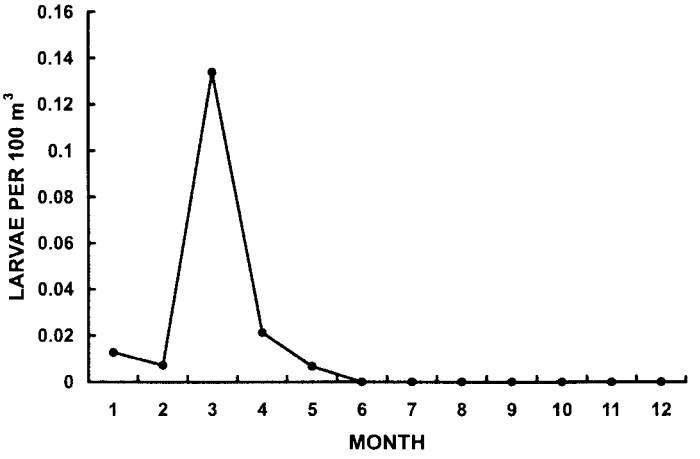



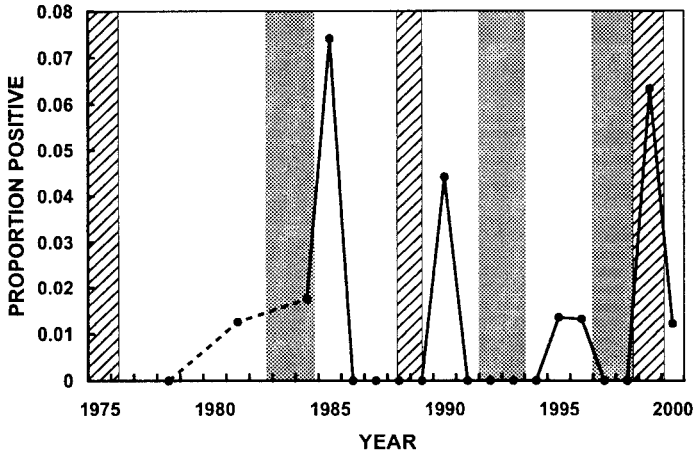



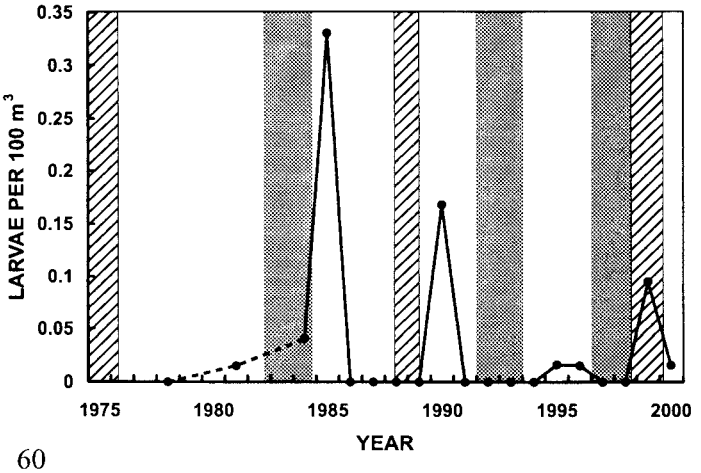

CalCOFI: 1977 - 1984
Total Larvae 14
San Diego
.5 .3 .1 .03
Average Larvae per 100 m³

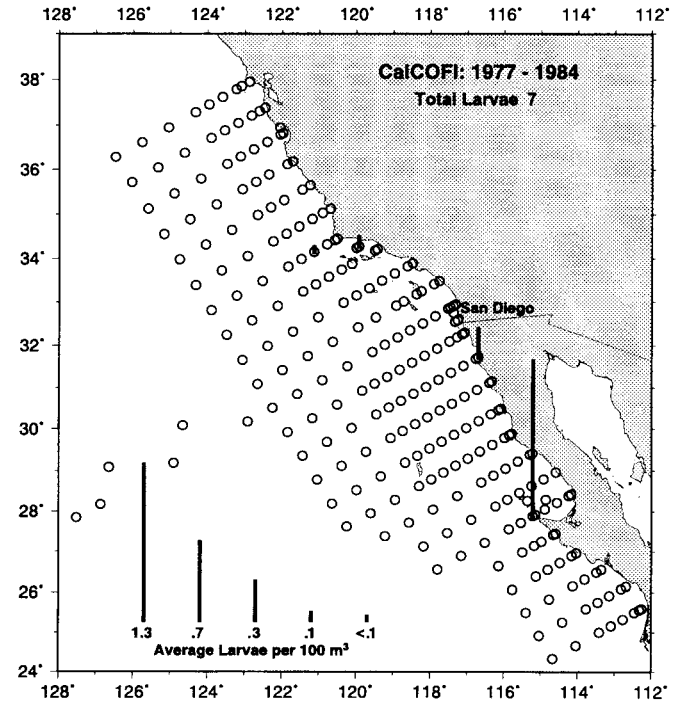

CalCOFI: 1977 - 2000
Total Larvae 32
San Diego
.01 .04 .07 .14
Average Larvae per 100 m³

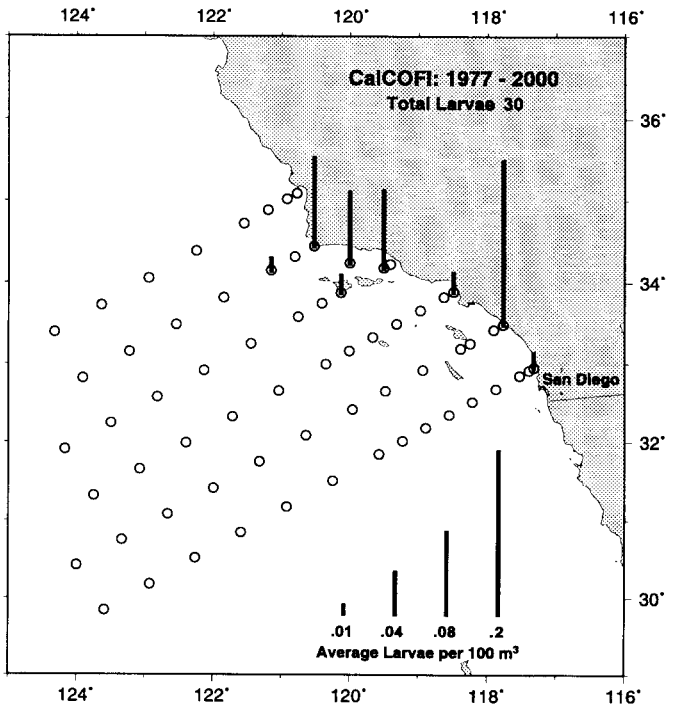

PROPORTION POSITIVE
MONTH

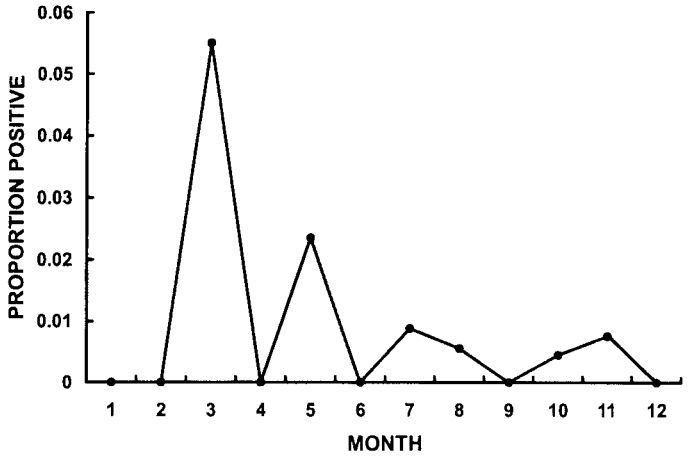

LARVAE PER 100 m³
MONTH

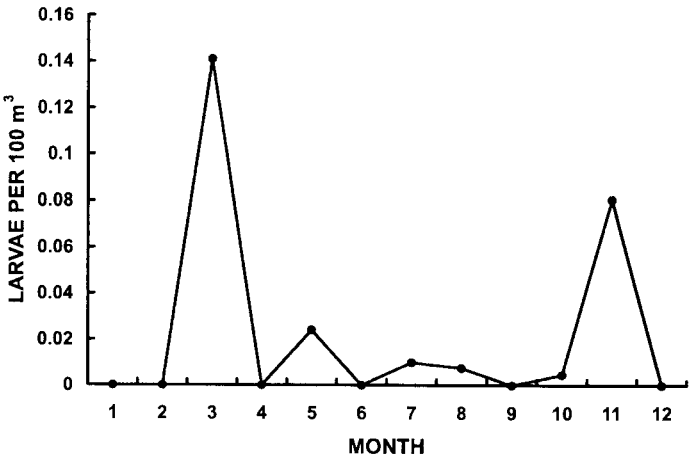

PROPORTION POSITIVE
YEAR

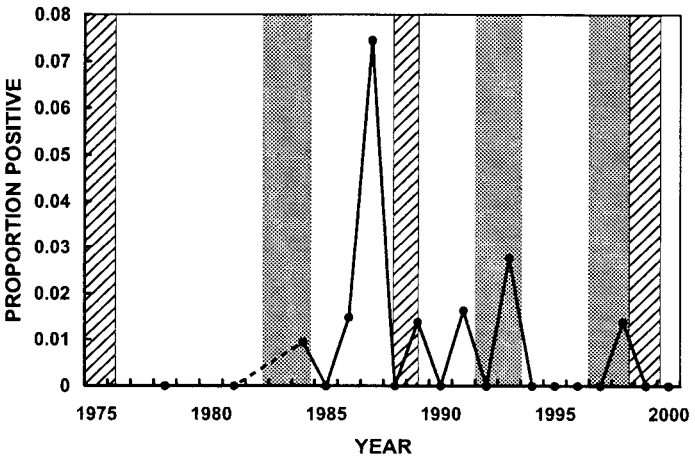

LARVAE PER 100 m³
YEAR

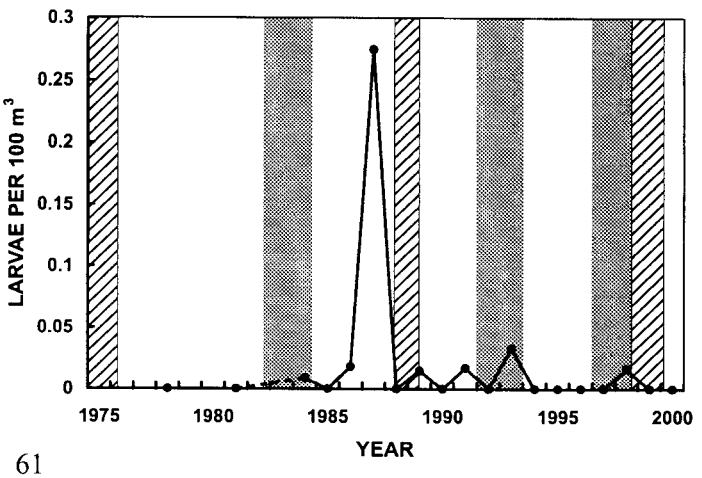

CalCOFI: 1977 - 1984
Total Larvae 7
San Diego
1.3 .7 .3 .1 <.1
Average Larvae per 100 m³

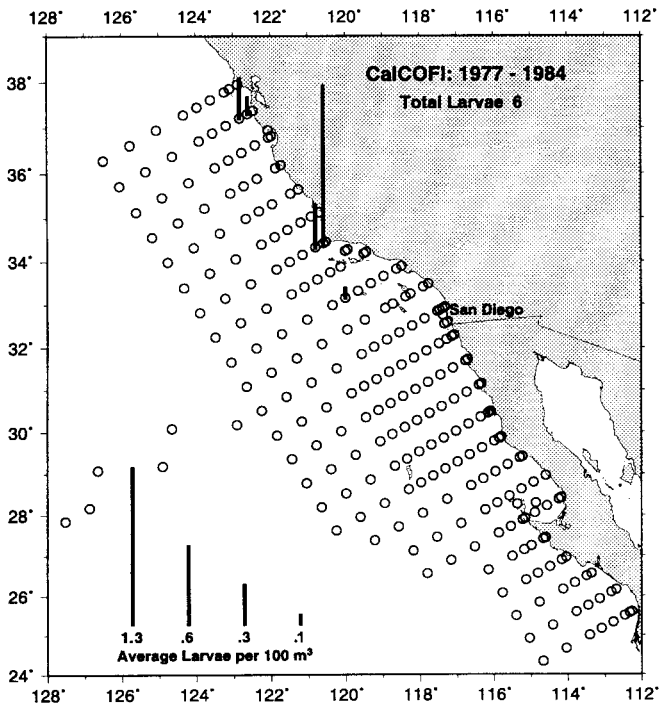

CalCOFI: 1977 - 2000
Total Larvae 30
San Diego
.01 .04 .08 .2
Average Larvae per 100 m³

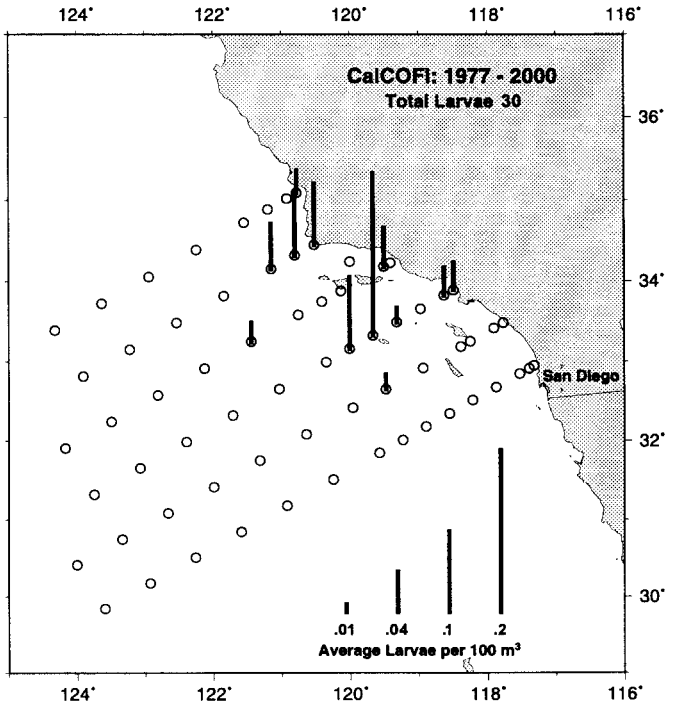

PROPORTION POSITIVE
MONTH

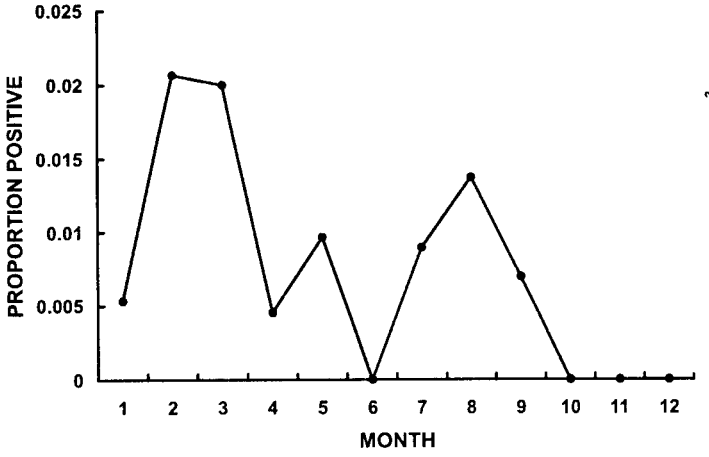

LARVAE PER 100 m³
MONTH

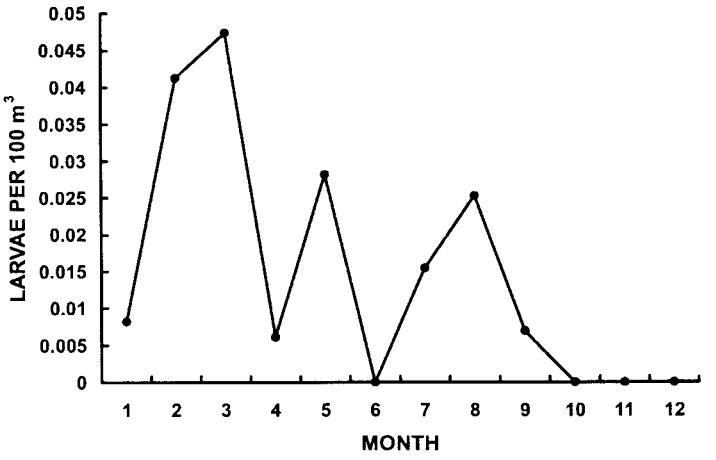

PROPORTION POSITIVE
YEAR

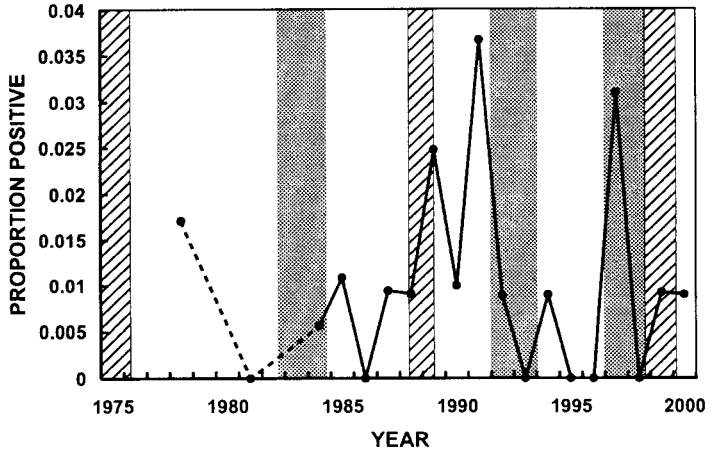

LARVAE PER 100 m³
YEAR

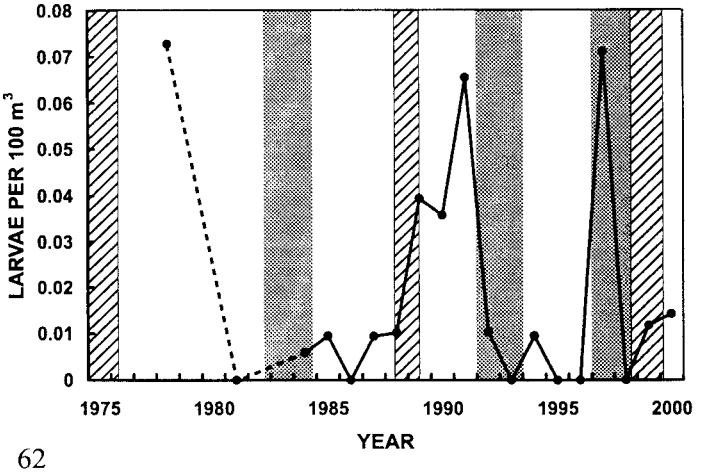

CalCOFI: 1977 - 1984
Total Larvae 6
San Diego
1.3 .6 .3 .1
Average Larvae per 100 m³

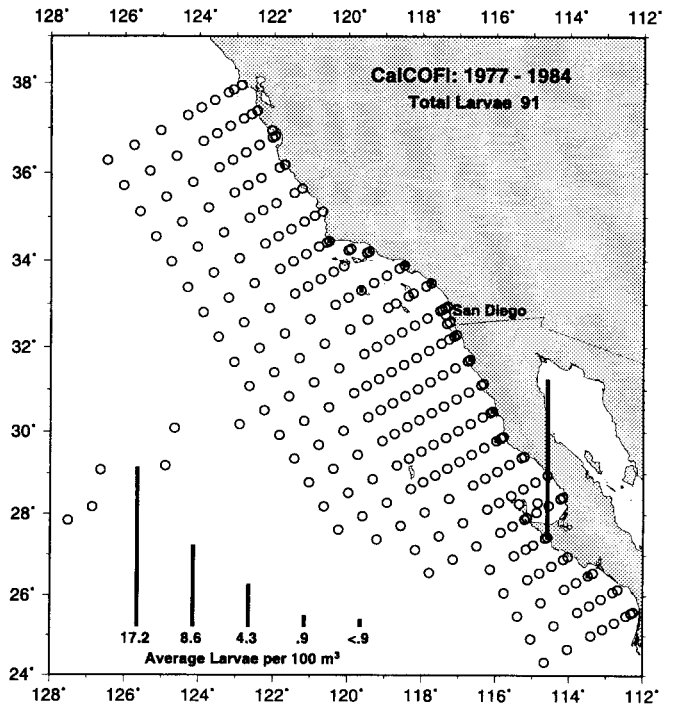

CalCOFI: 1977 - 2000
Total Larvae 30
San Diego
.01 .04 .1 .2
Average Larvae per 100 m³

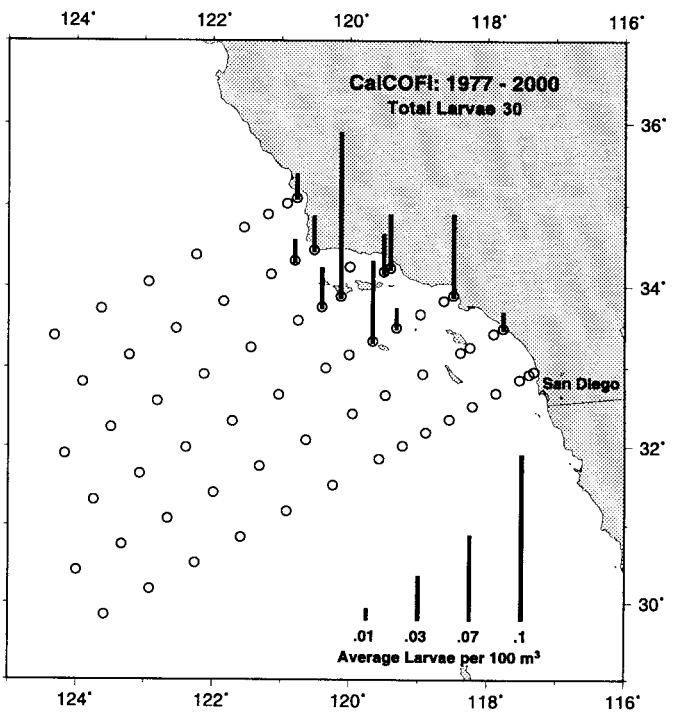

PROPORTION POSITIVE
MONTH

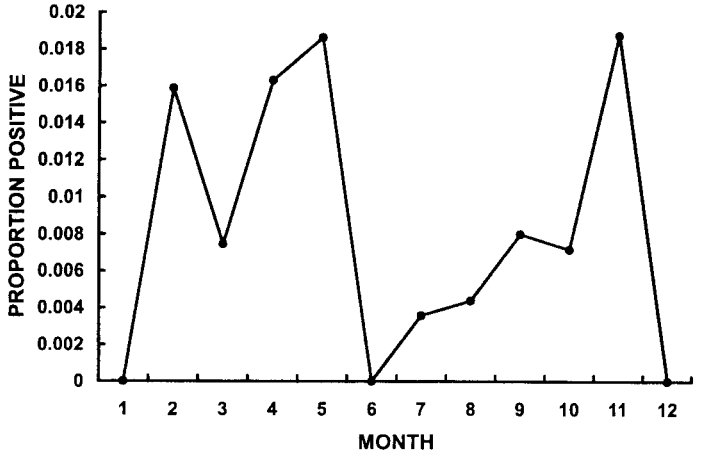

LARVAE PER 100 m³
MONTH

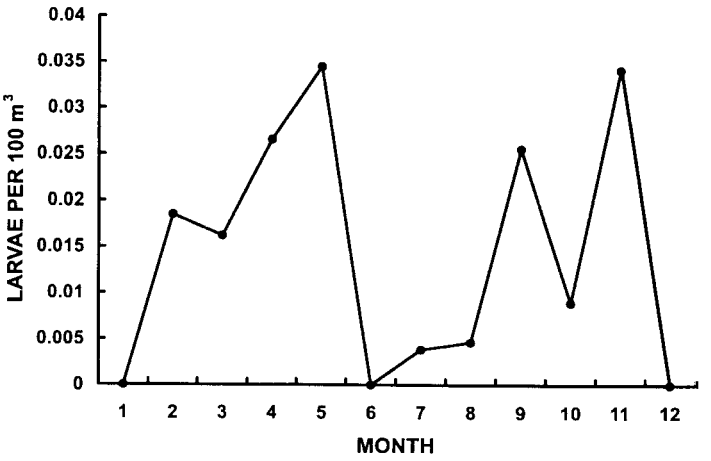

PROPORTION POSITIVE
YEAR

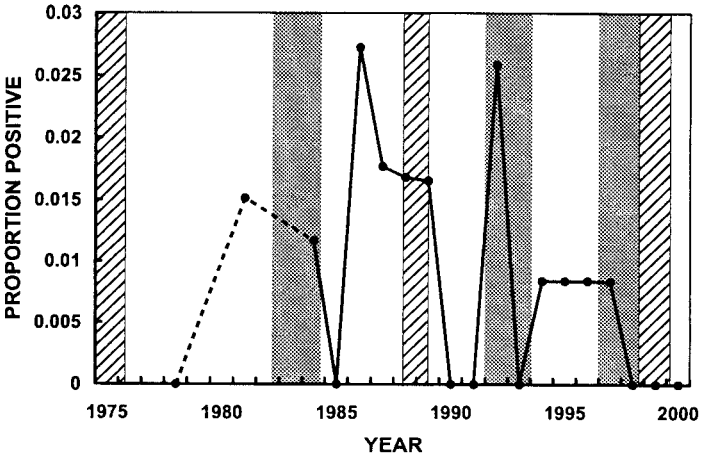

LARVAE PER 100 m³
YEAR

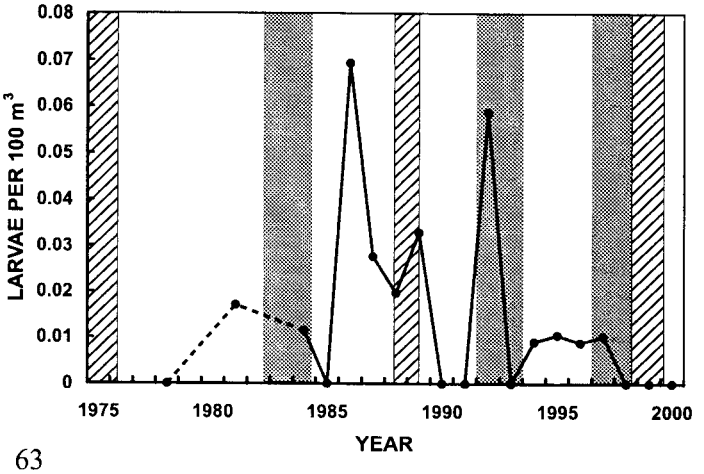

CalCOFI: 1977 - 1984
Total Larvae 91
San Diego
17.2
8.6
4.3
.9
<.9
Average Larvae per 100 m³

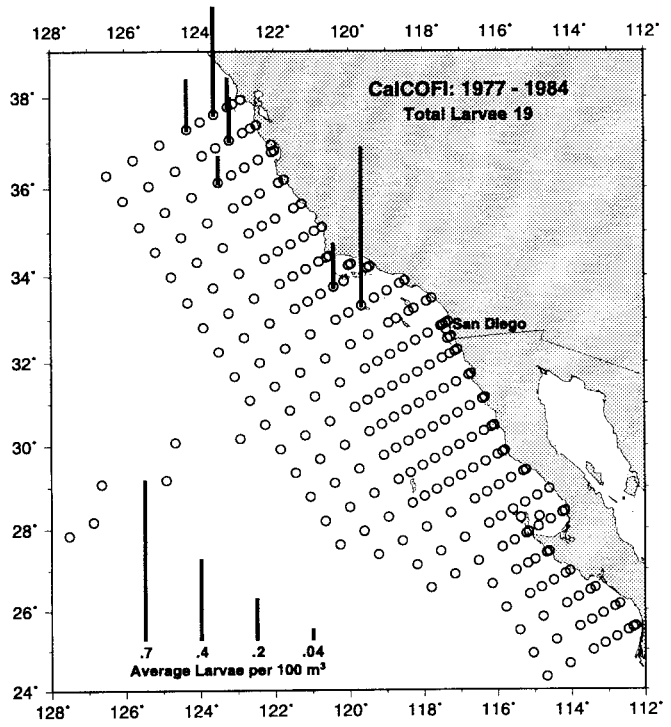

CalCOFI: 1977 - 2000
Total Larvae 30
San Diego
.01
.03
.07
.1
Average Larvae per 100 m³

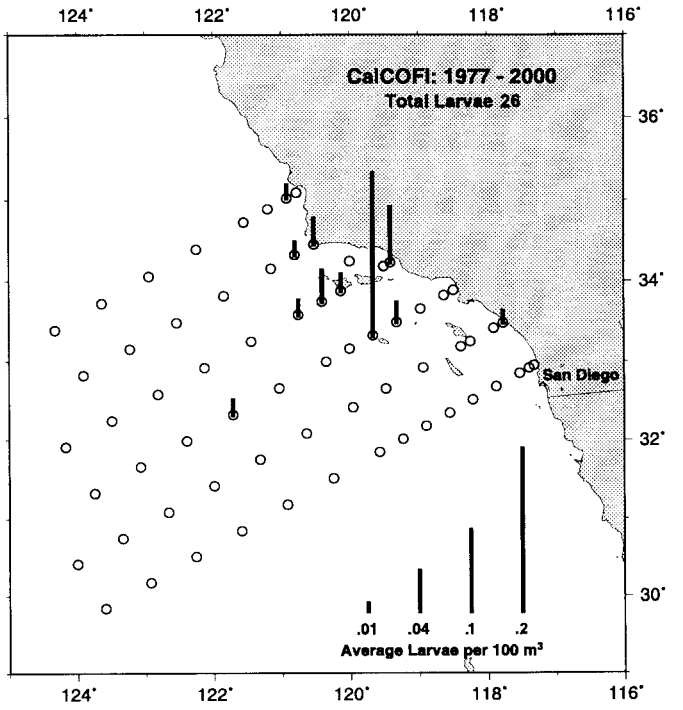

PROPORTION POSITIVE
MONTH

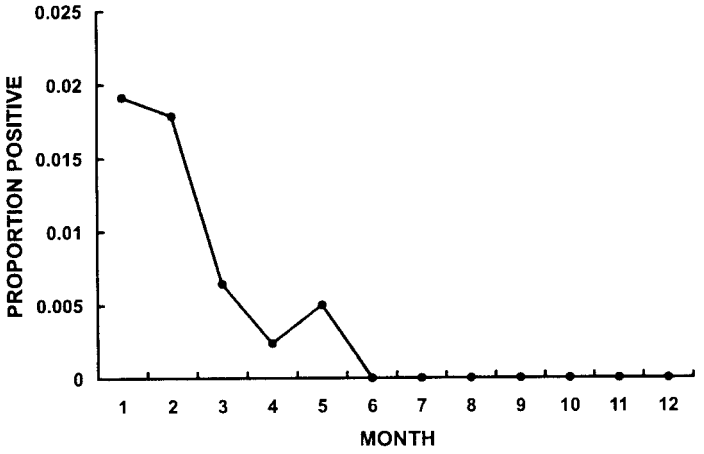

LARVAE PER 100 m³
MONTH

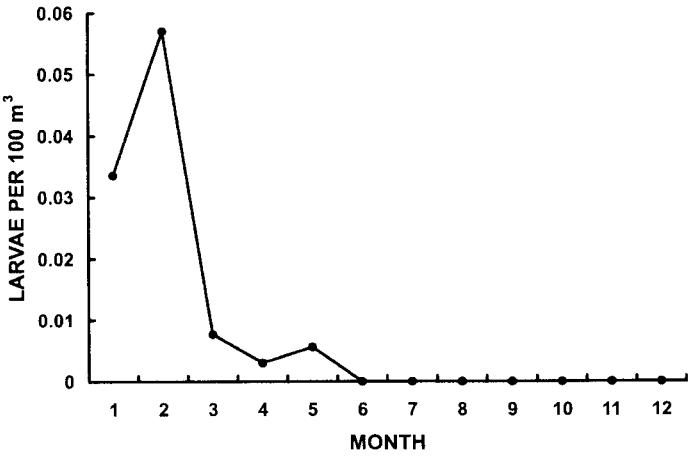

PROPORTION POSITIVE
YEAR

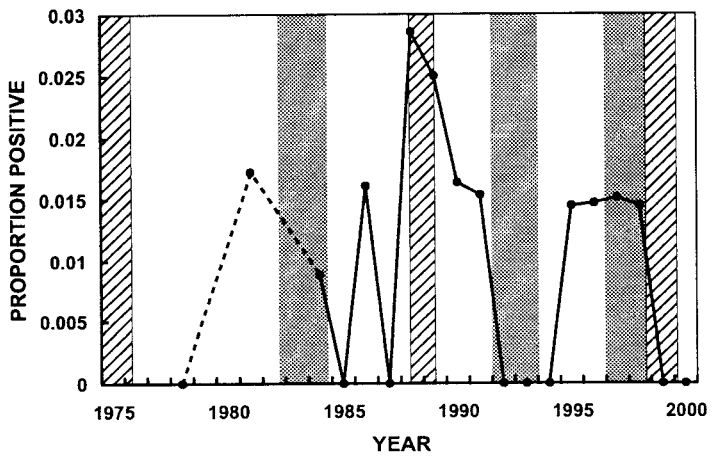

LARVAE PER 100 m³
YEAR

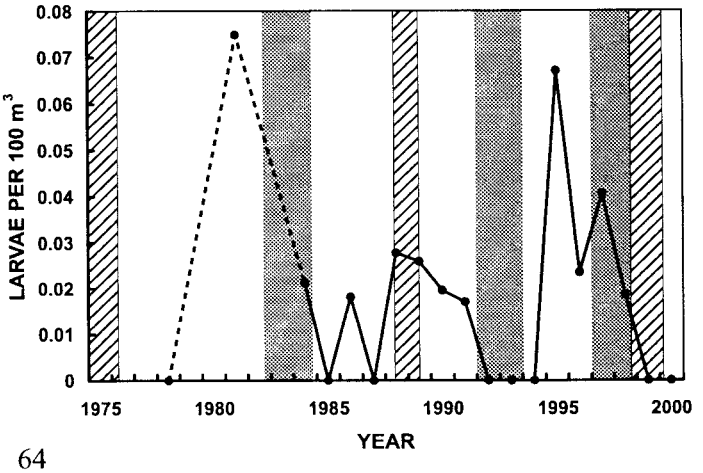

CalCOFI: 1977 - 1984
Total Larvae 19
San Diego
.7 .4 .2 .04
Average Larvae per 100 m³

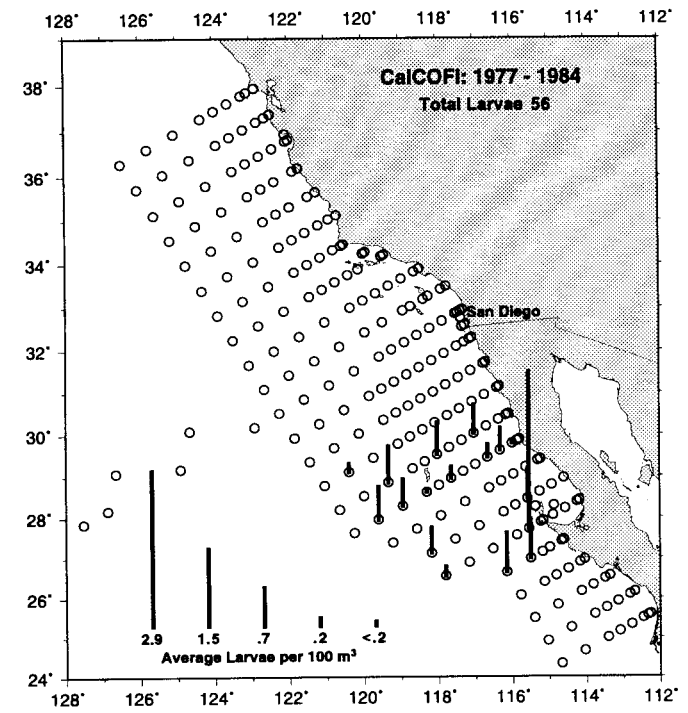

CalCOFI: 1977 - 2000
Total Larvae 26
San Diego
.01 .04 .1 .2
Average Larvae per 100 m³

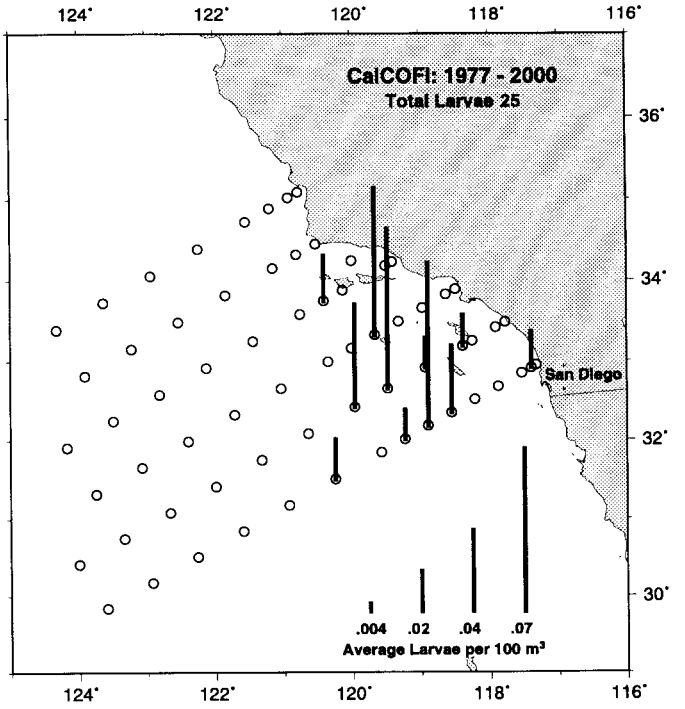

PROPORTION POSITIVE
MONTH

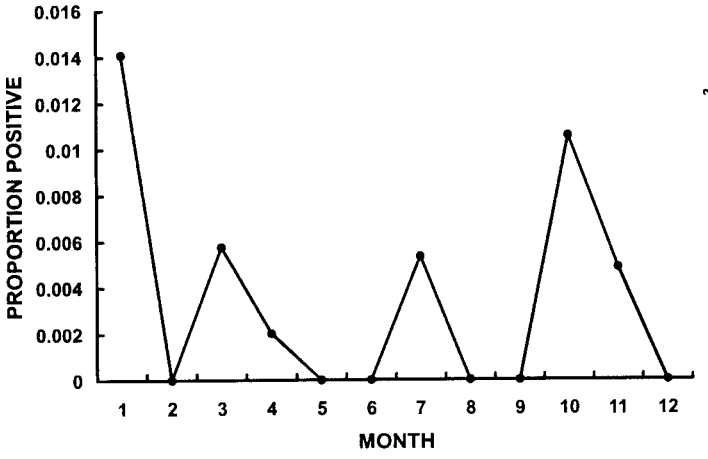

LARVAE PER 100 m³
MONTH

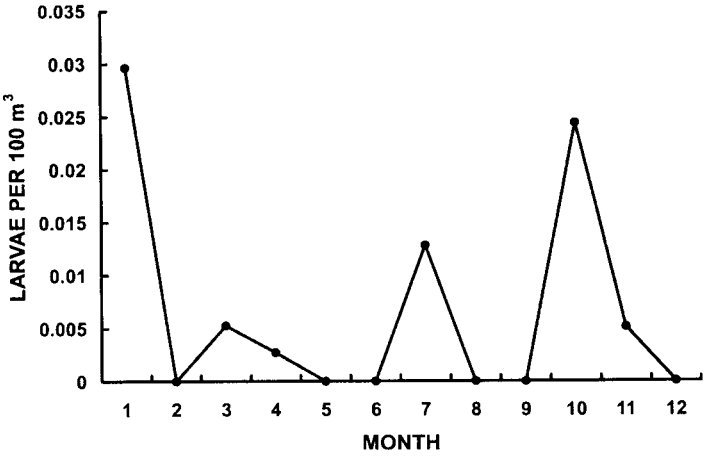

PROPORTION POSITIVE
YEAR

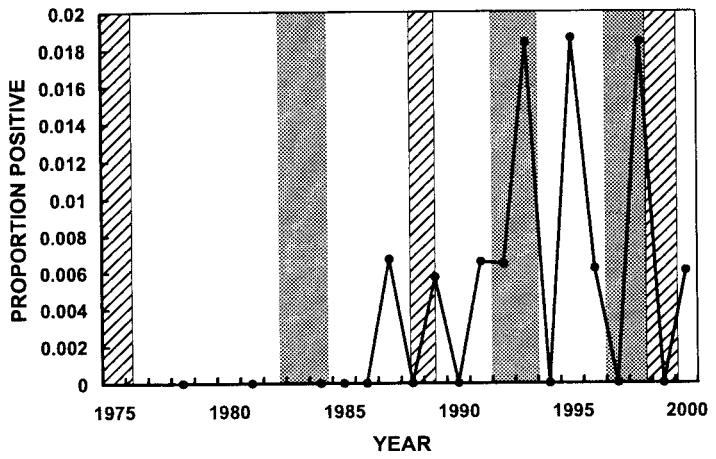

LARVAE PER 100 m³
YEAR

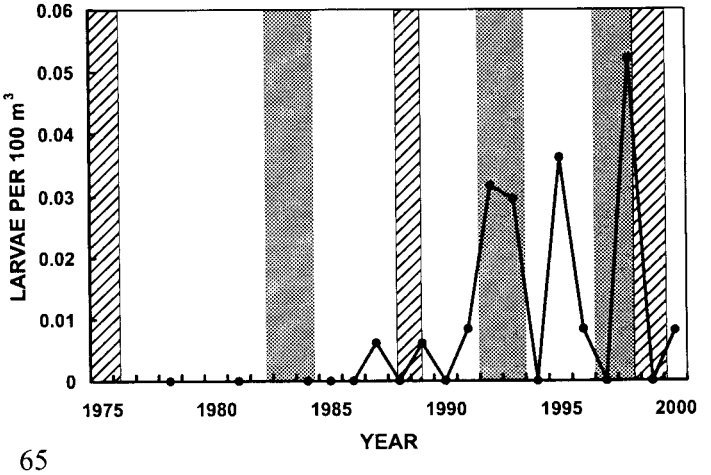

CalCOFI: 1977 - 1984
Total Larvae 56
San Diego
2.9 1.5 .7 .2 <.2
Average Larvae per 100 m³

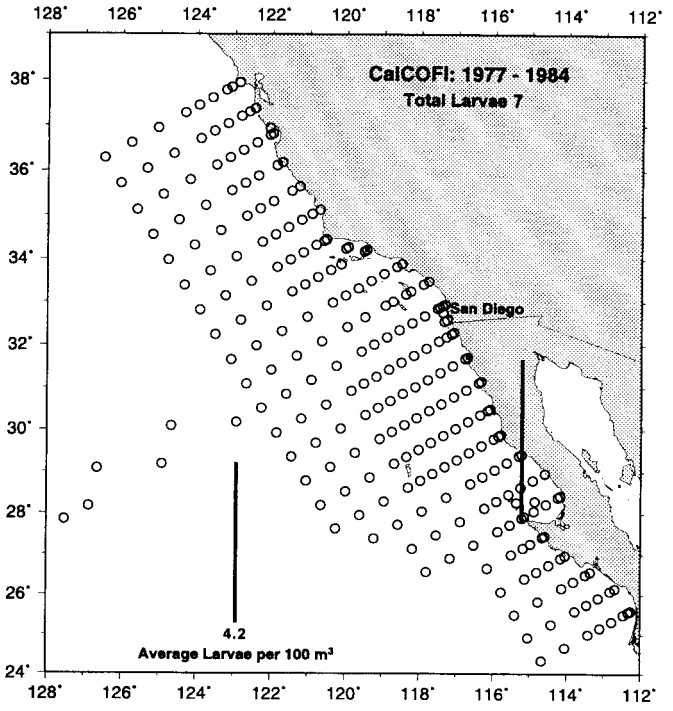

CalCOFI: 1977 - 2000
Total Larvae 25
San Diego
.004 .02 .04 .07
Average Larvae per 100 m³

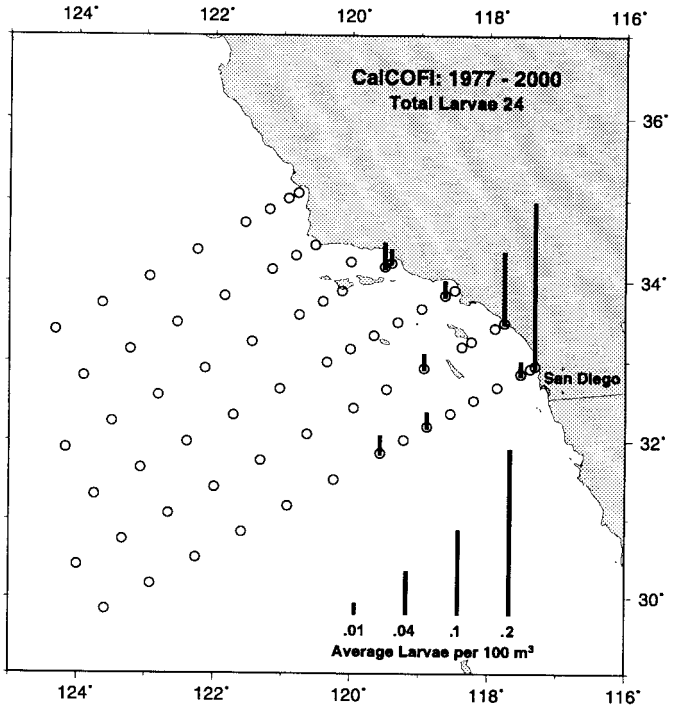

PROPORTION POSITIVE
MONTH

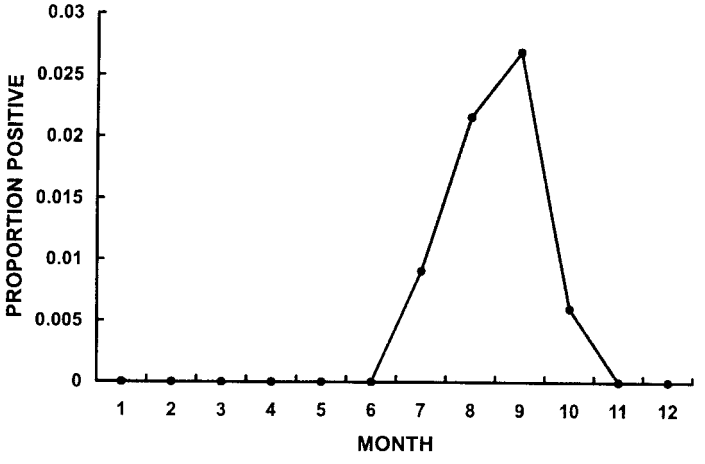

LARVAE PER 100 m³
MONTH

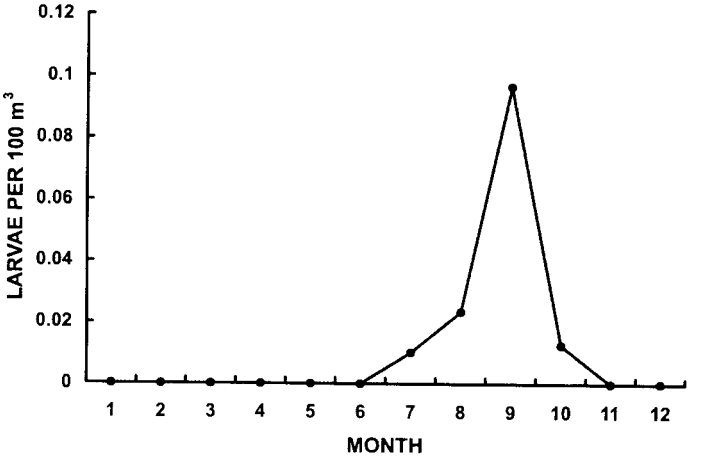

PROPORTION POSITIVE
YEAR

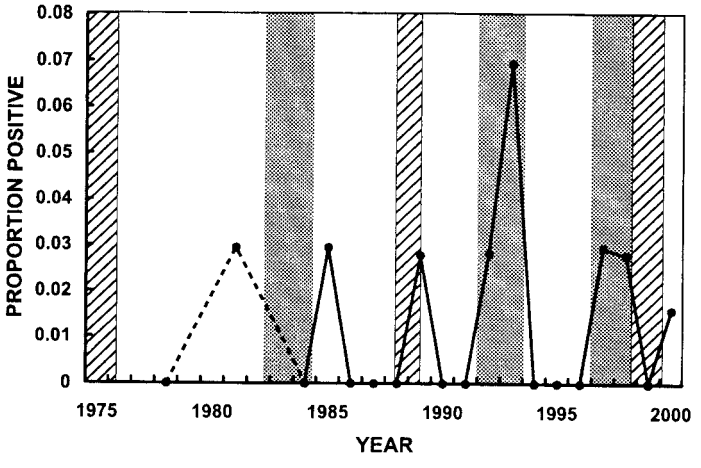

LARVAE PER 100 m³
YEAR

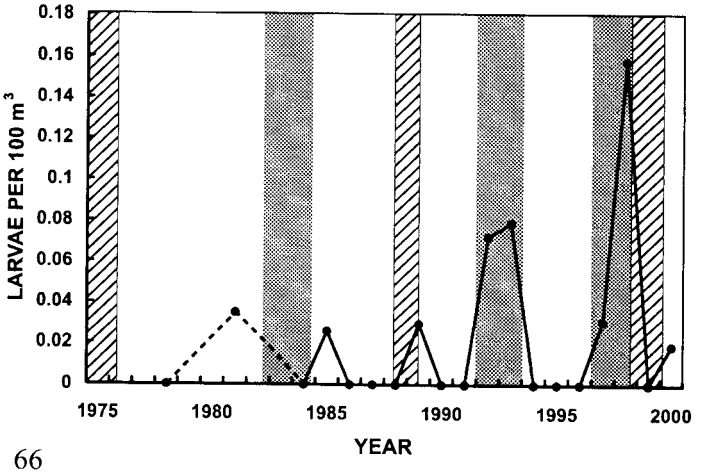

CalCOFI: 1977 - 1984
Total Larvae 7
San Diego
4.2
Average Larvae per 100 m³

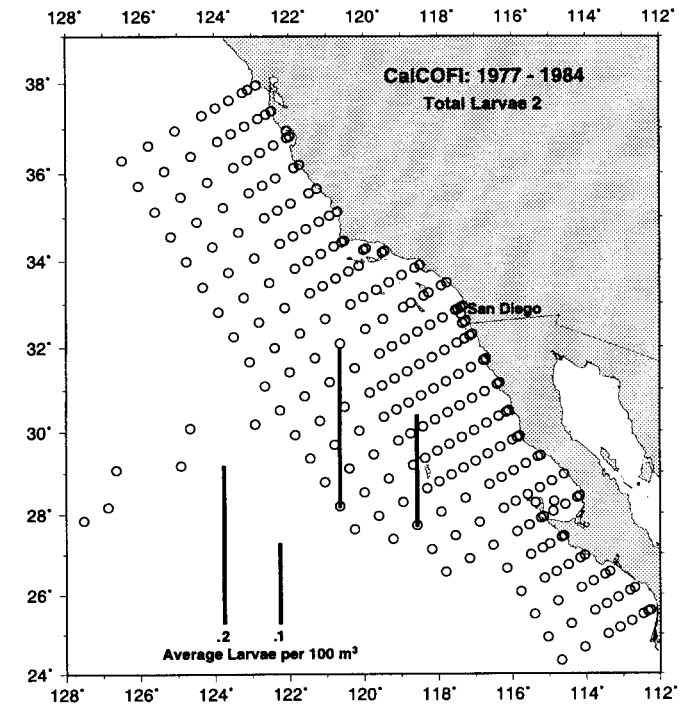

CalCOFI: 1977 - 2000
Total Larvae 24
San Diego
.01 .04 .1 .2
Average Larvae per 100 m³

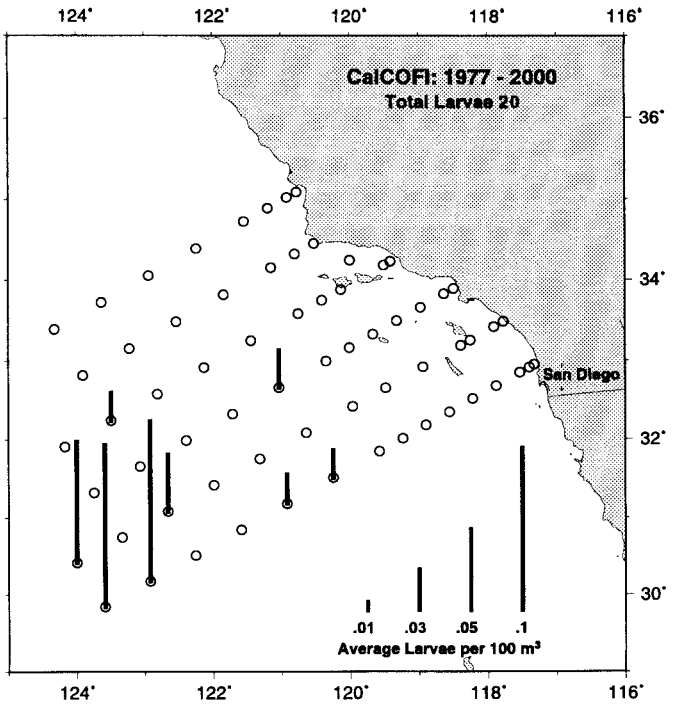

PROPORTION POSITIVE
MONTH

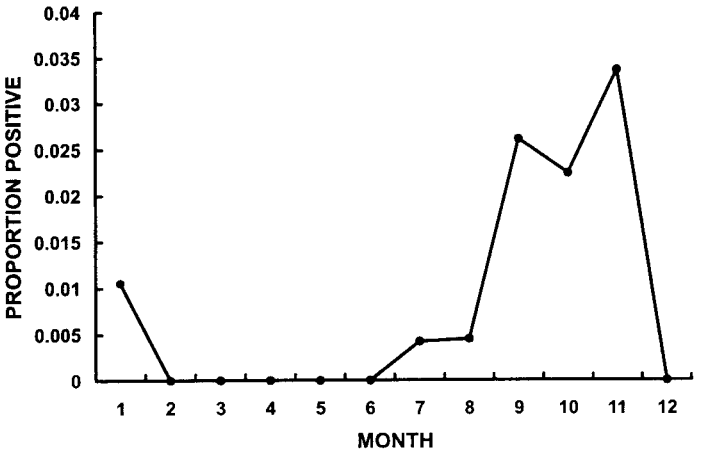

LARVAE PER 100 m³
MONTH

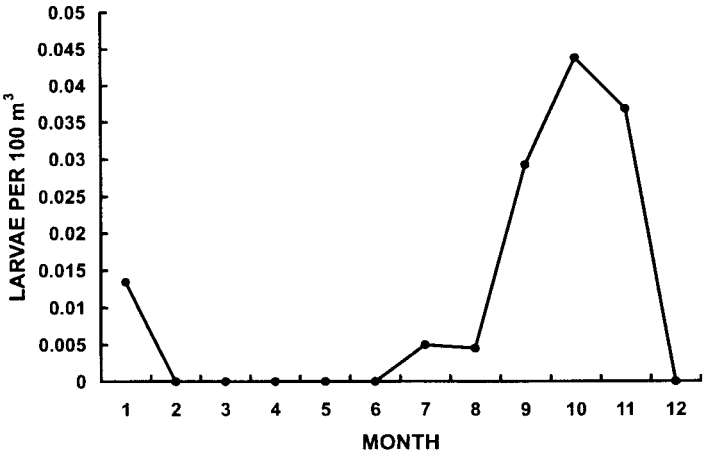

PROPORTION POSITIVE
YEAR

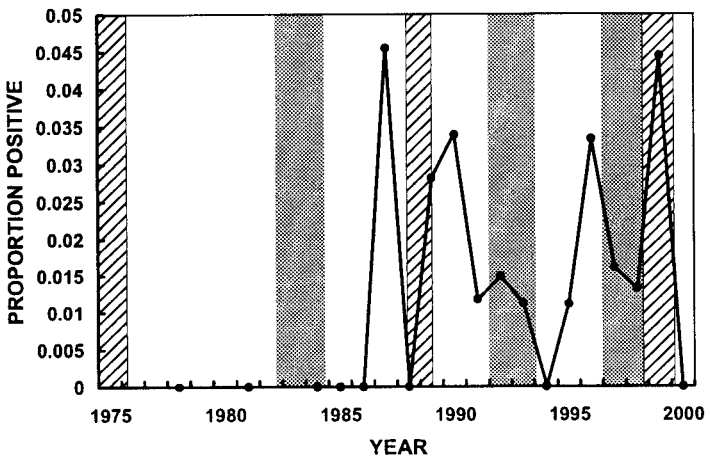

LARVAE PER 100 m³
YEAR

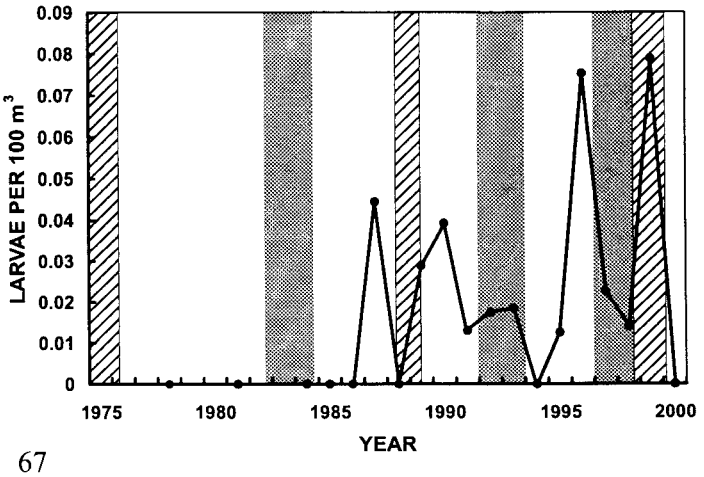

CalCOFI: 1977 - 1984
Total Larvae 2
San Diego
.2
.1
Average Larvae per 100 m³

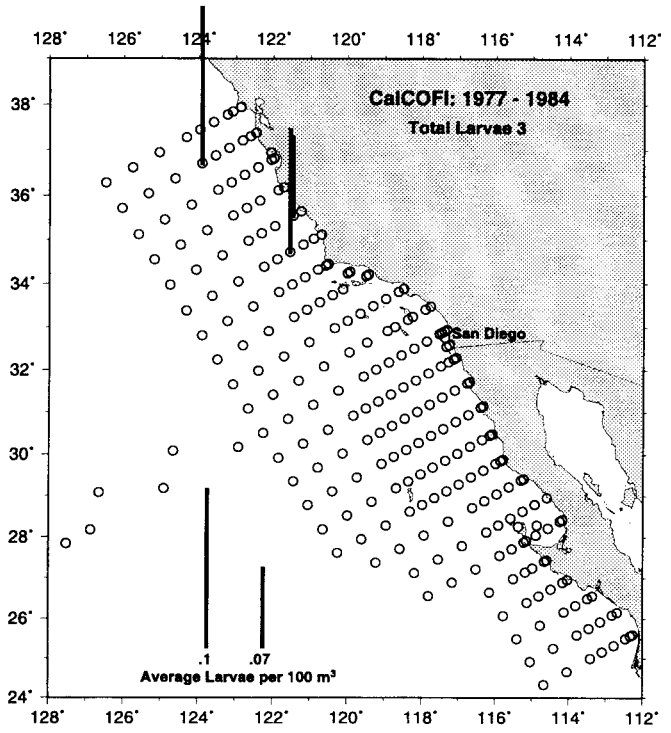

CalCOFI: 1977 - 2000
Total Larvae 20
San Diego
.01
.03
.05
.1
Average Larvae per 100 m³

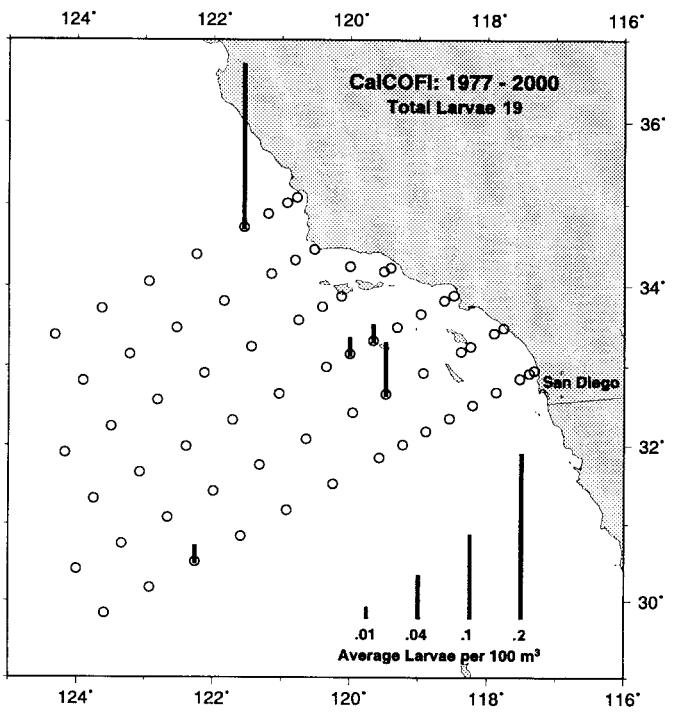

PROPORTION POSITIVE
MONTH

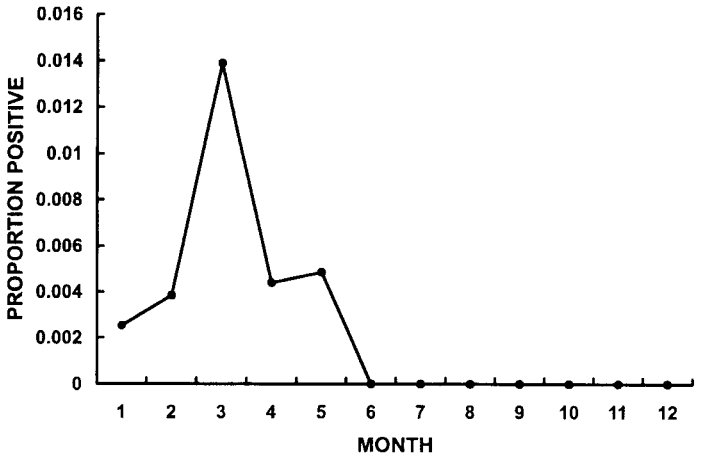

LARVAE PER 100 m³
MONTH

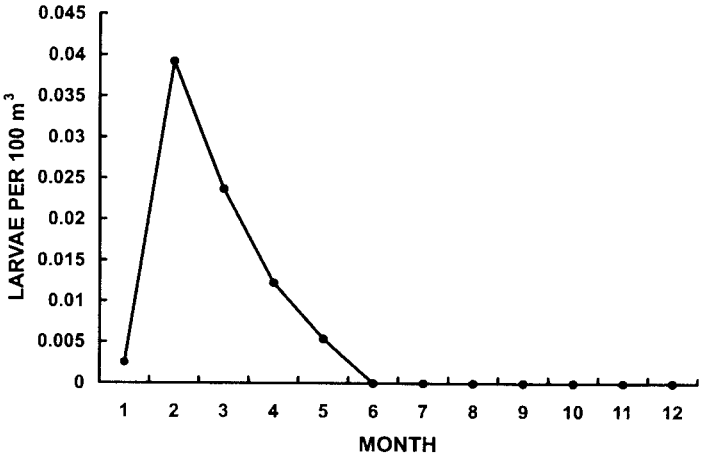

PROPORTION POSITIVE
YEAR

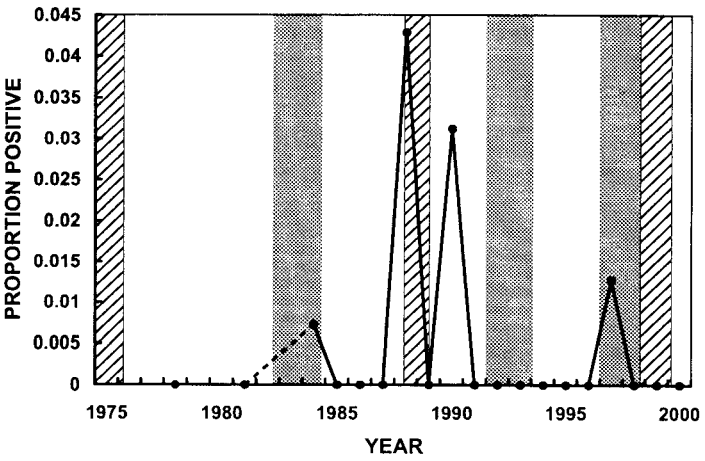

LARVAE PER 100 m³
YEAR

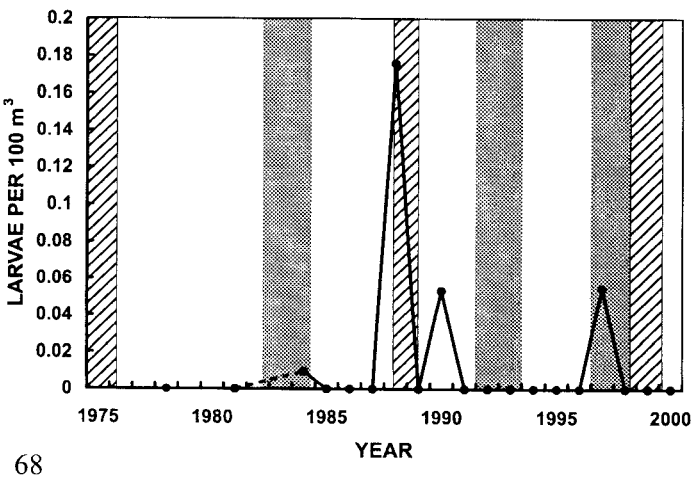

CalCOFI: 1977 - 1984
Total Larvae 3
San Diego
.1 .07
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 19
San Diego
.01 .04 .1 .2
Average Larvae per 100 m³

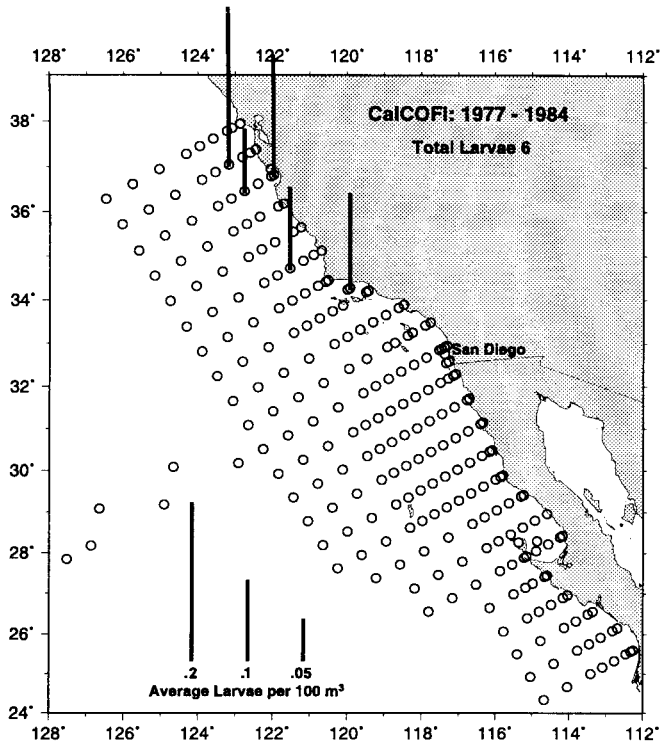

PROPORTION POSITIVE
MONTH

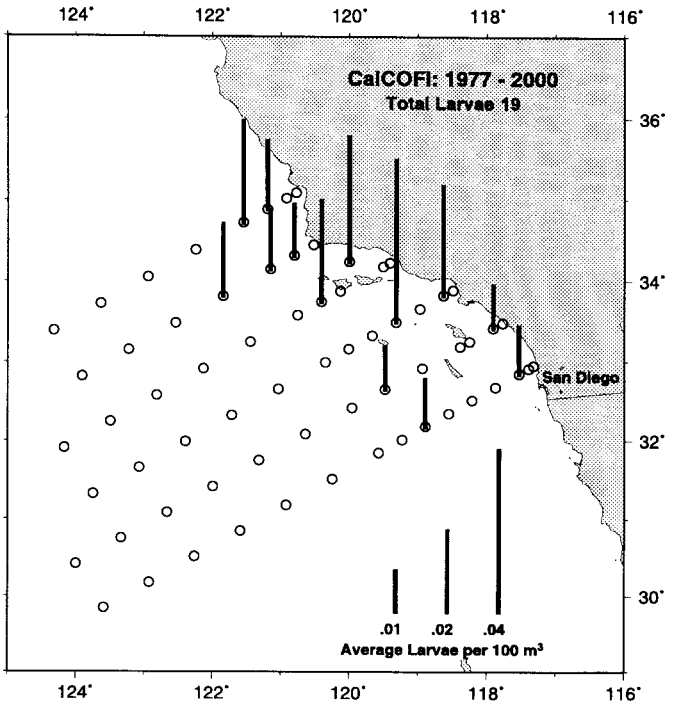

LARVAE PER 100 m³
MONTH

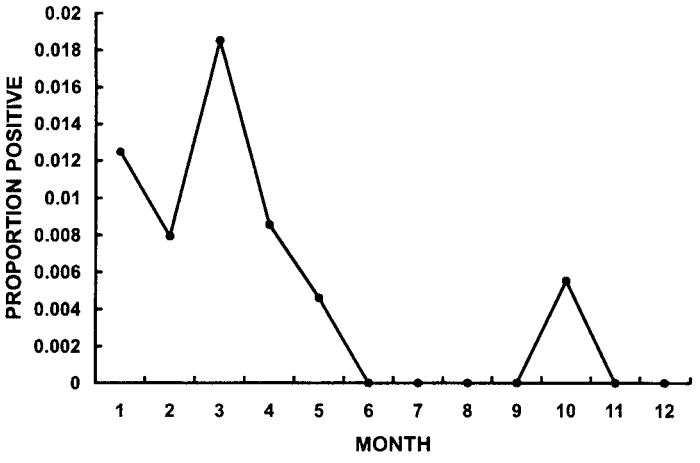

PROPORTION POSITIVE
YEAR

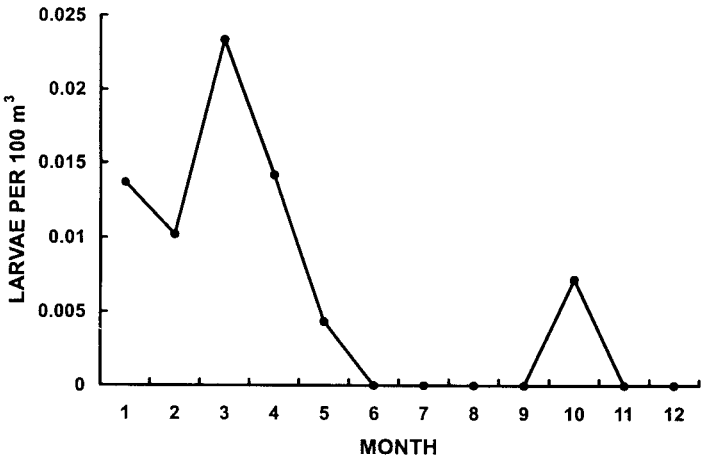

LARVAE PER 100 m³
YEAR

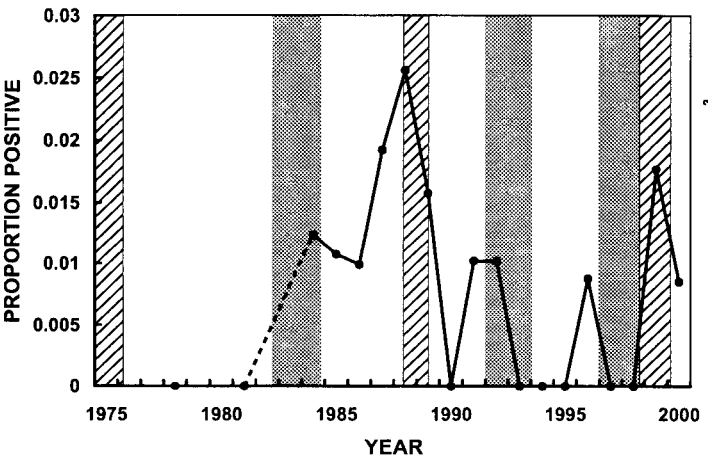
PLEURONECTIDAE Curlfin turbot ***Pleuronichthys decurrens***

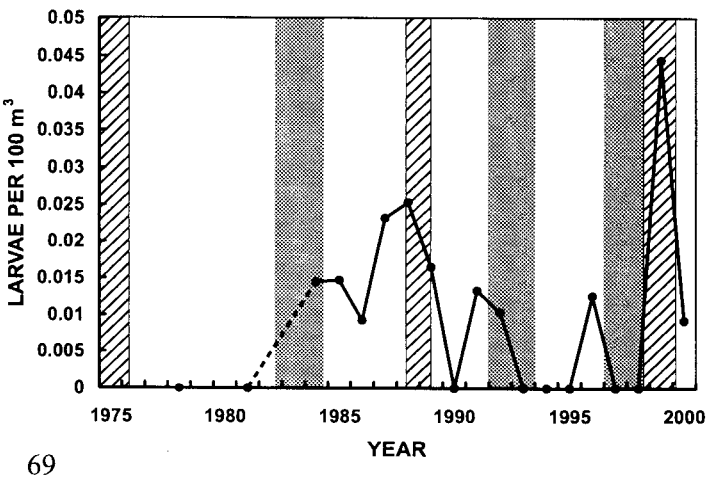


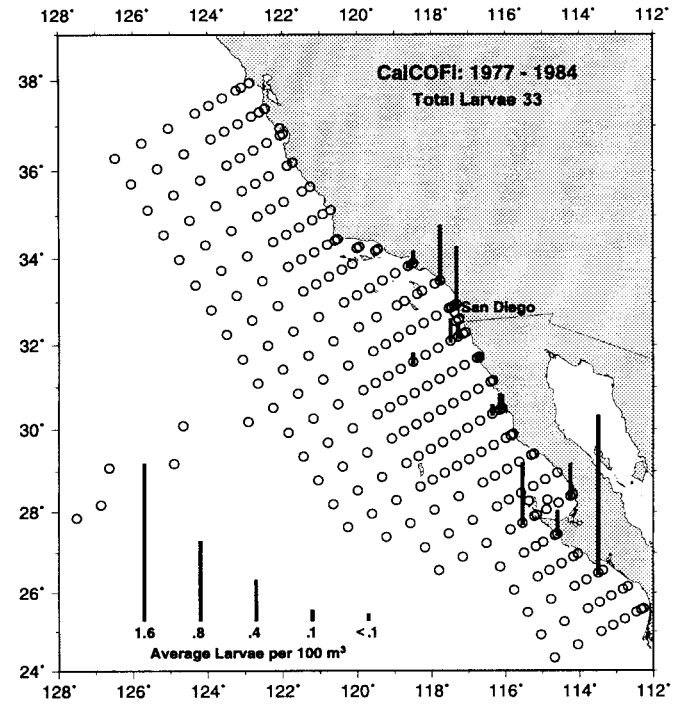



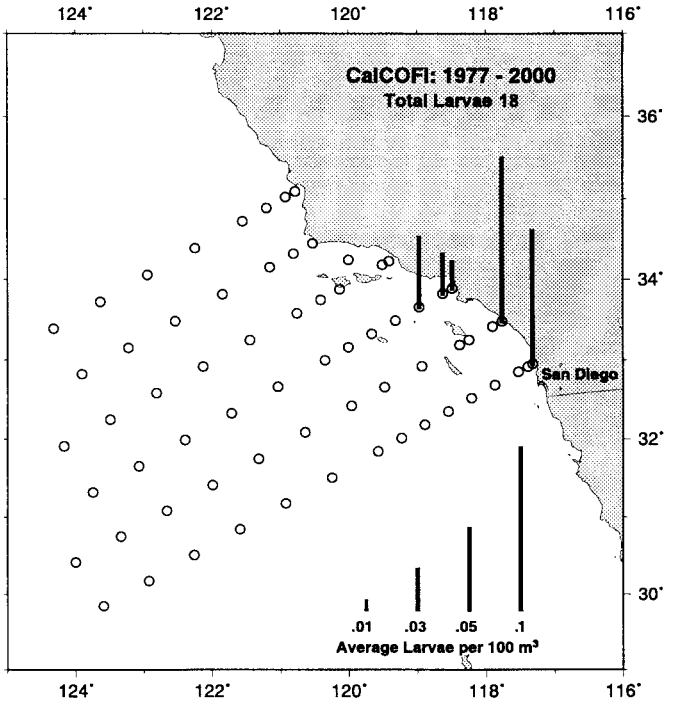



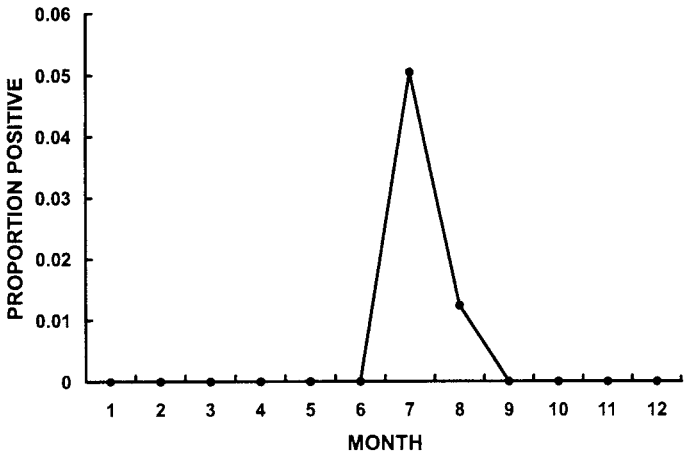



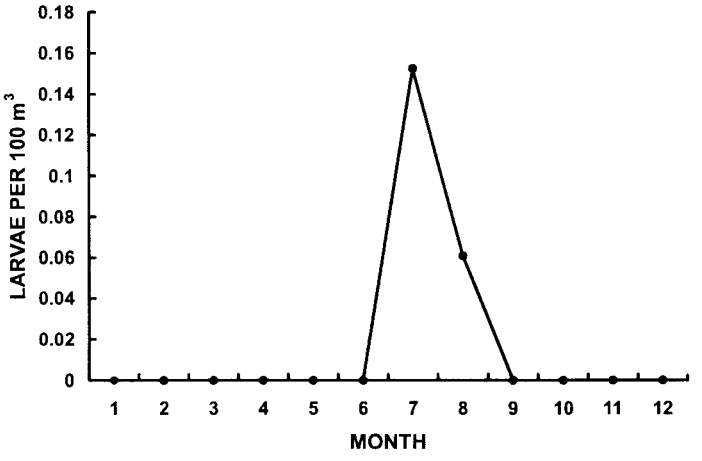



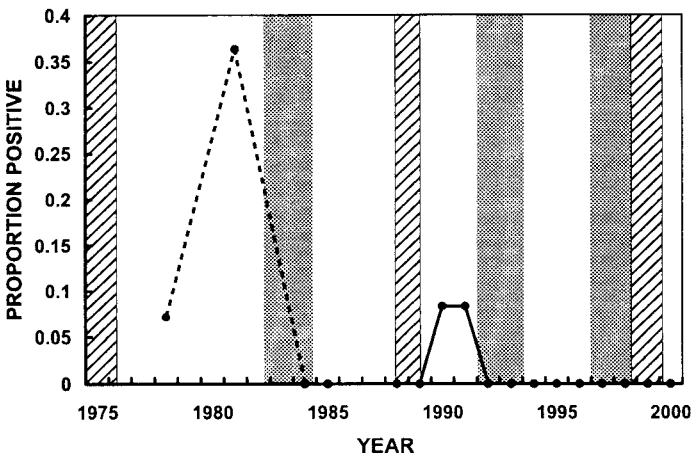



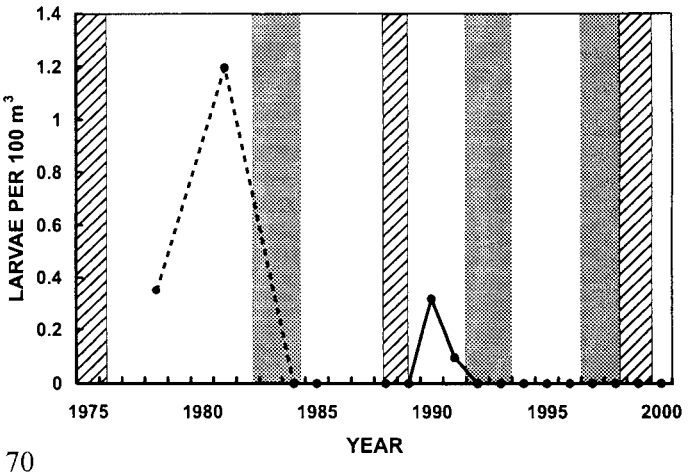

CalCOFI: 1977 - 1984
Total Larvae 33
San Diego
1.6 .8 .4 .1 <.1
Average Larvae per 100 m³

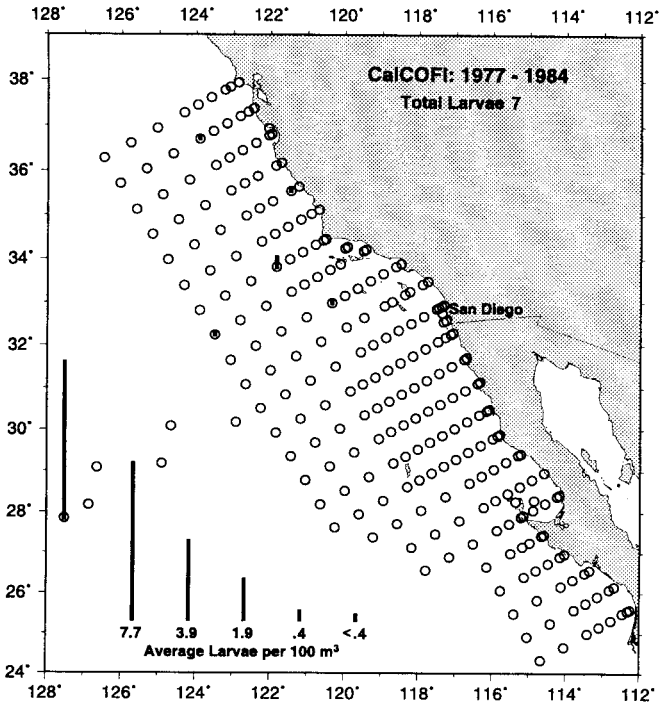

CalCOFI: 1977 - 2000
Total Larvae 18
San Diego
.01 .03 .05 .1
Average Larvae per 100 m³

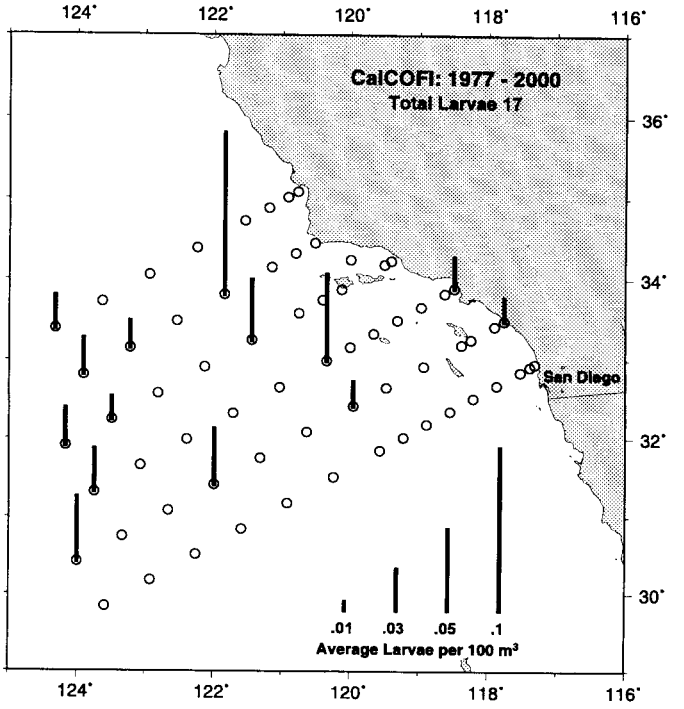

PROPORTION POSITIVE
MONTH

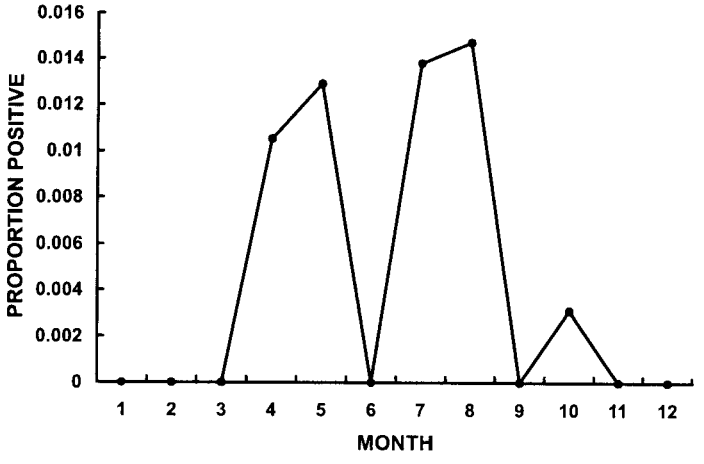

LARVAE PER 100 m³
MONTH

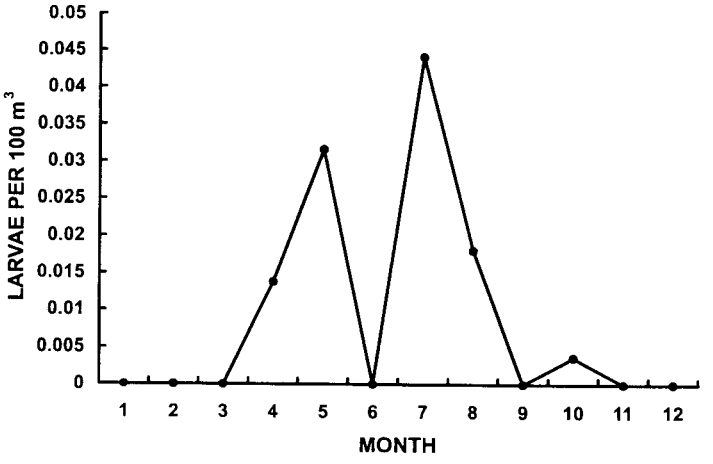

PROPORTION POSITIVE
YEAR

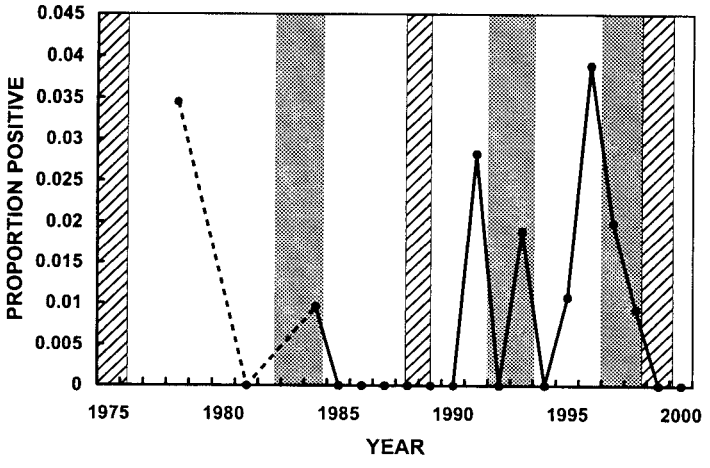

LARVAE PER 100 m³
YEAR

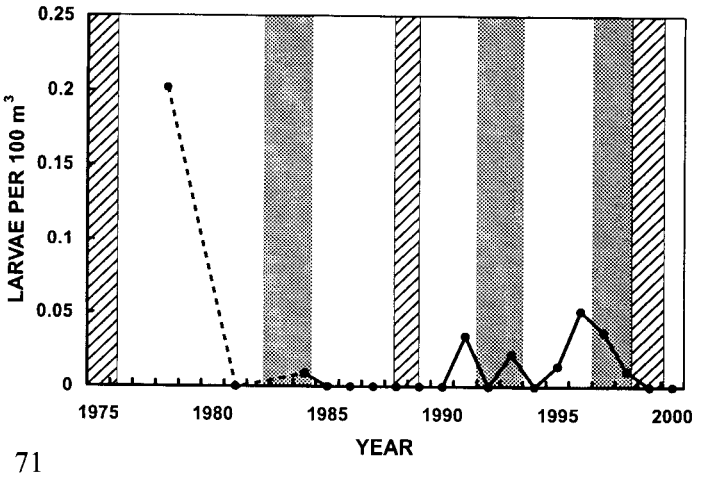

CalCOFI: 1977 - 1984
Total Larvae 7
San Diego
7.7 3.9 1.9 .4 <.4
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 17
San Diego
.01 .03 .05 .1
Average Larvae per 100 m³

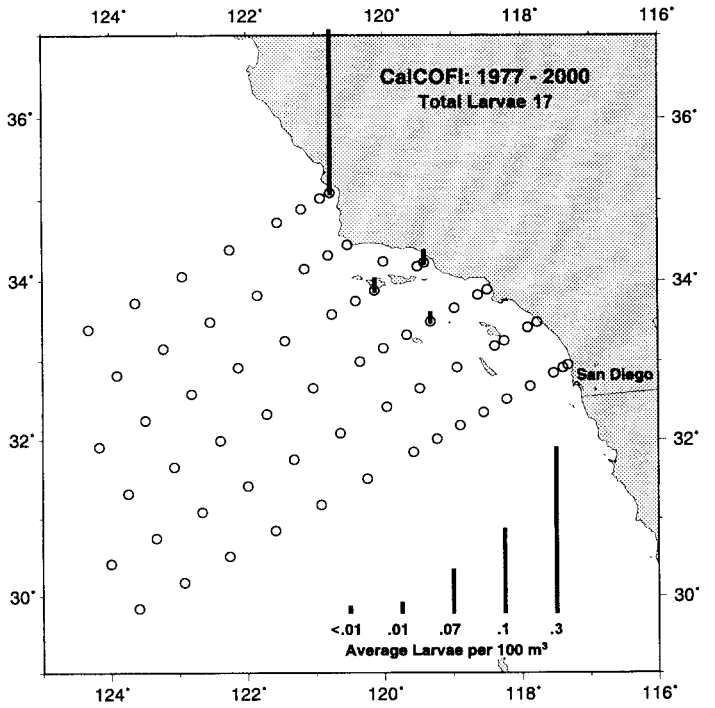

PROPORTION POSITIVE
MONTH

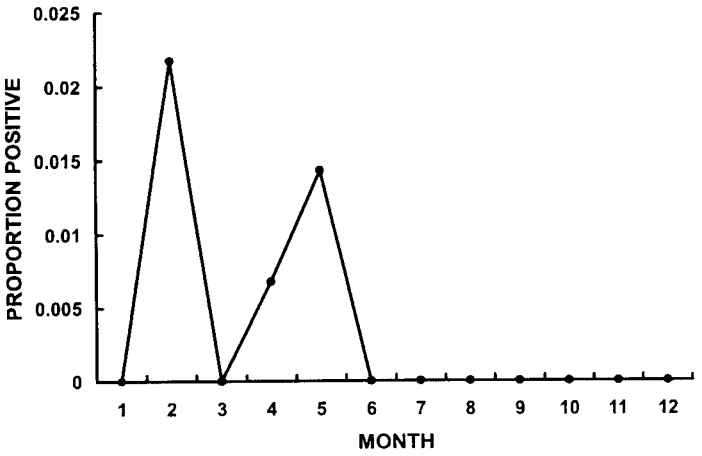

LARVAE PER 100 m³
MONTH

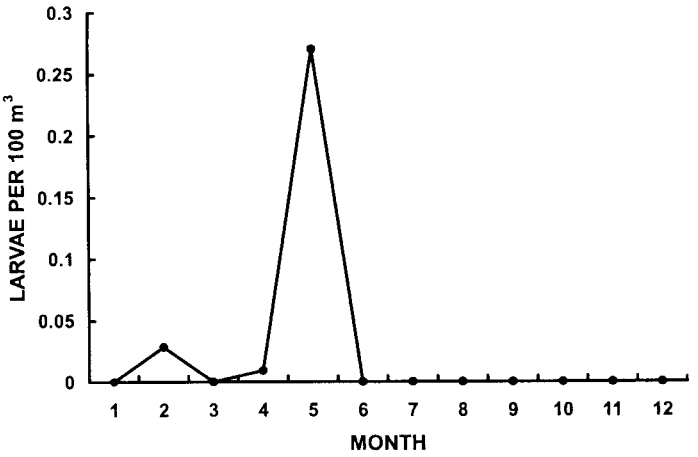

PROPORTION POSITIVE
YEAR

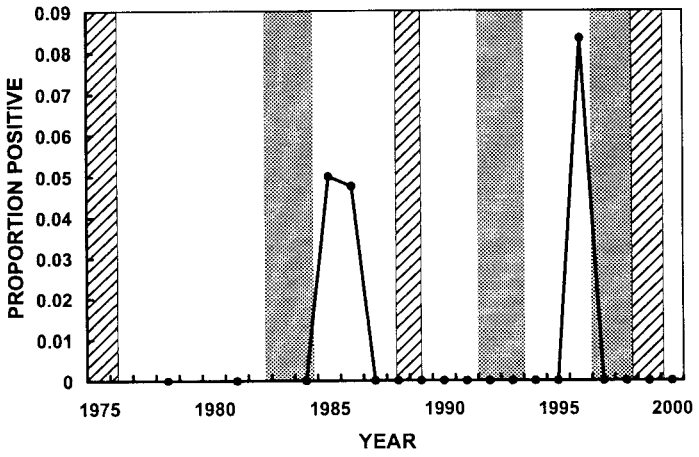

LARVAE PER 100 m³
YEAR

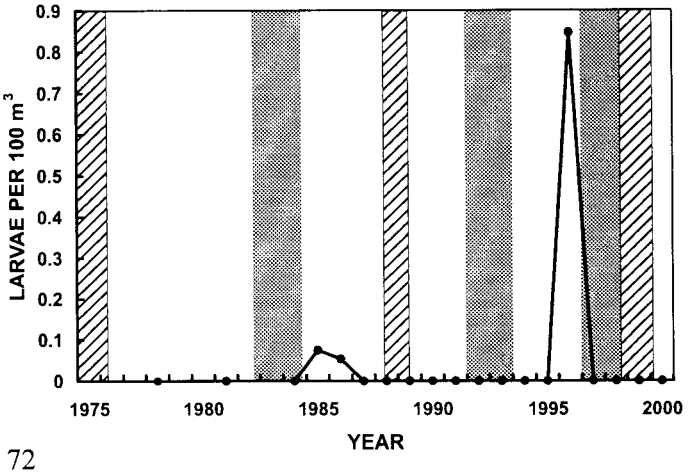
***Rathbunella alleni*** Rough ronquil BATHYMASTERIDAE

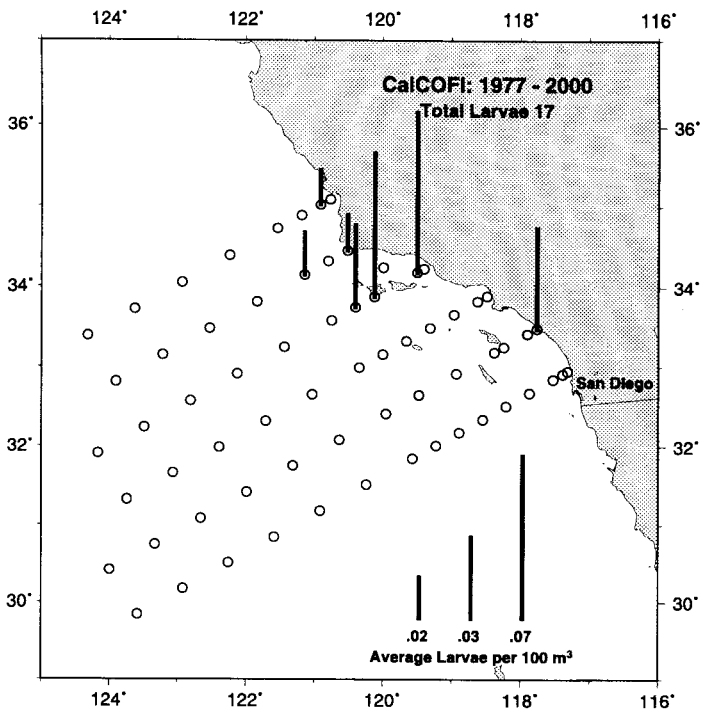


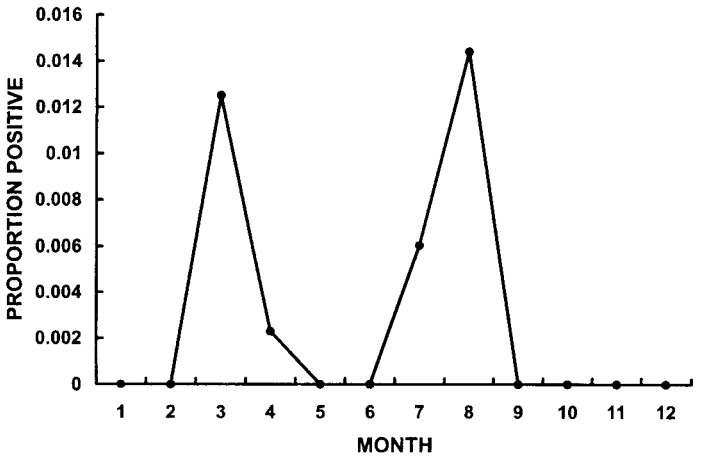



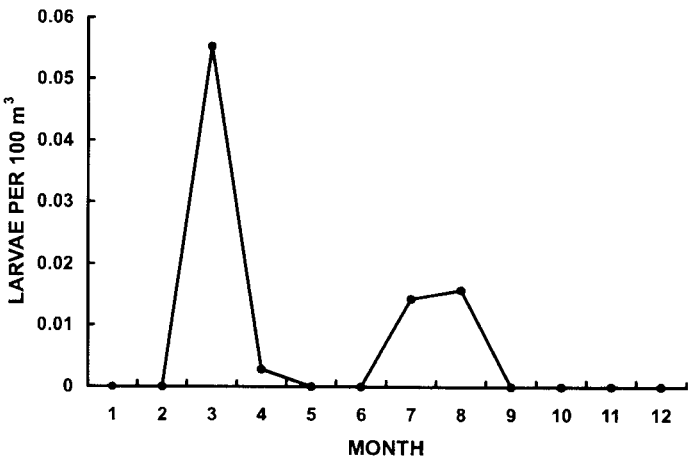



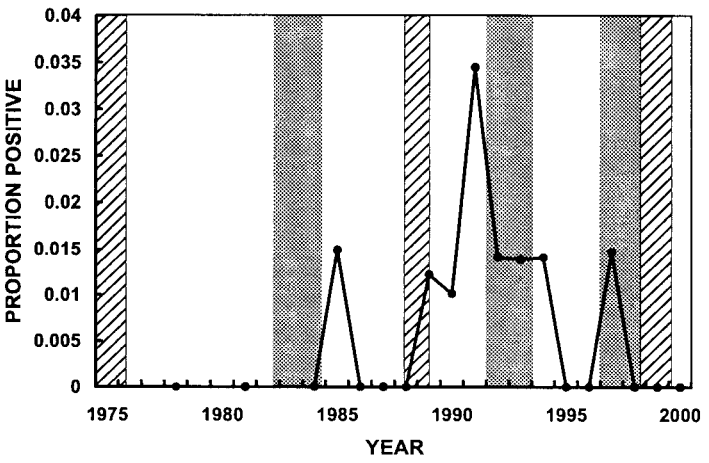



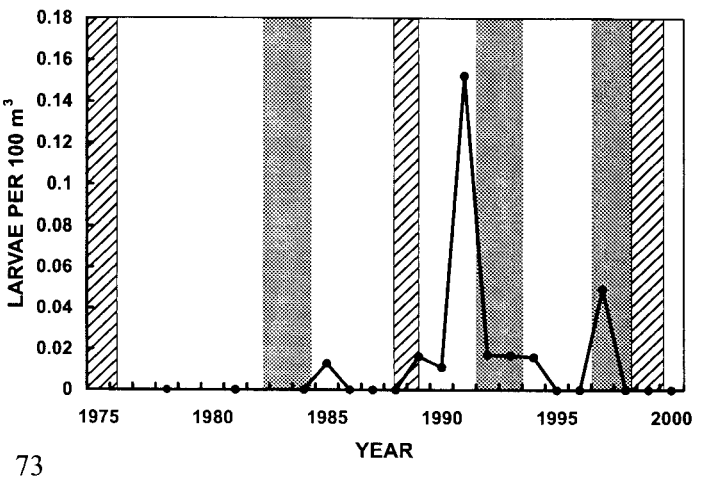



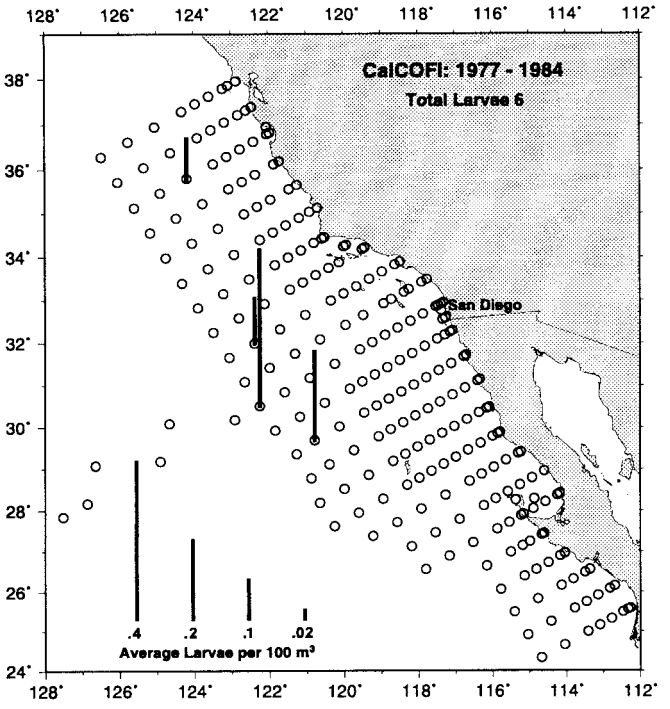

124°
122°
120°
118°
116°
36°
34°
32°
30°
CalCOFI: 1977 - 2000
Total Larvae 17
San Diego
.02
.03
.07
Average Larvae per 100 m³

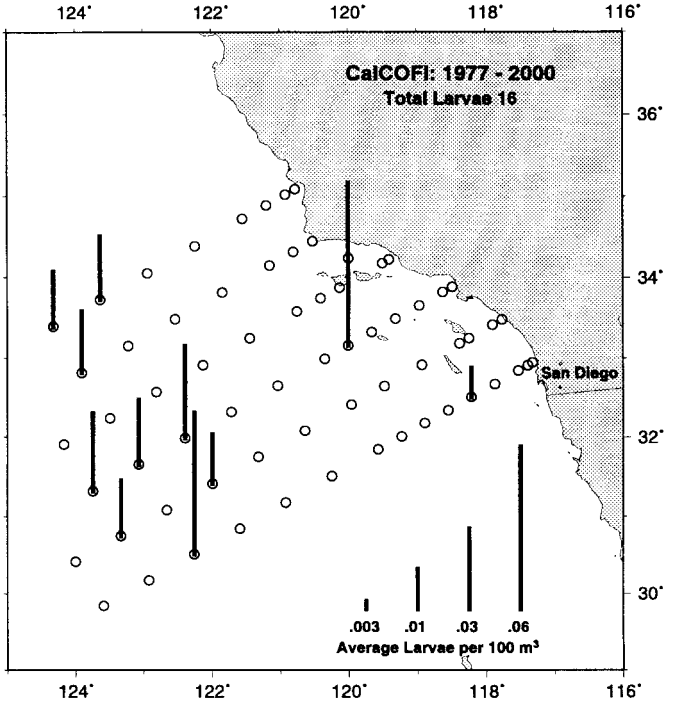

PROPORTION POSITIVE
0.016
0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
1 2 3 4 5 6 7 8 9 10 11 12
MONTH

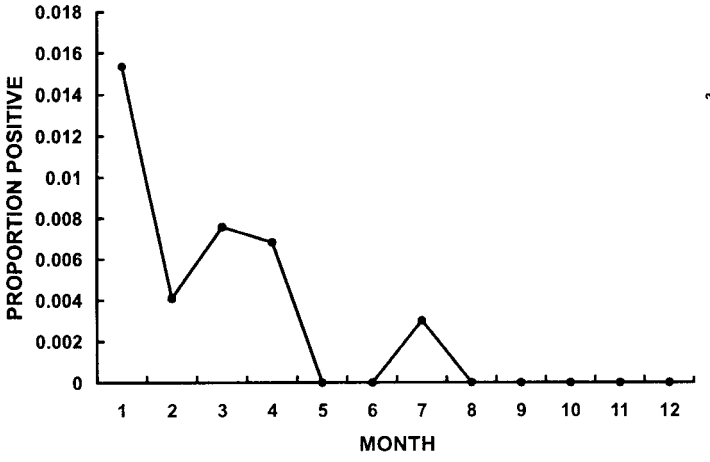

LARVAE PER 100 m³
0.06
0.05
0.04
0.03
0.02
0.01
0
1 2 3 4 5 6 7 8 9 10 11 12
MONTH

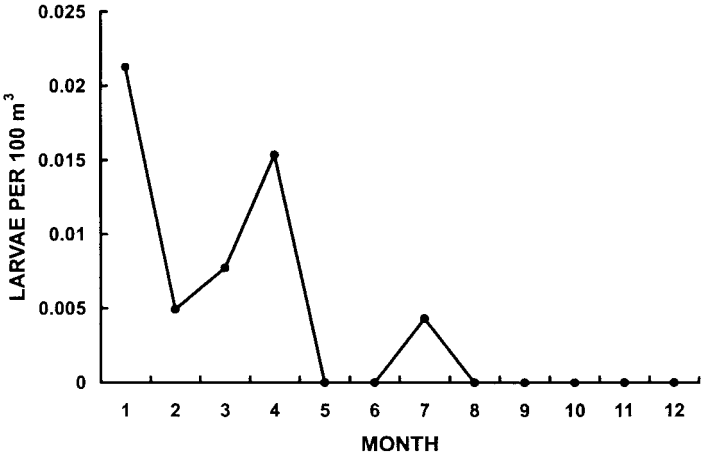

PROPORTION POSITIVE
0.04
0.035
0.03
0.025
0.02
0.015
0.01
0.005
0
1975 1980 1985 1990 1995 2000
YEAR

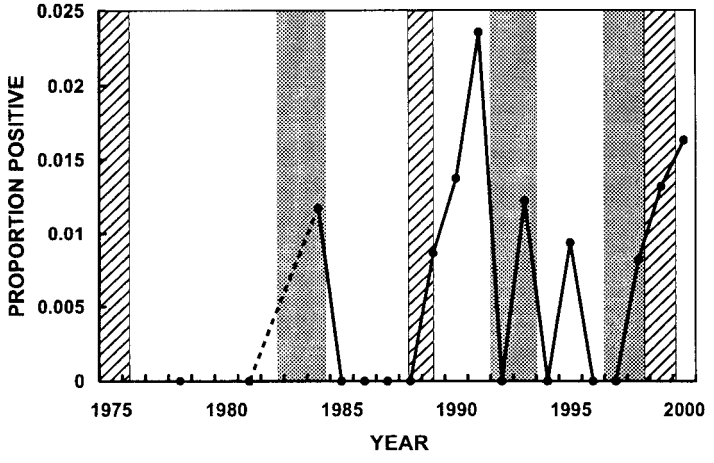

LARVAE PER 100 m³
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1975 1980 1985 1990 1995 2000
YEAR

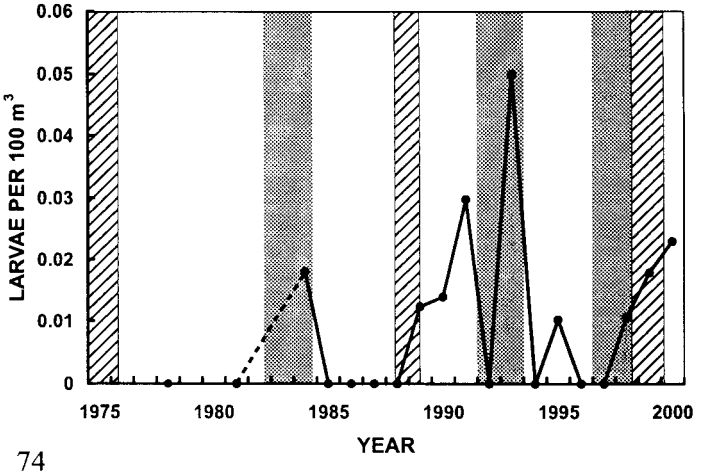

CalCOFI: 1977 - 1984
Total Larvae 6
San Diego
.4 .2 .1 .02
Average Larvae per 100 m³

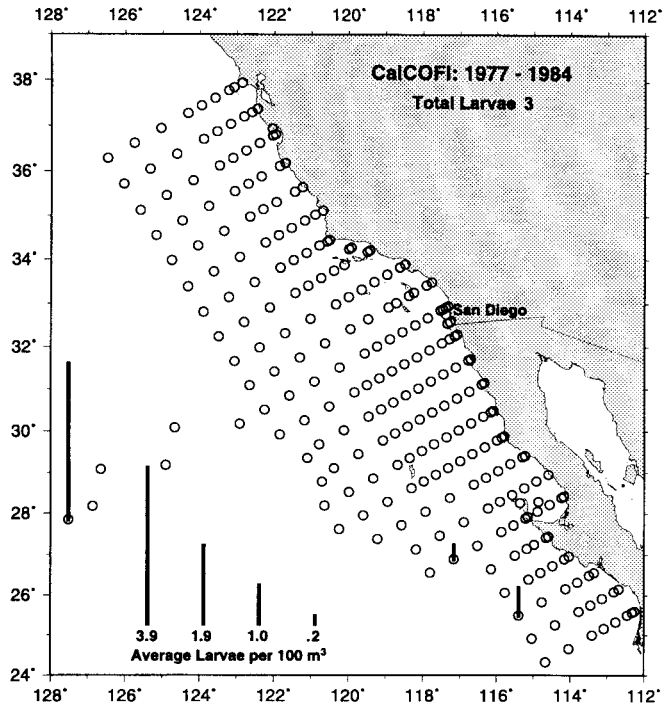

CalCOFI: 1977 - 2000
Total Larvae 16
San Diego
.003 .01 .03 .06
Average Larvae per 100 m³

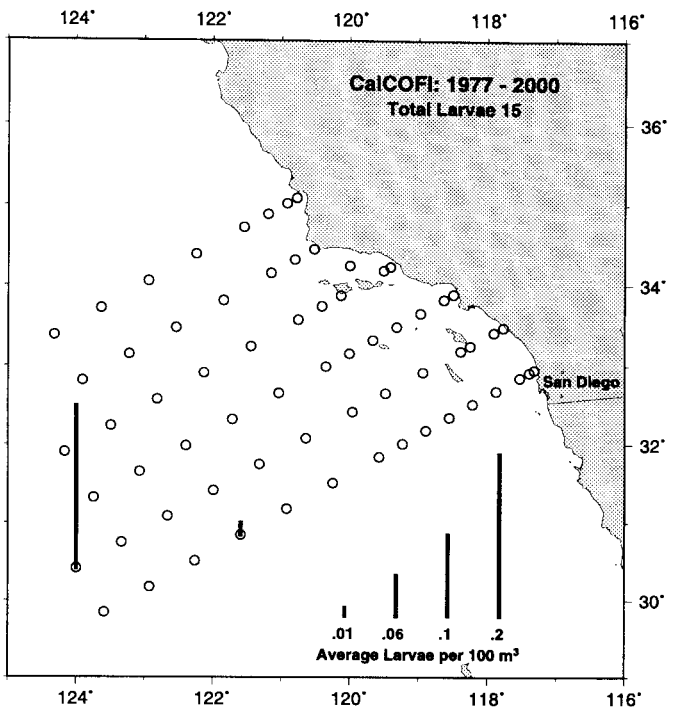

PROPORTION POSITIVE
MONTH

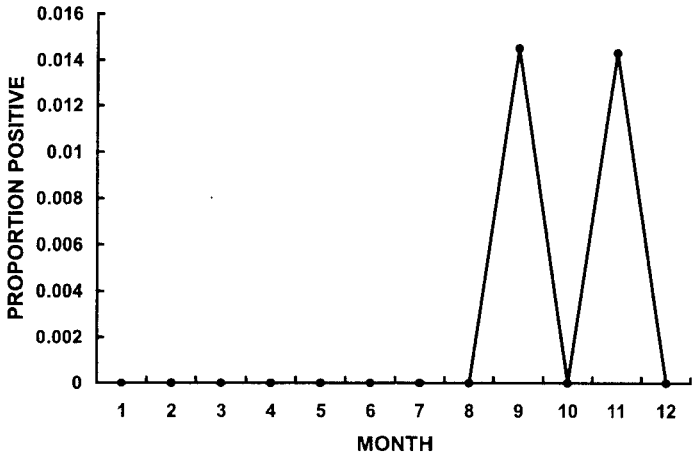

LARVAE PER 100 m³
MONTH

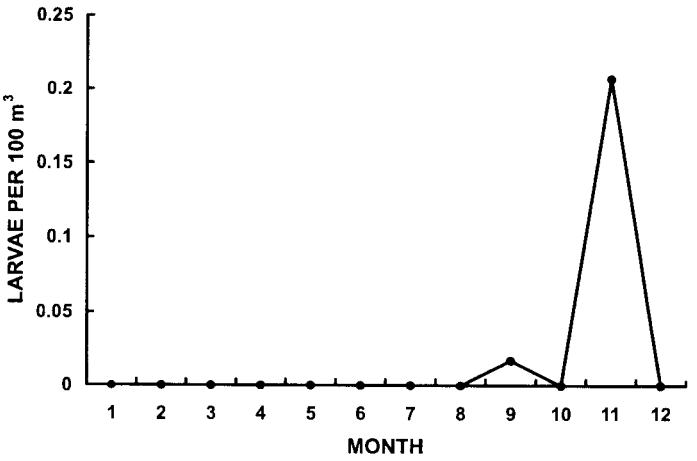

PROPORTION POSITIVE
YEAR

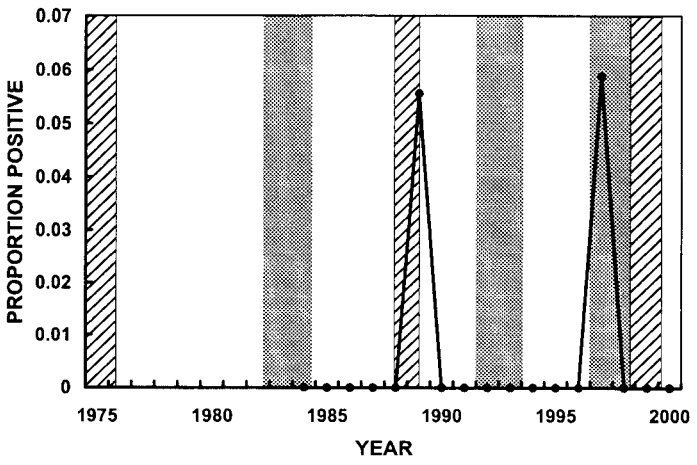

LARVAE PER 100 m³
YEAR

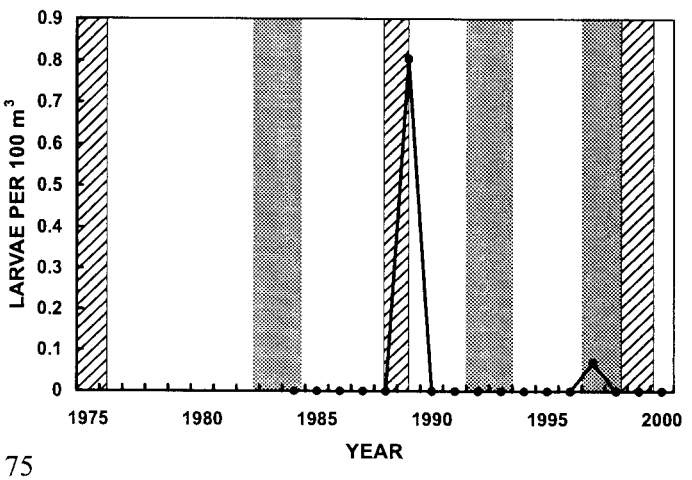

CalCOFI: 1977 - 1984
Total Larvae 3
San Diego
3.9 1.9 1.0 .2
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 15
San Diego
.01 .06 .1 .2
Average Larvae per 100 m³

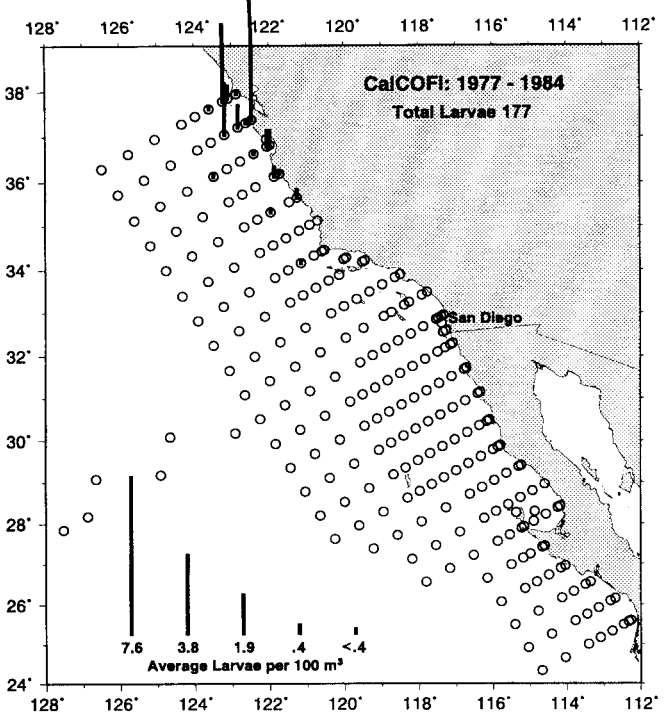

PROPORTION POSITIVE
MONTH

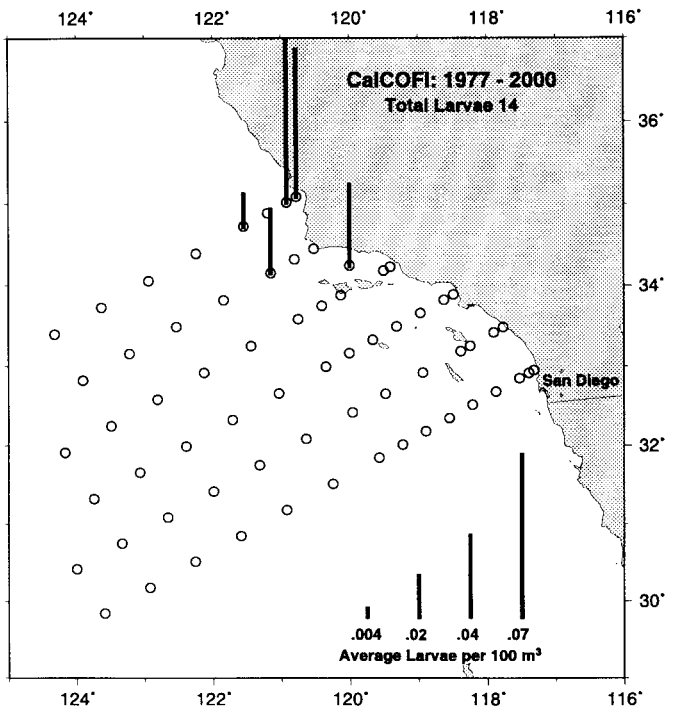

LARVAE PER 100 m³
MONTH

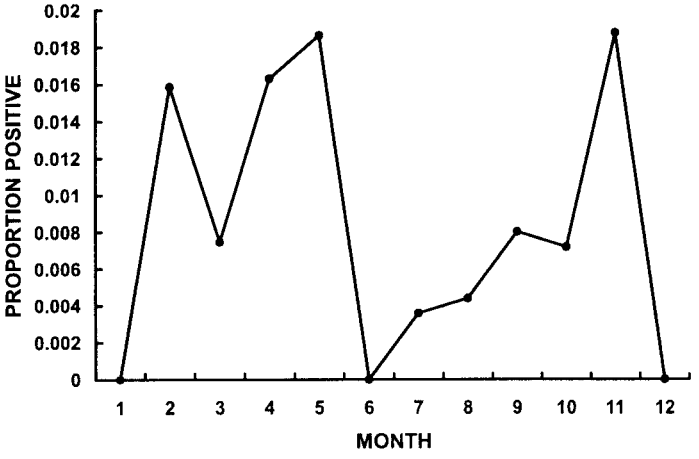

PROPORTION POSITIVE
YEAR

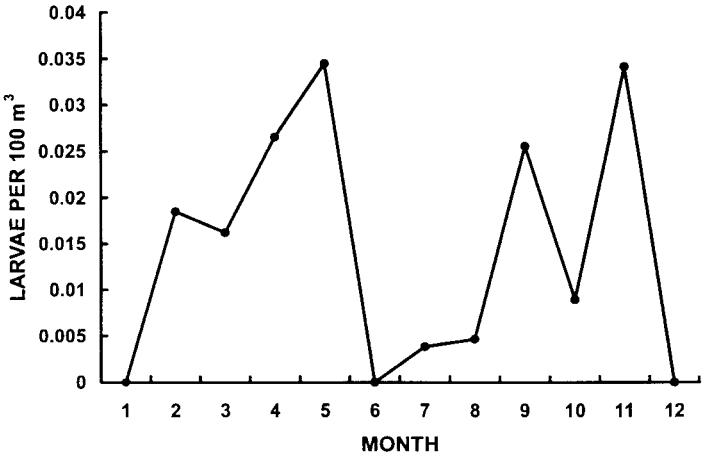

LARVAE PER 100 m³
YEAR

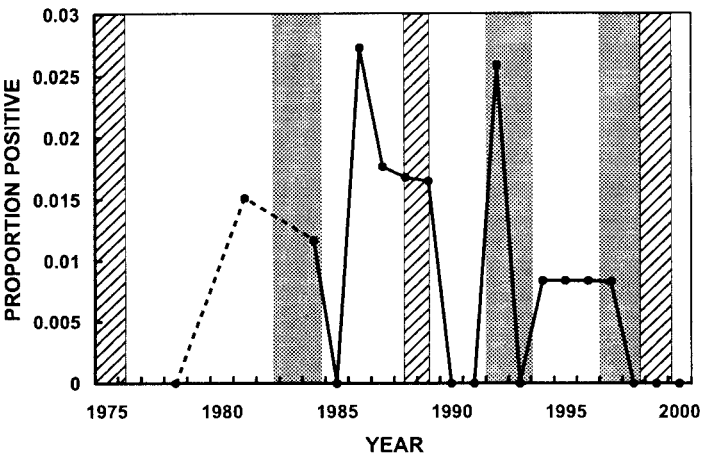
***Hemilepidotus spinosus*** Brown Irish Lord COTTIDAE

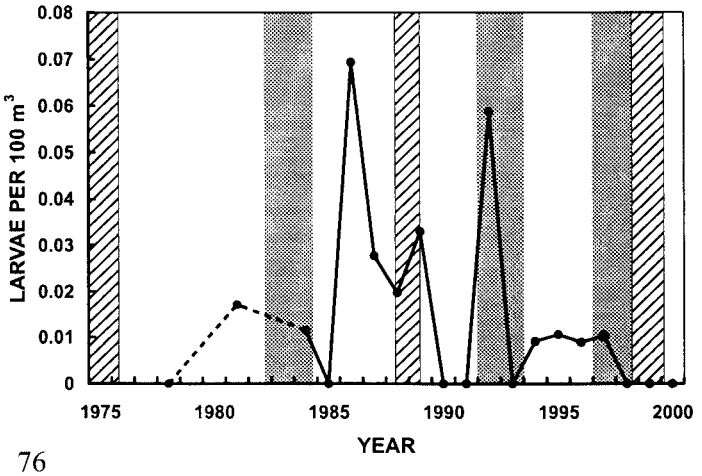


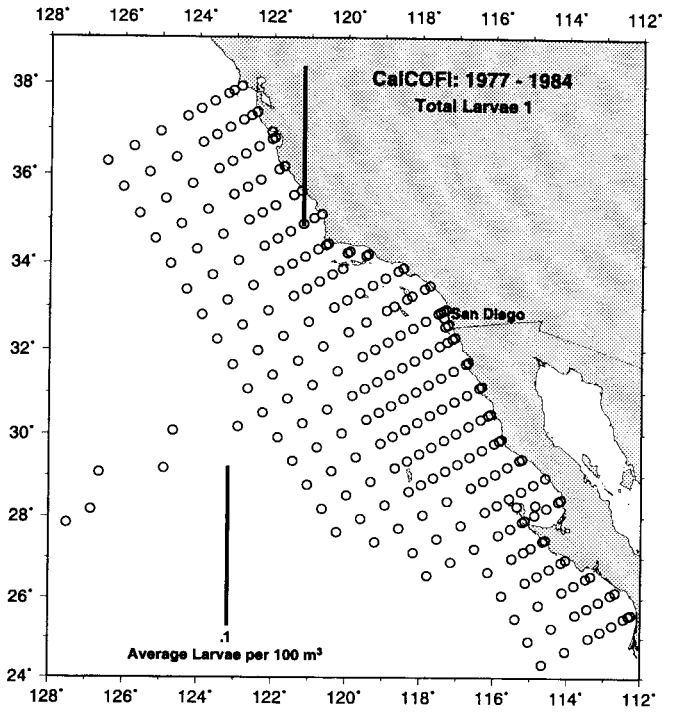



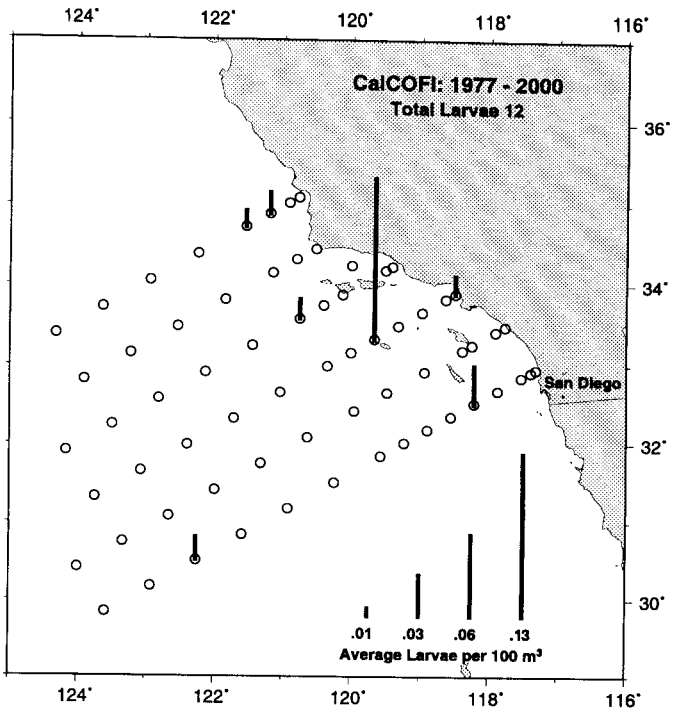



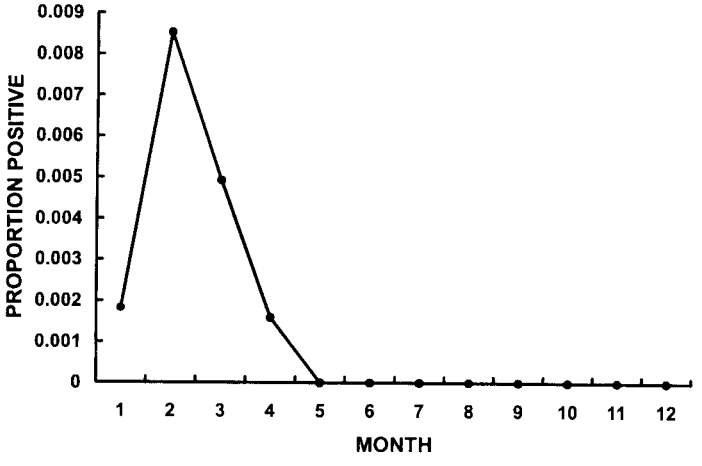



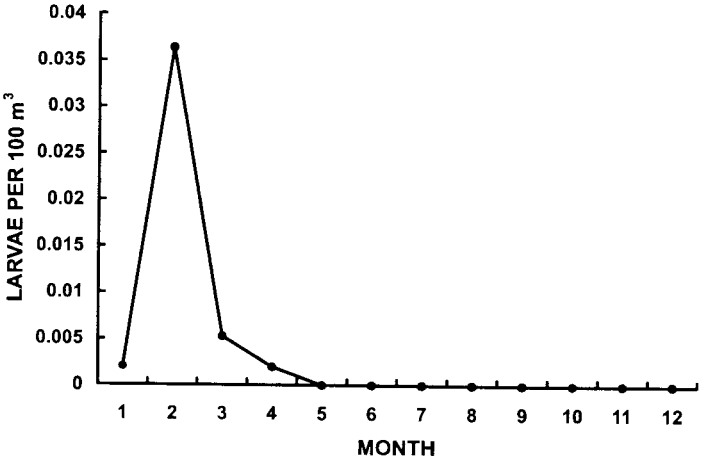



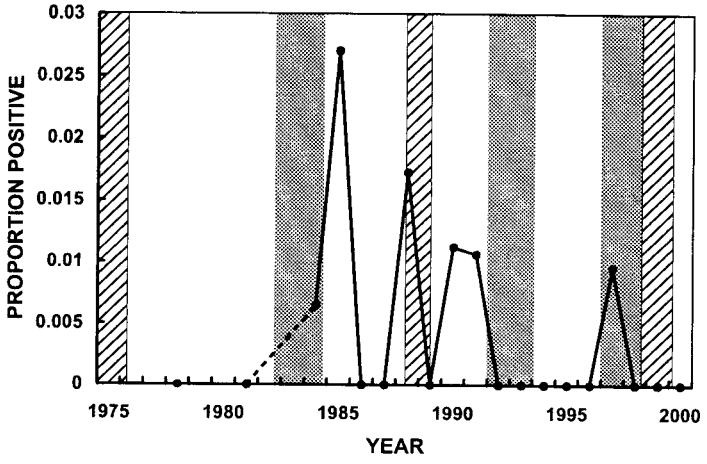
BATHYLAGIDAE California smoothtongue ***Leuroglossus stilbius***

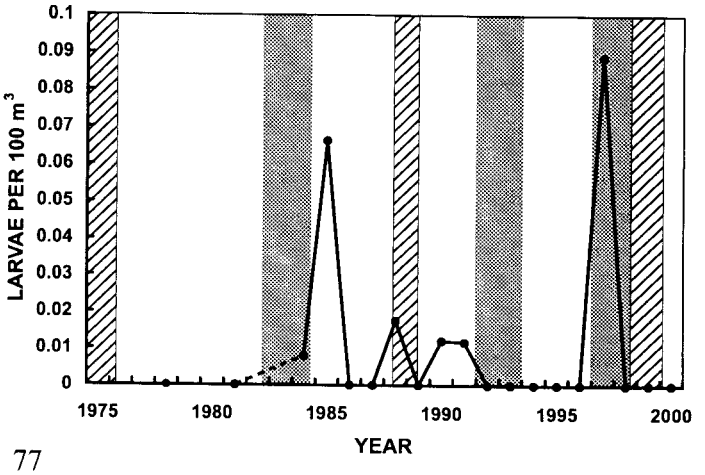


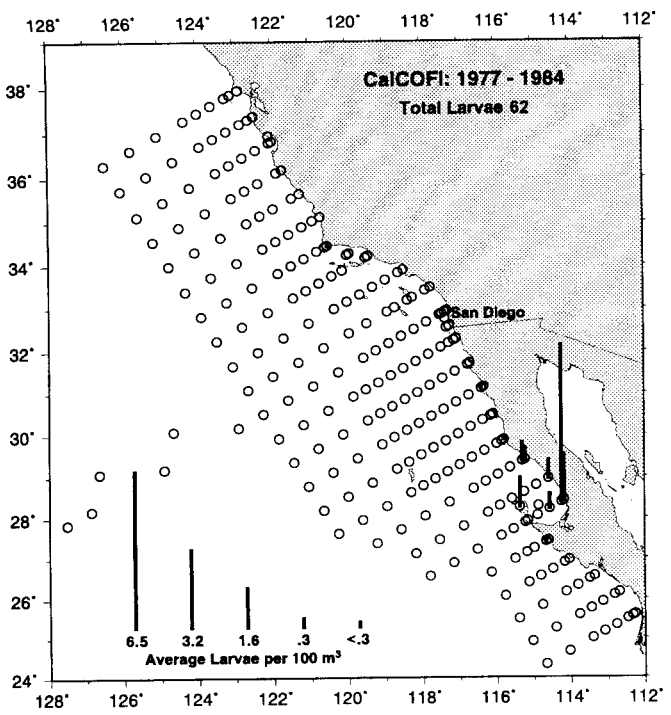



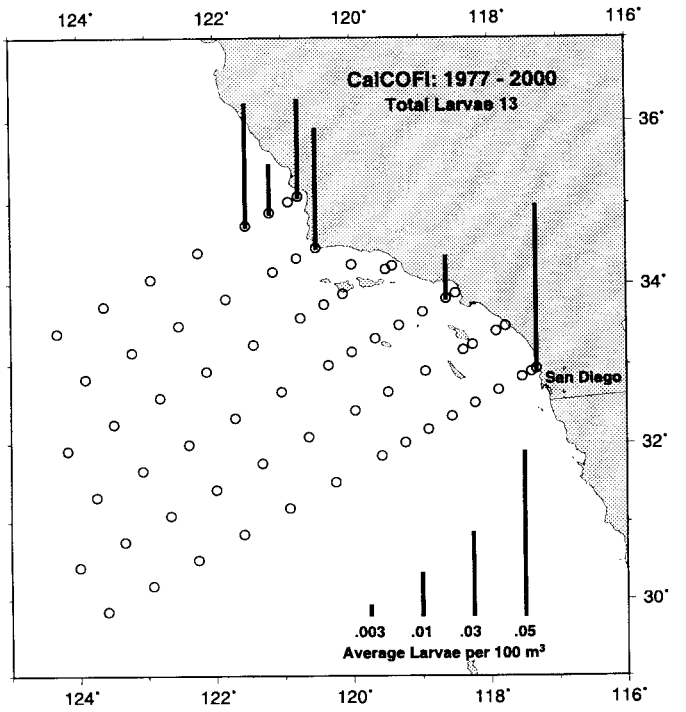



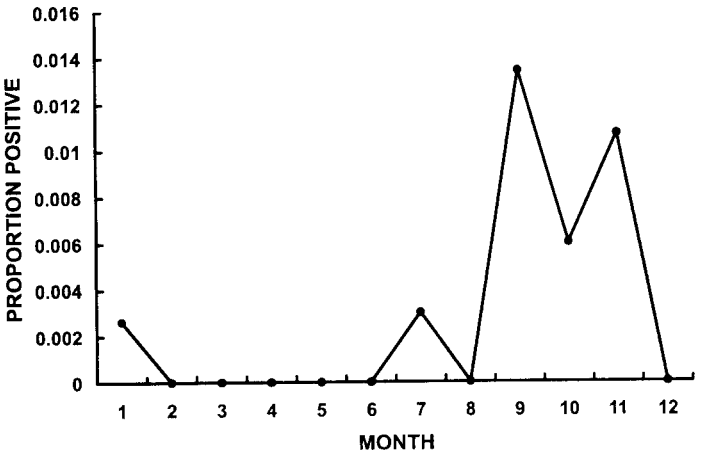



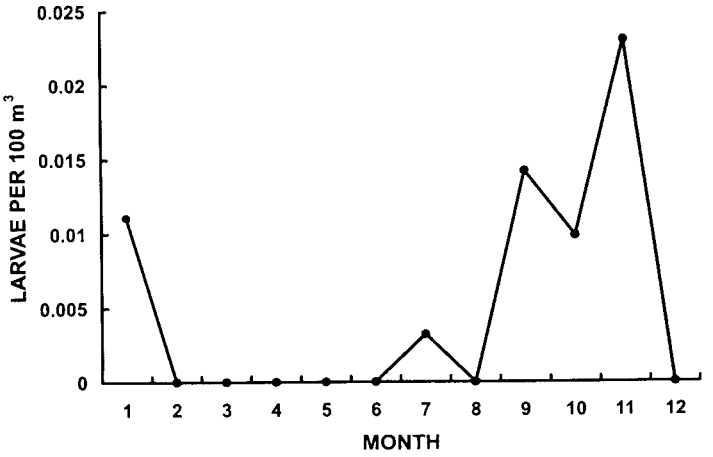



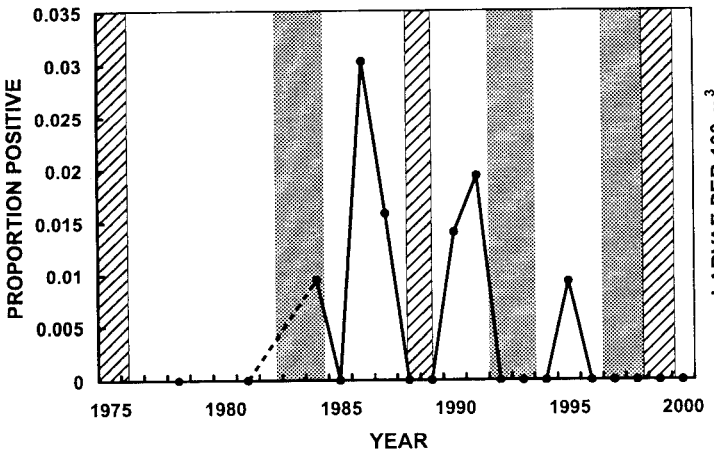



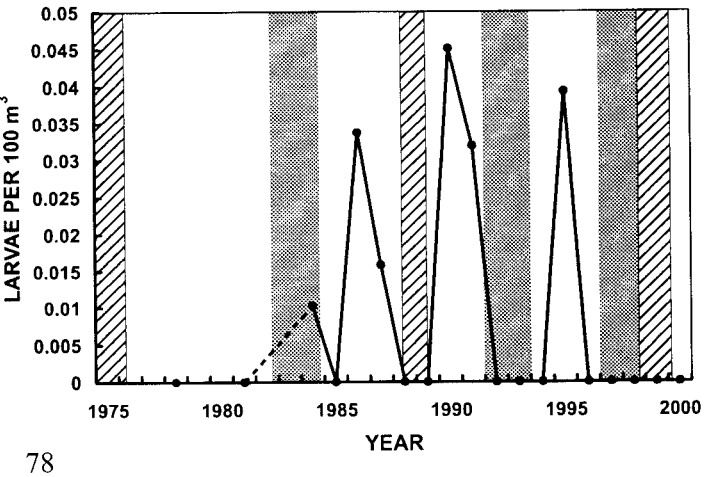

CalCOFI: 1977 - 1984
Total Larvae 62
San Diego
6.5 3.2 1.6 .3 <.3
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 13
San Diego
.003 .01 .03 .05
Average Larvae per 100 m³

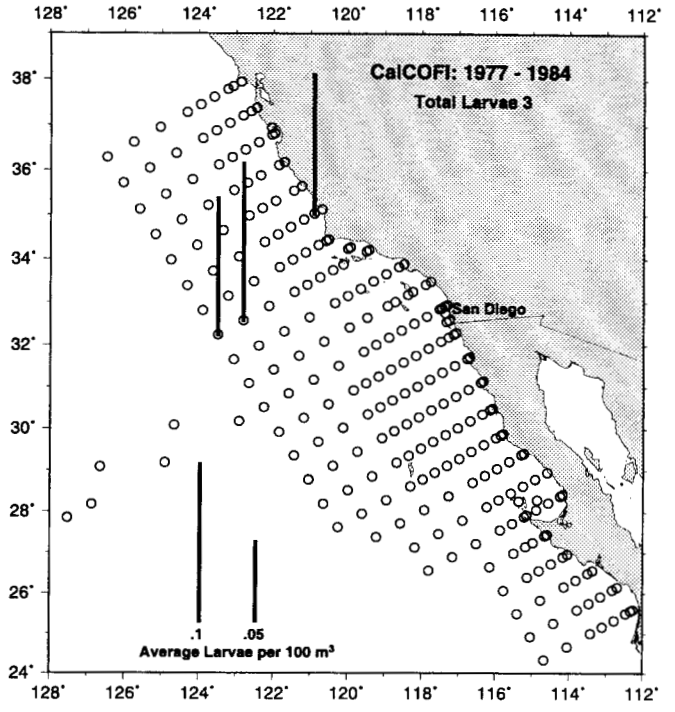

PROPORTION POSITIVE
MONTH

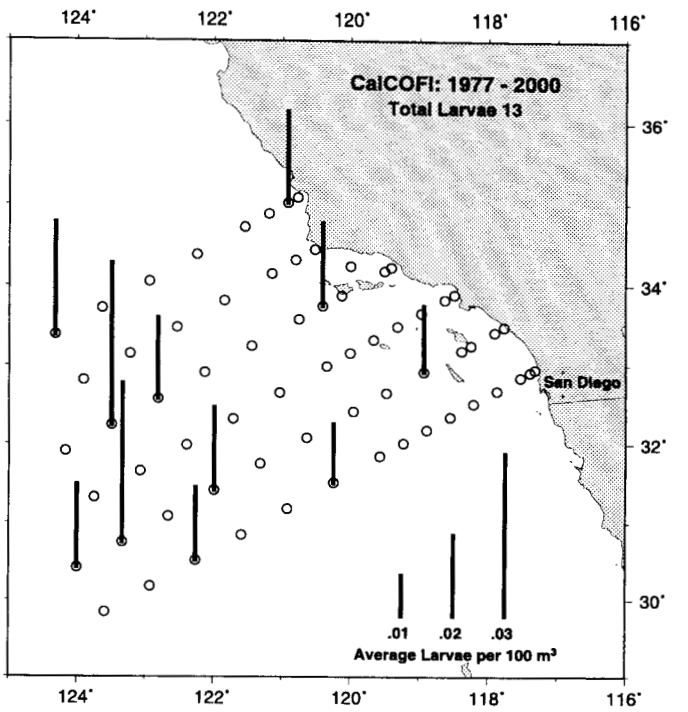

LARVAE PER 100 m³
MONTH

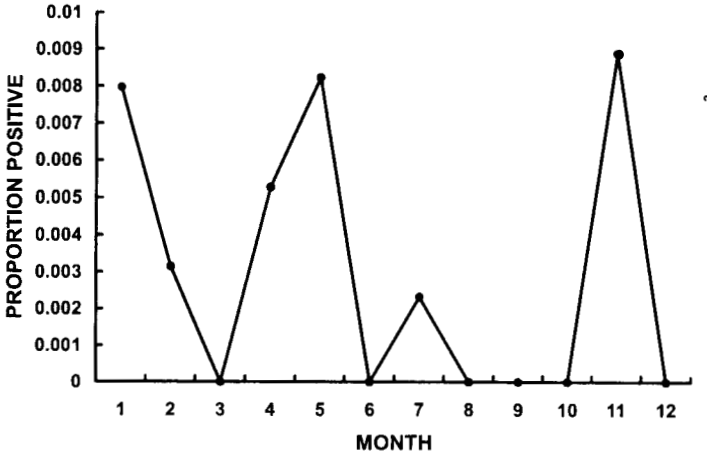

PROPORTION POSITIVE
YEAR

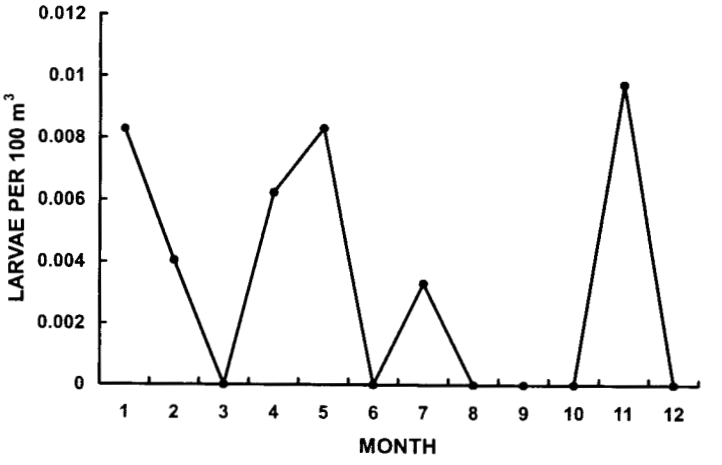

LARVAE PER 100 m³
YEAR

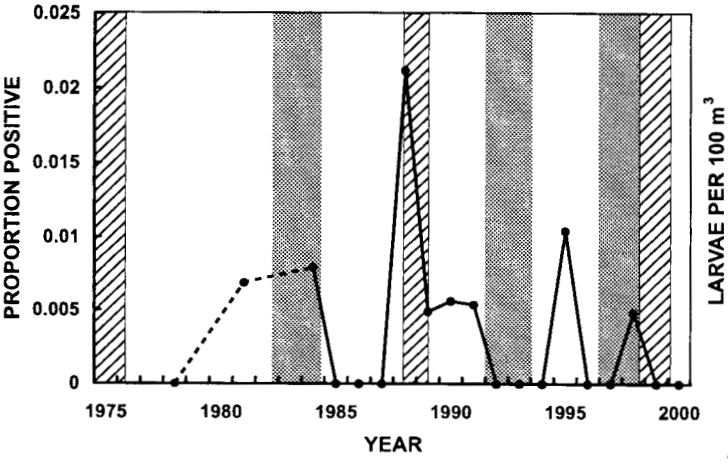
MYCTOPHIDAE Longfin lanternfish ***Diogenichthys atlanticus***

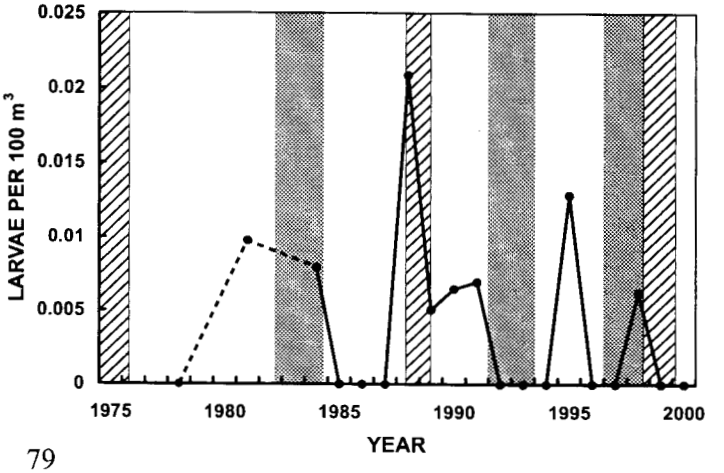


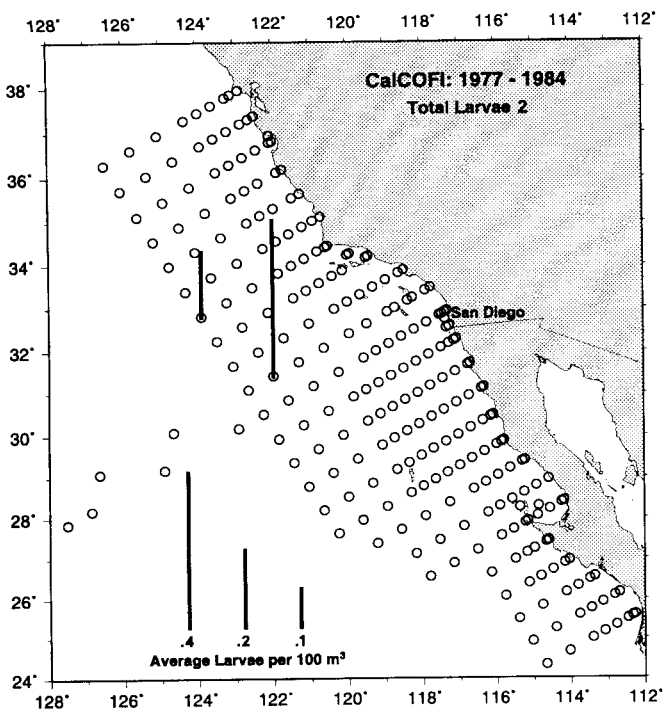



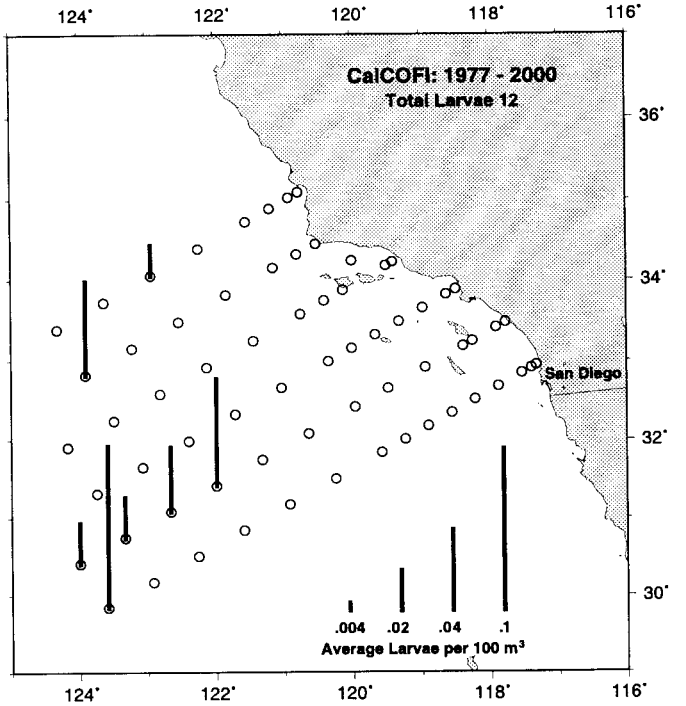



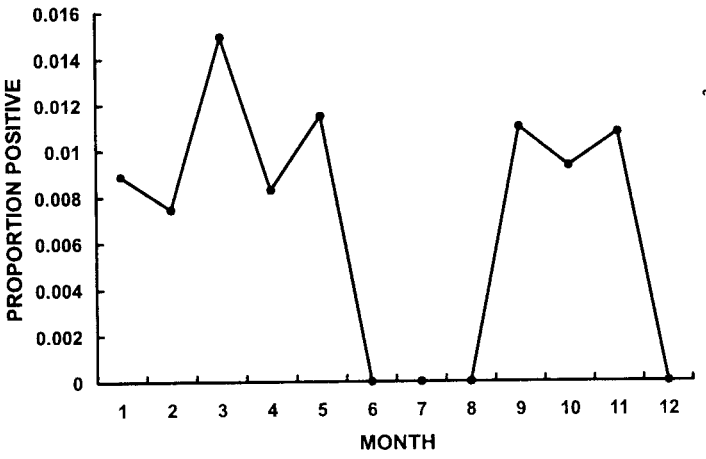



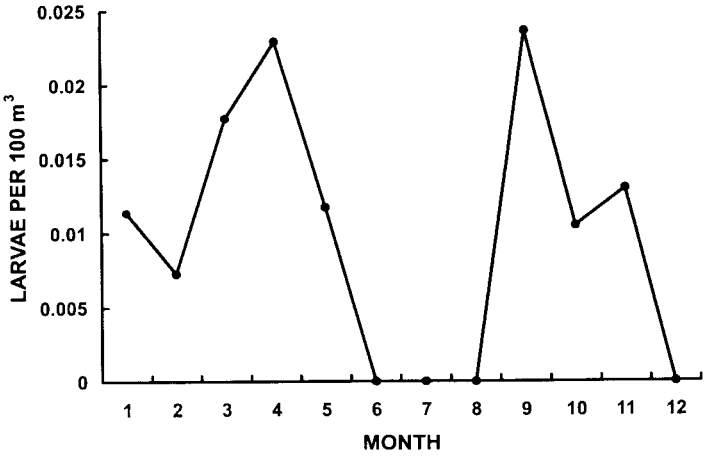



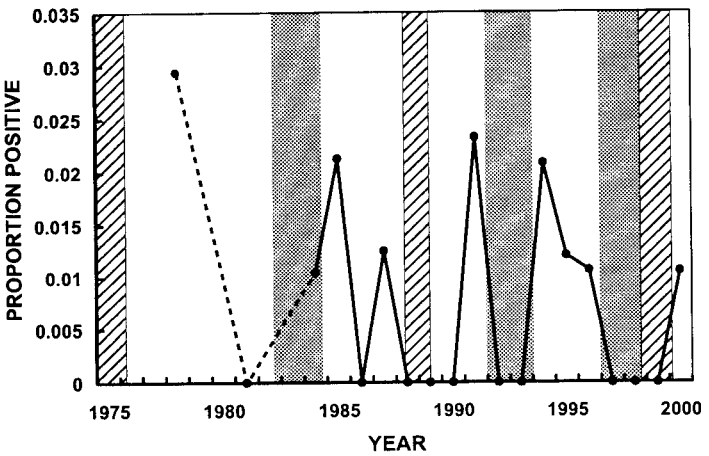
***Bathophilus flemingi*** Highfin dragonfish STOMIIDAE

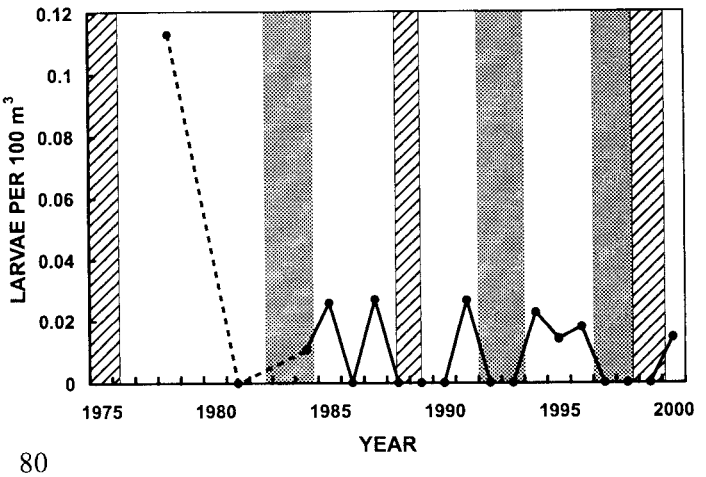


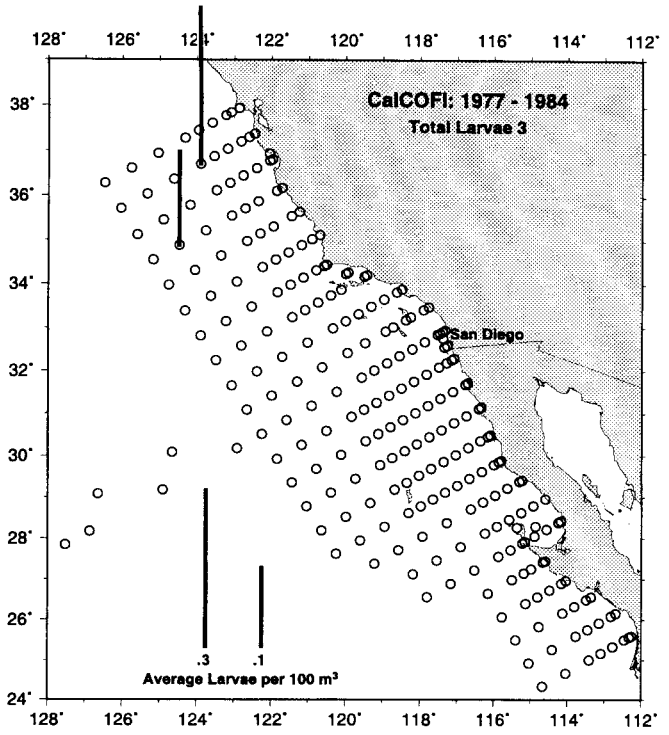



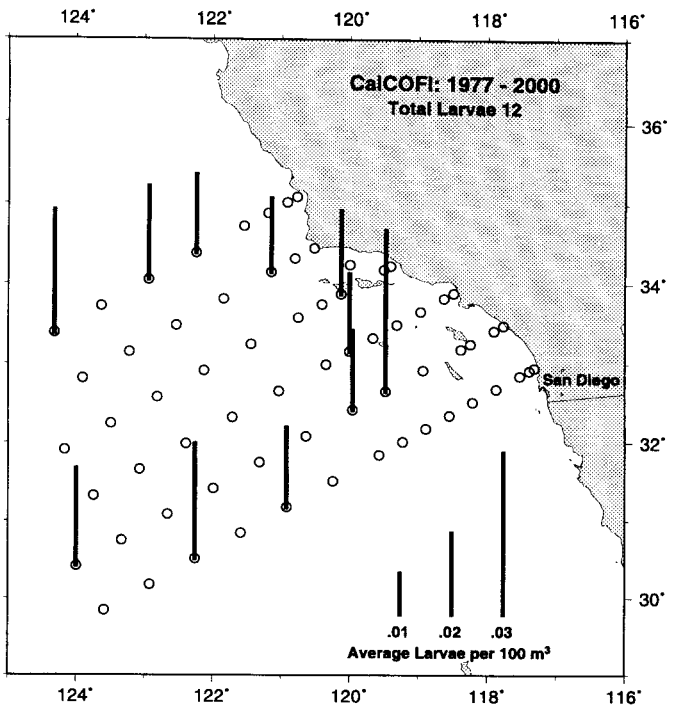



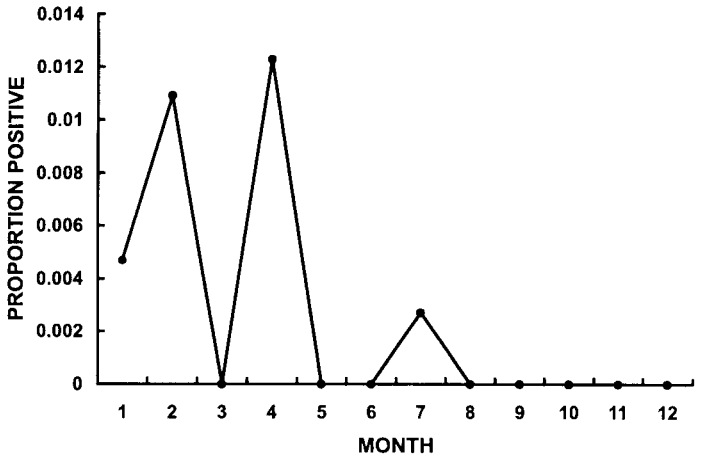



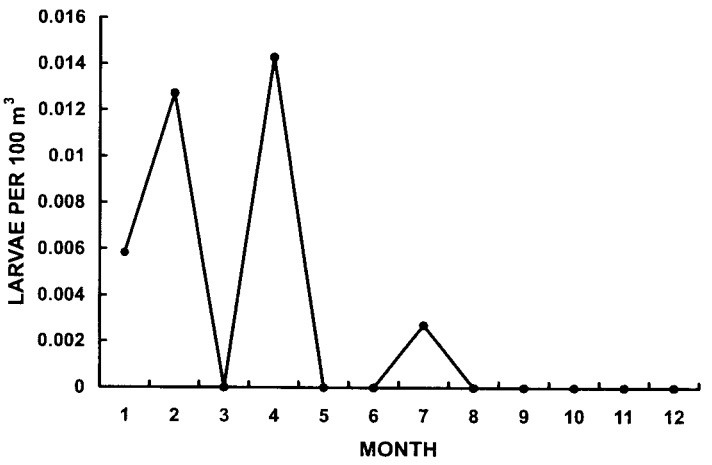



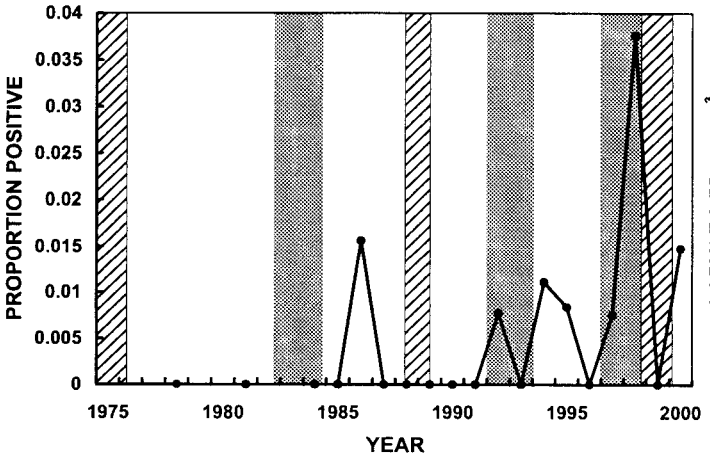
MYCTOPHIDAE California flashlightfish ***Protomyctophum crockeri***

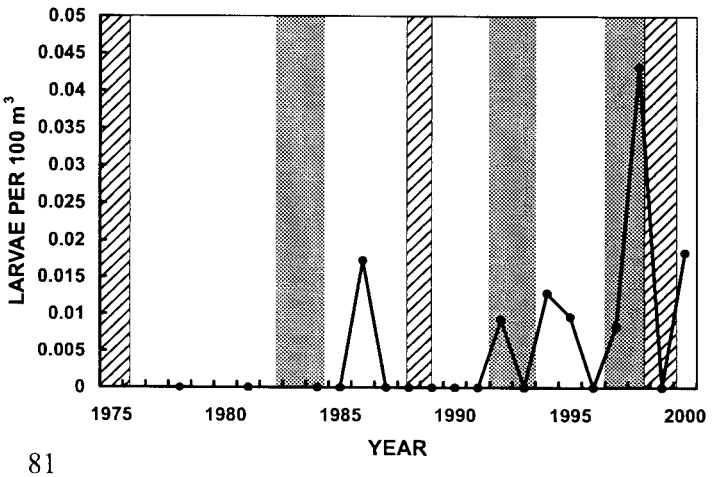


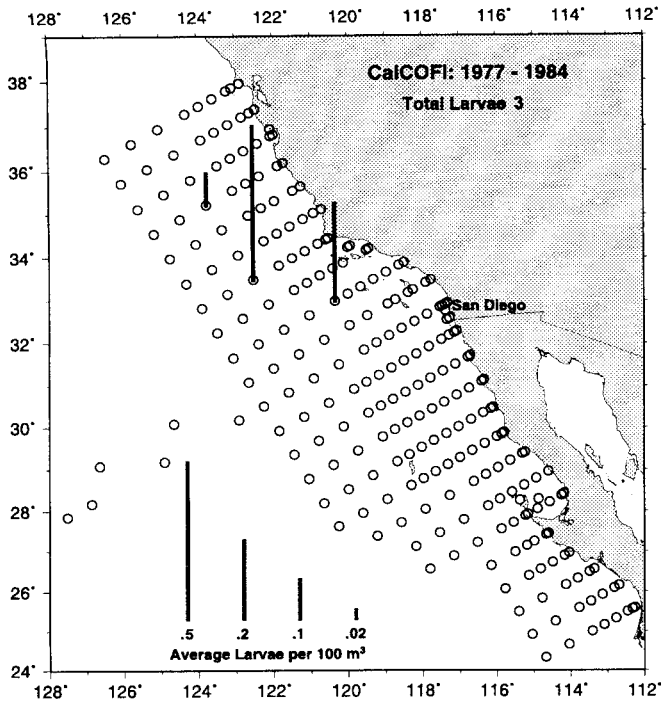



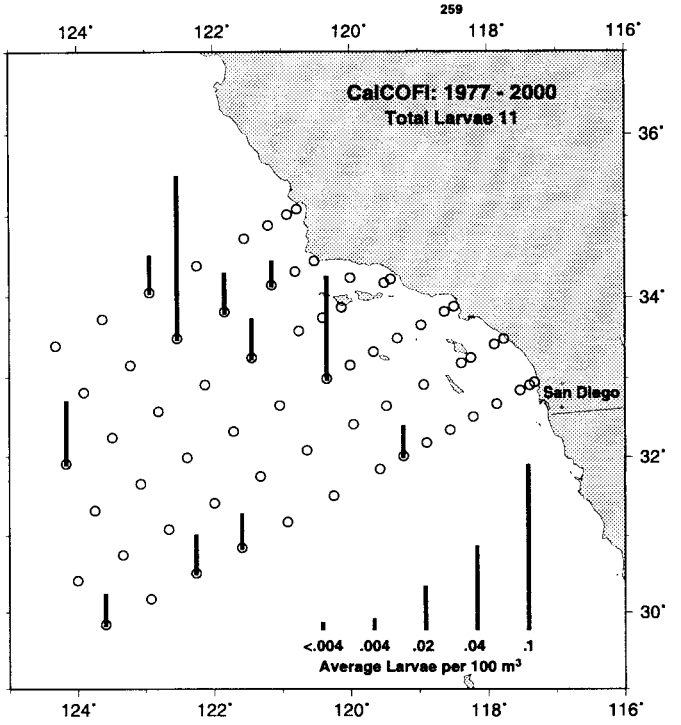



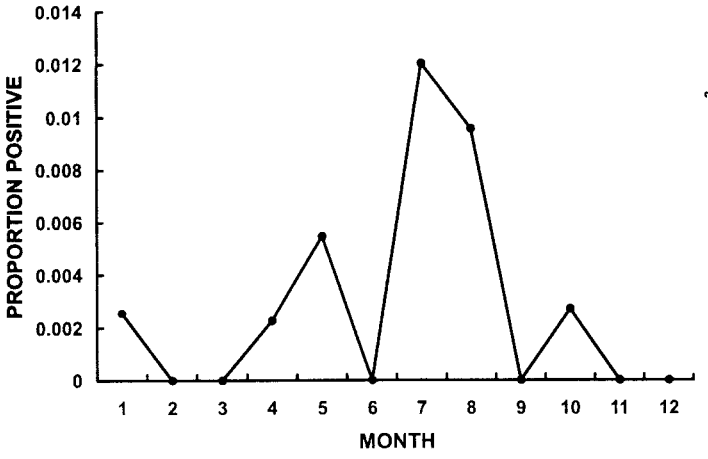



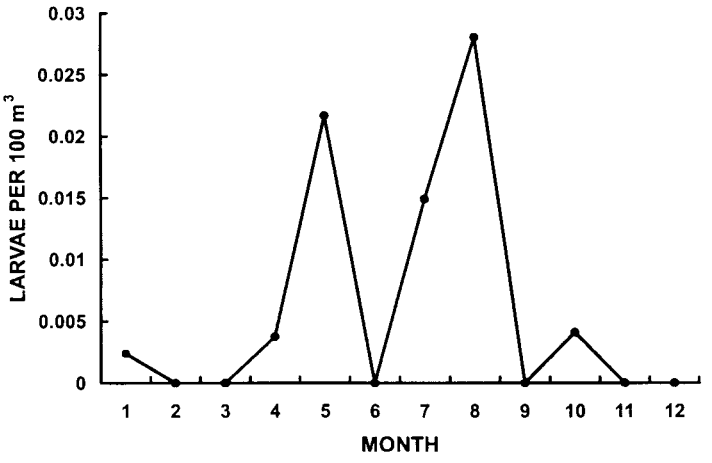



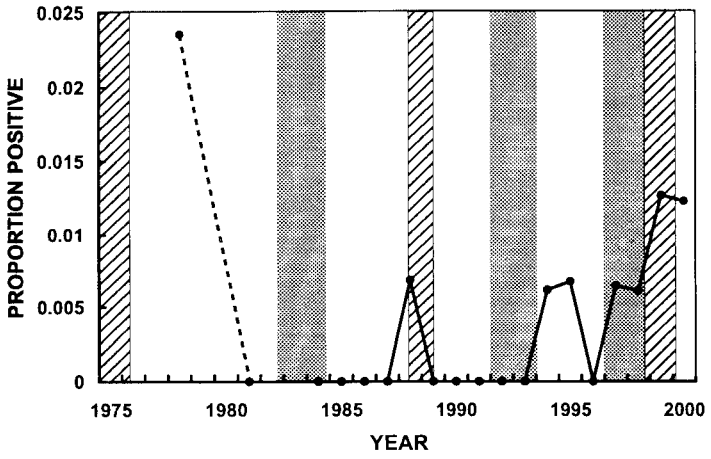
## *Nannobrachium regale* Pinpoint lightfish MYCTOPHIDAE

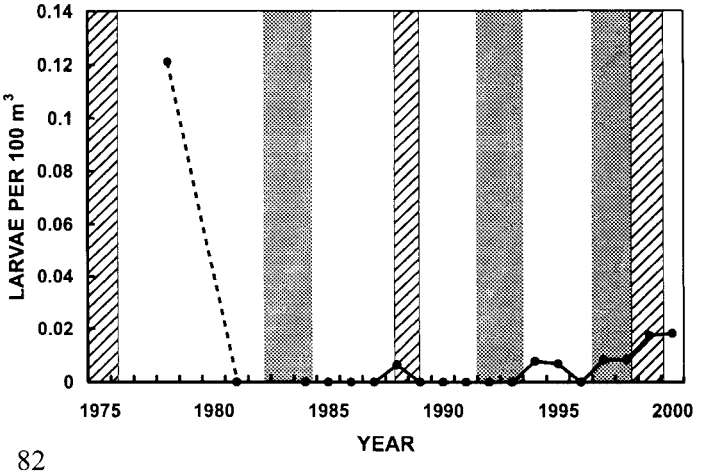


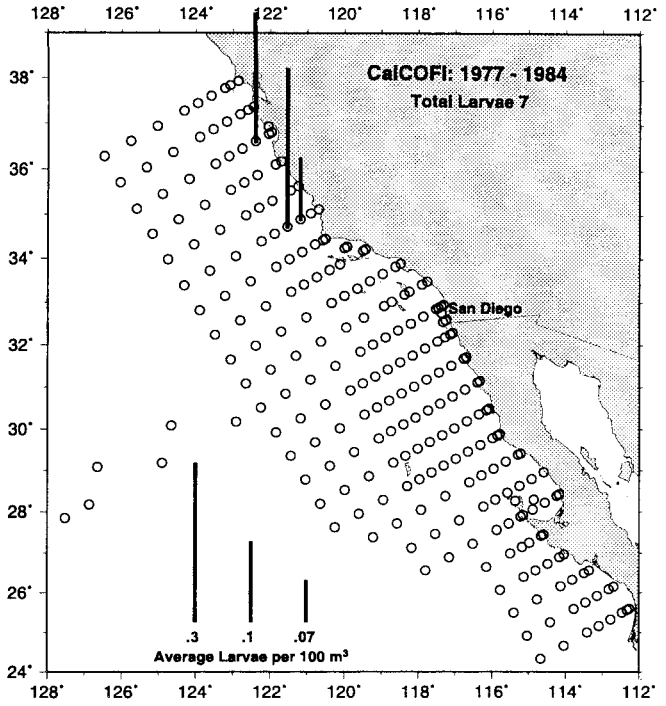



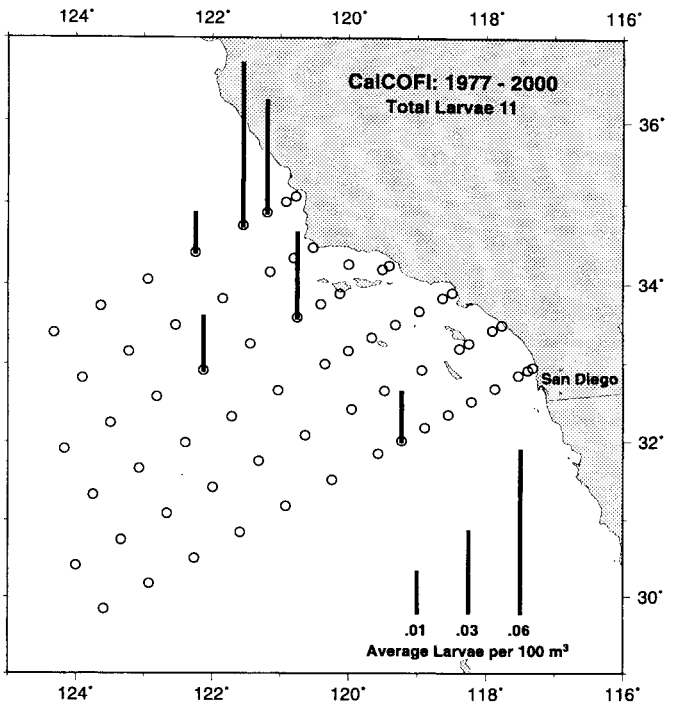



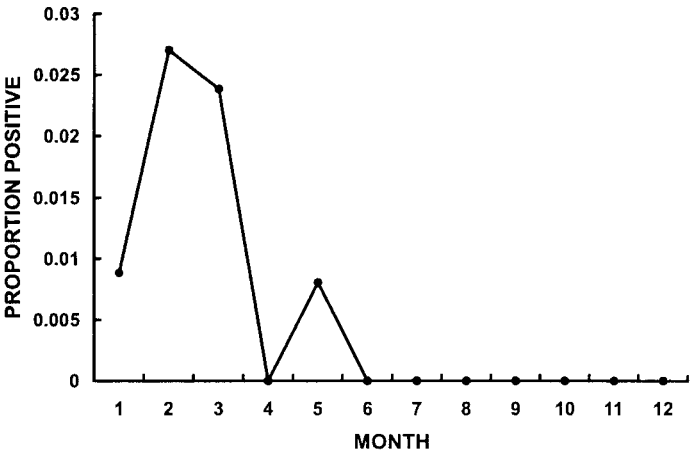



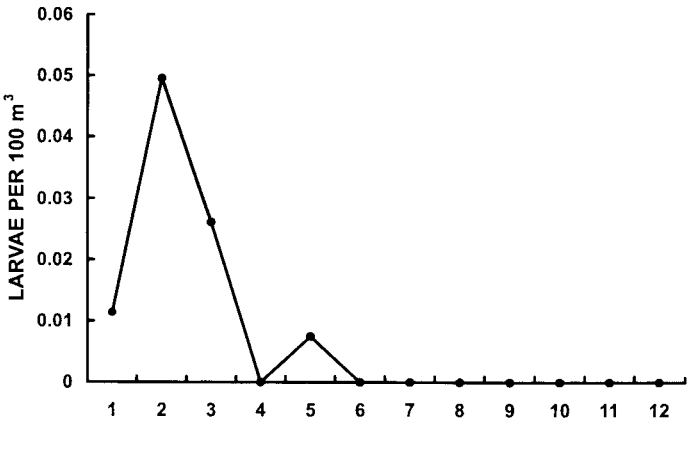



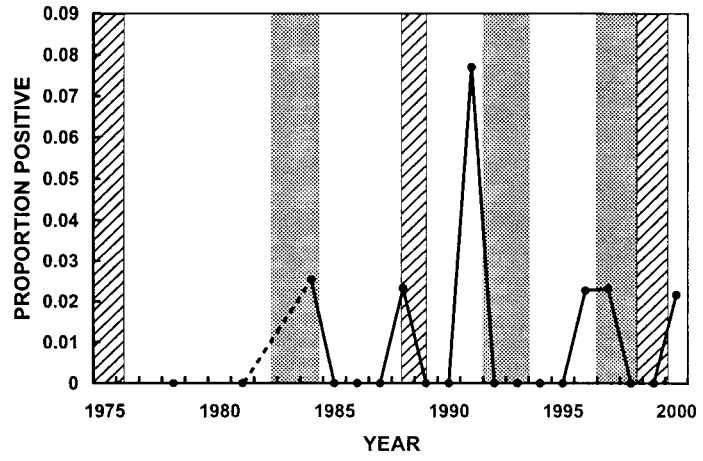



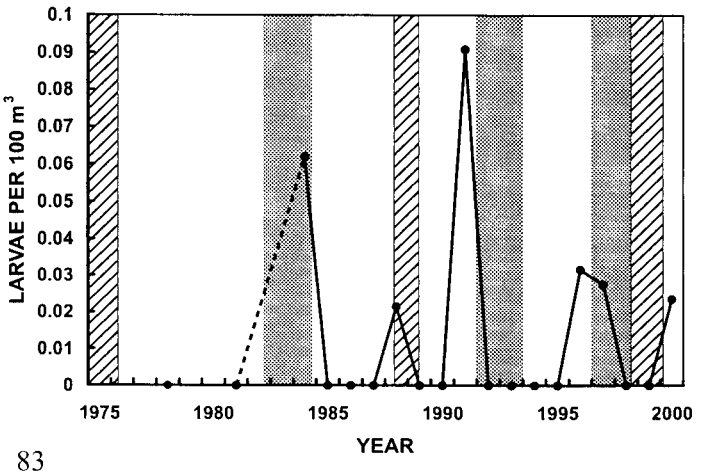

CalCOFI: 1977 - 1984
Total Larvae 7
San Diego
.3 .1 .07
Average Larvae per 100 m³

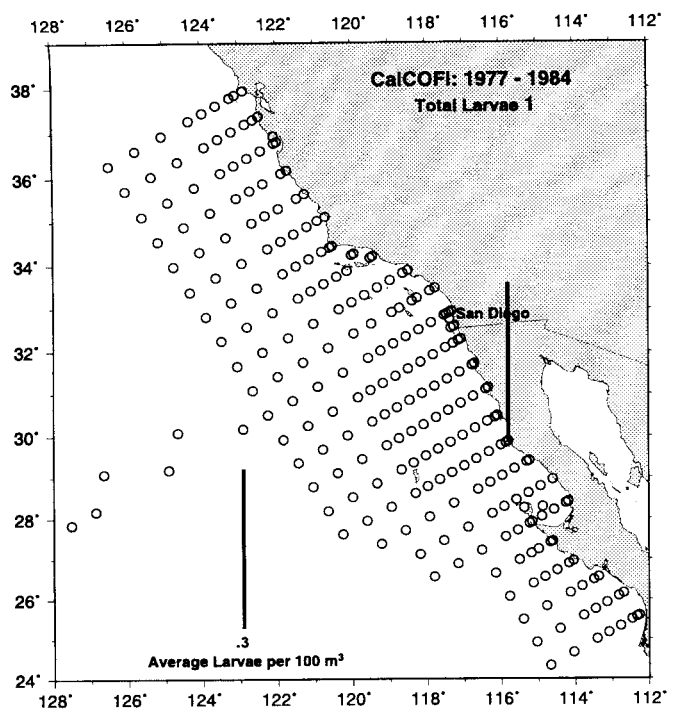

CalCOFI: 1977 - 2000
Total Larvae 11
San Diego
.01 .03 .06
Average Larvae per 100 m³

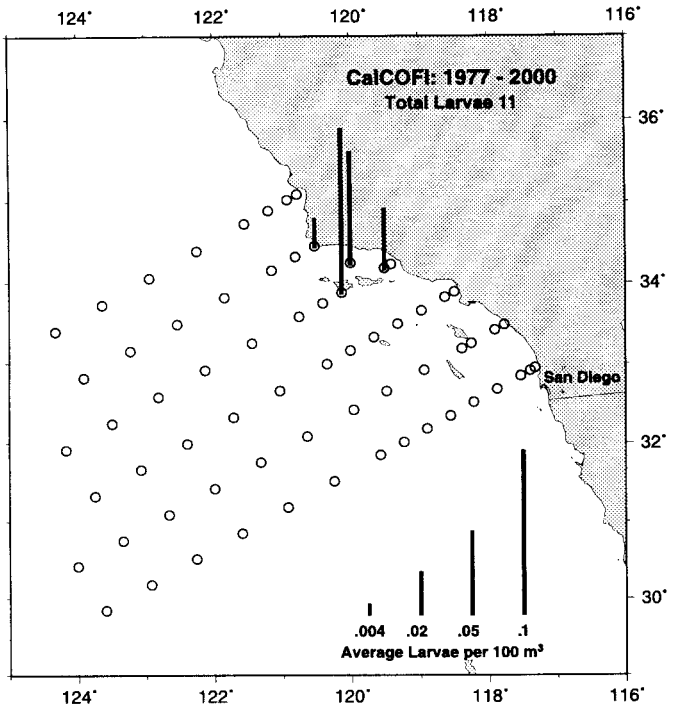

PROPORTION POSITIVE
MONTH

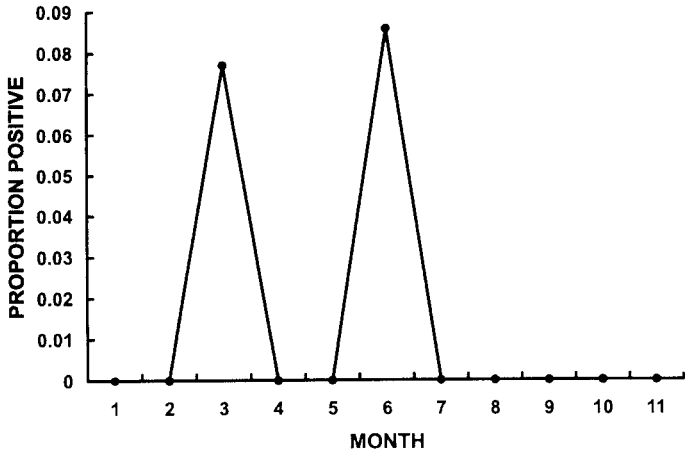

LARVAE PER 100 m³
MONTH

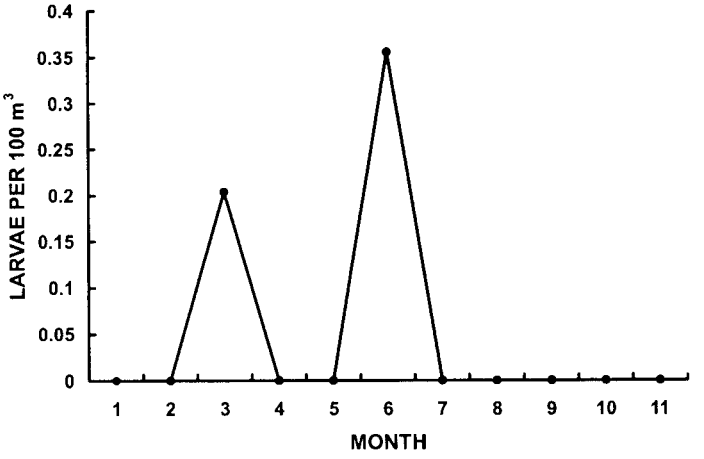

PROPORTION POSITIVE
YEAR

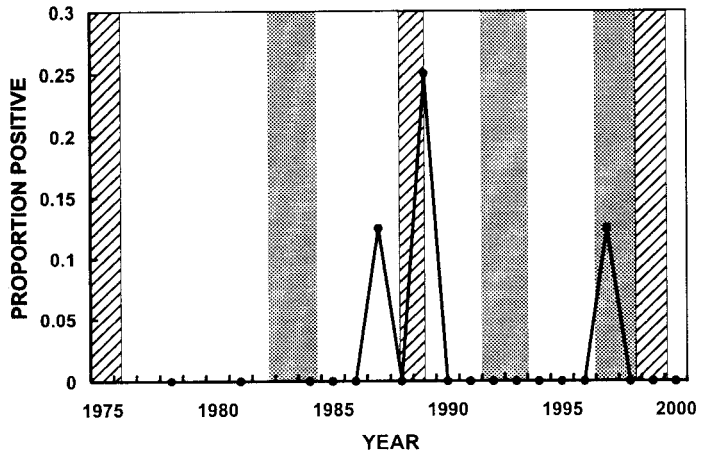

LARVAE PER 100 m³
YEAR

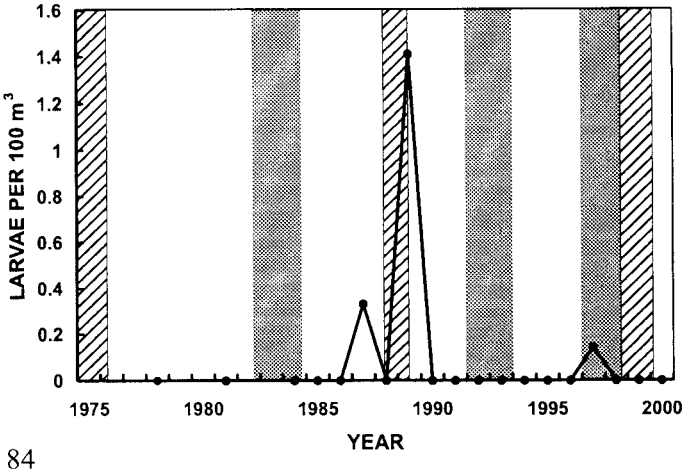

CalCOFI: 1977 - 1984
Total Larvae 1
San Diego
.3
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 11
San Diego
.004 .02 .05 .1
Average Larvae per 100 m³

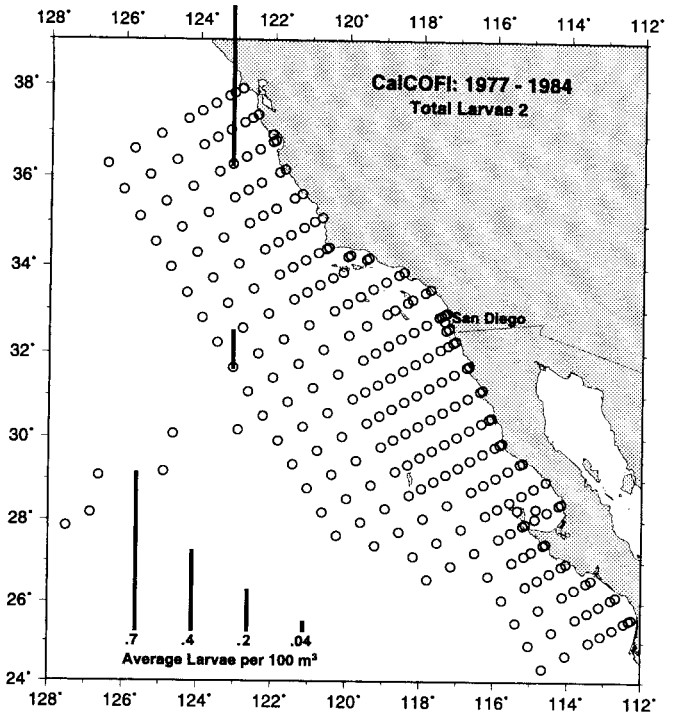

PROPORTION POSITIVE
MONTH

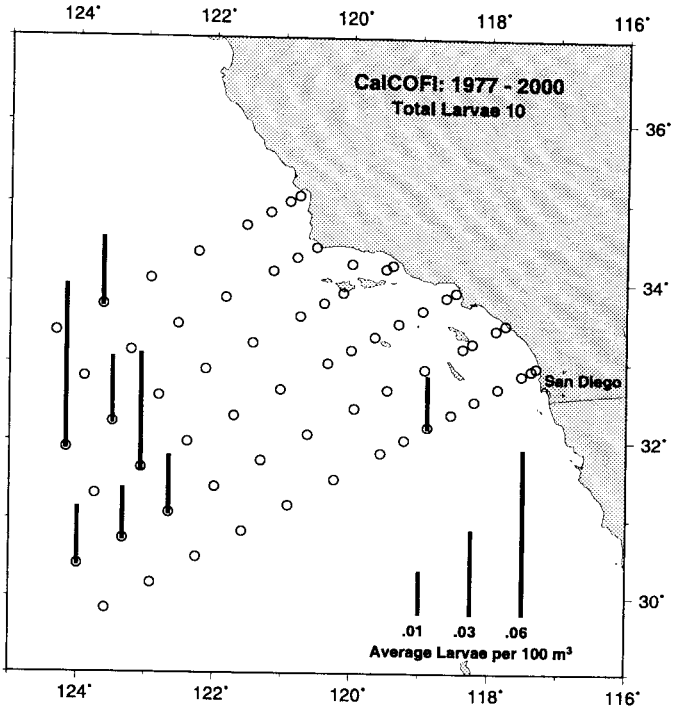

LARVAE PER 100 m³
MONTH

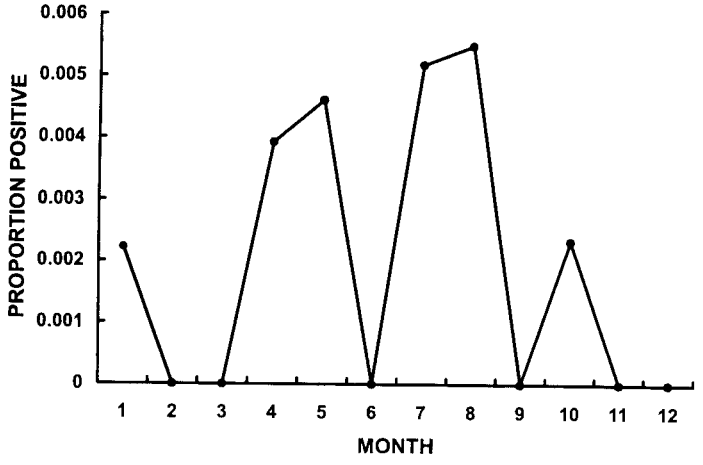

PROPORTION POSITIVE
YEAR

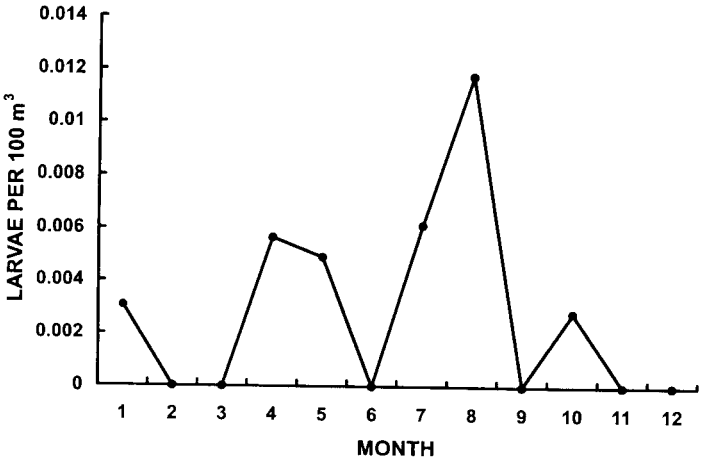

LARVAE PER 100 m³
YEAR

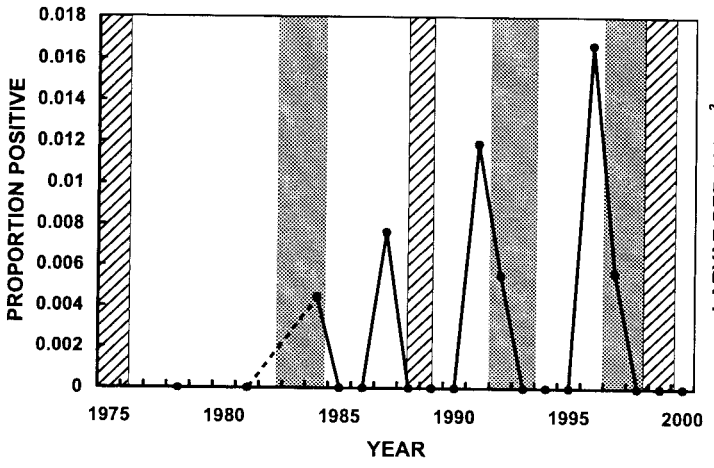
STOMIIDAE Longfin dragonfish ***Tactostoma macropus***

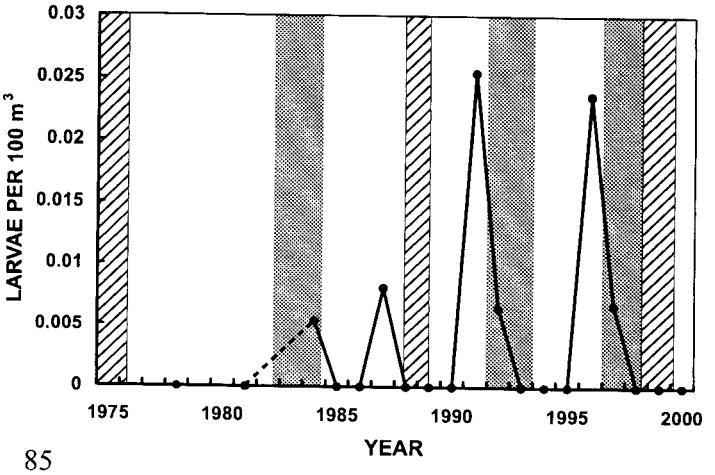


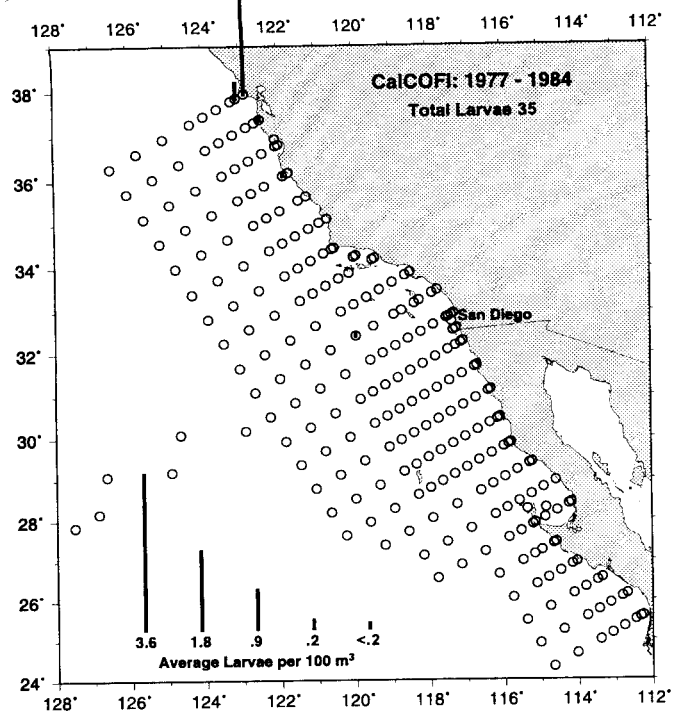



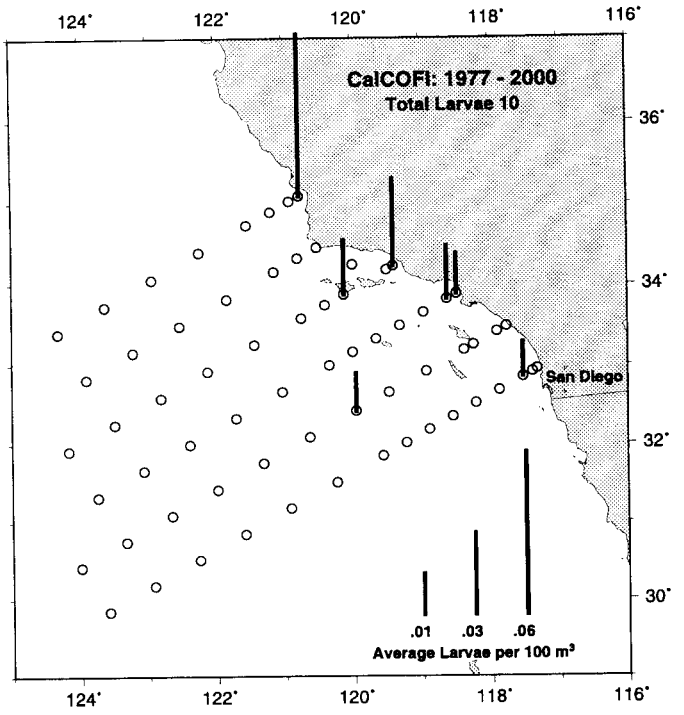



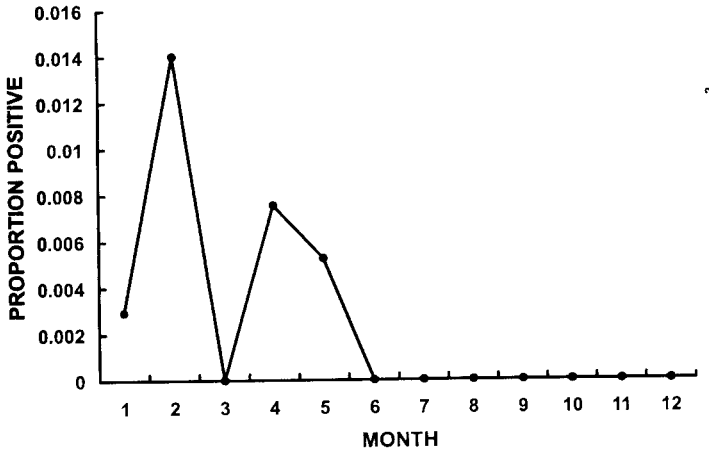



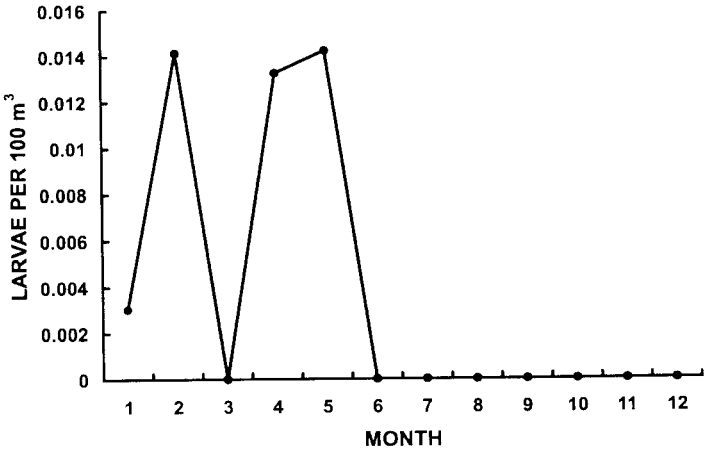



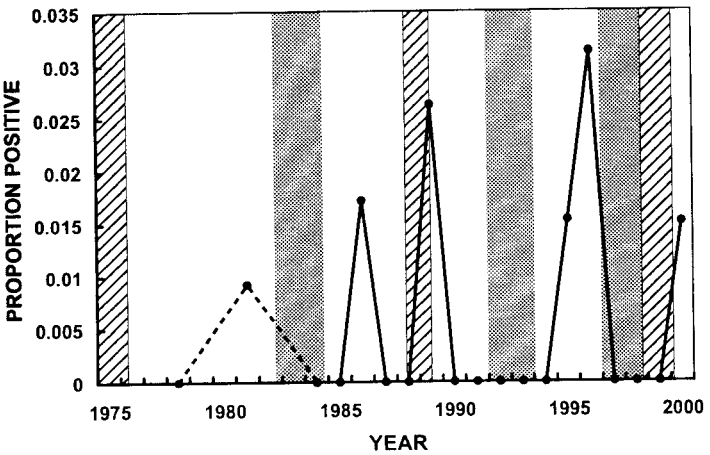
***Parophrys vetulus*** English sole PLEURONECTIDAE

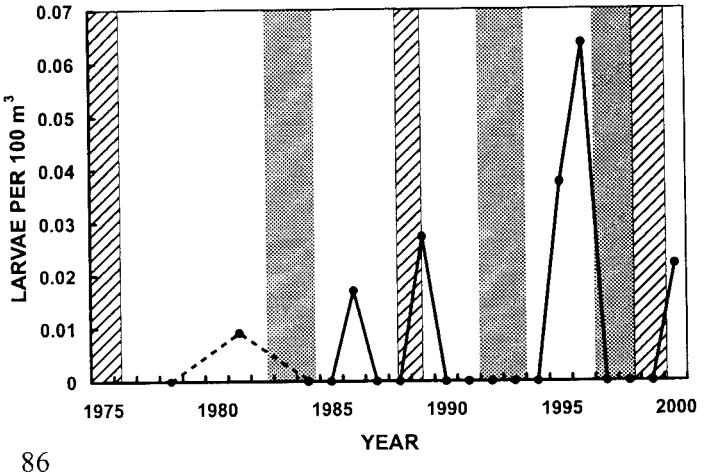


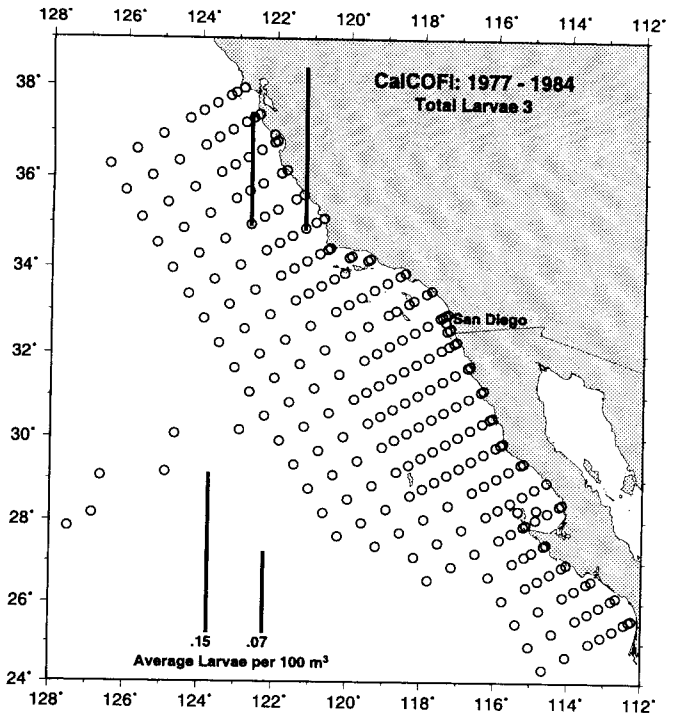



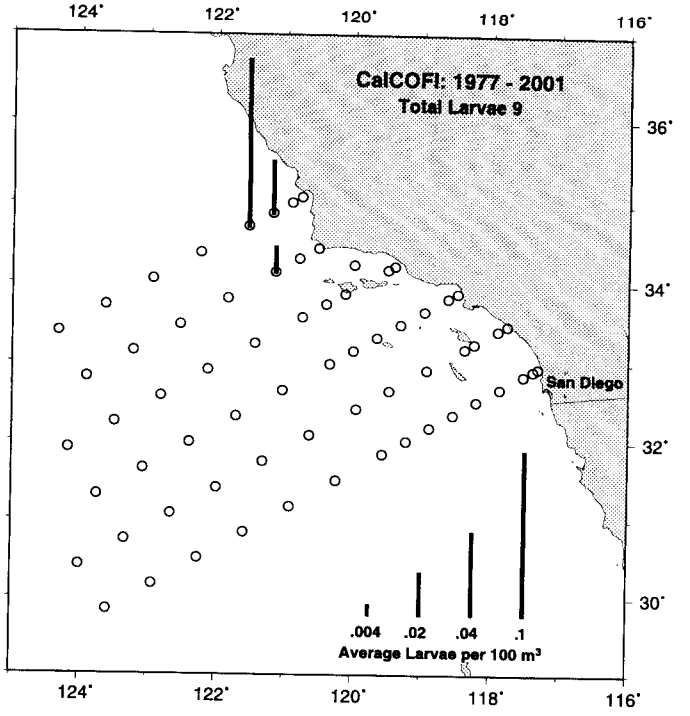



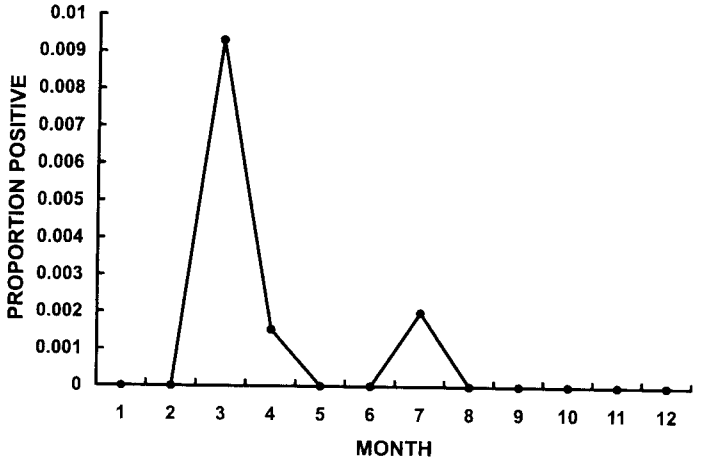



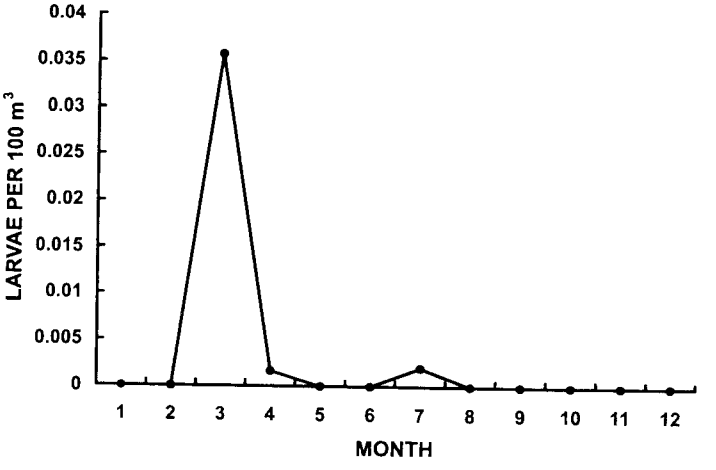



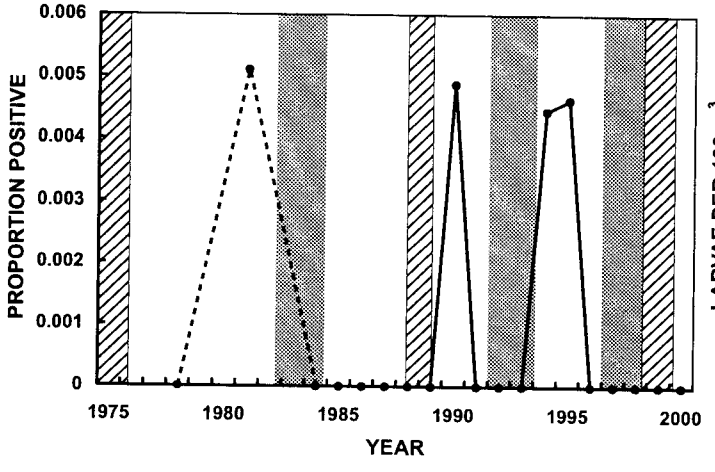



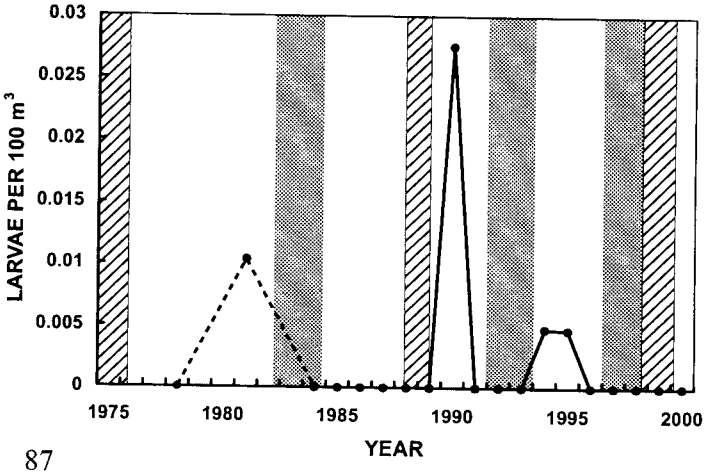

CalCOFI: 1977 - 1984
Total Larvae 3
San Diego
.15
.07
Average Larvae per 100 m³

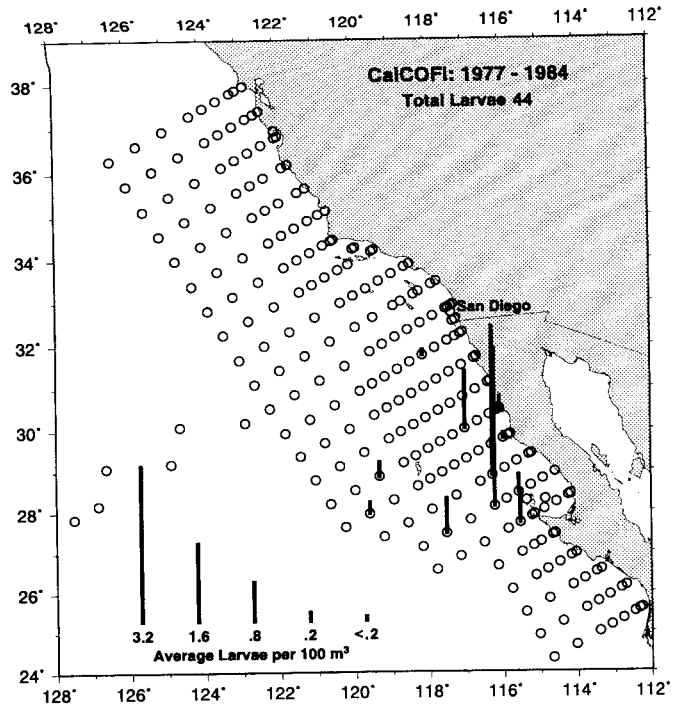

CalCOFI: 1977 - 2001
Total Larvae 9
San Diego
.004
.02
.04
.1
Average Larvae per 100 m³

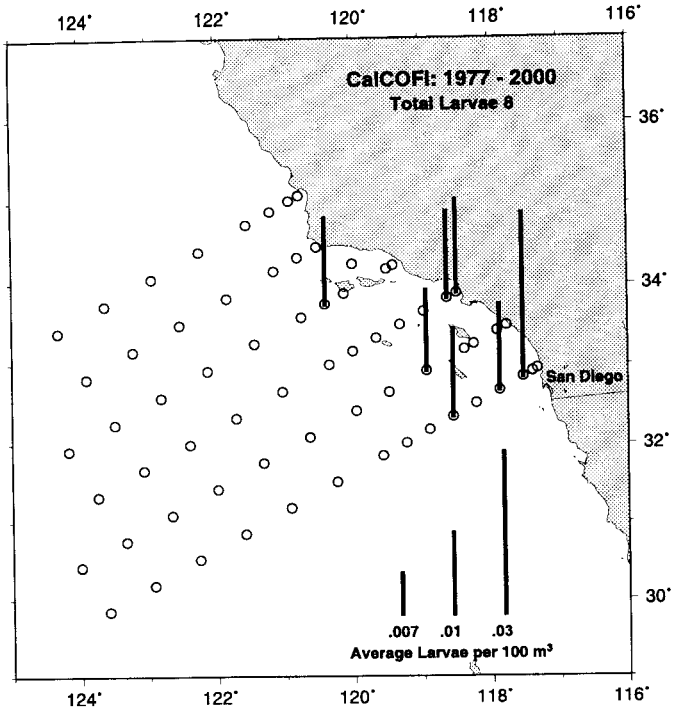

PROPORTION POSITIVE
MONTH

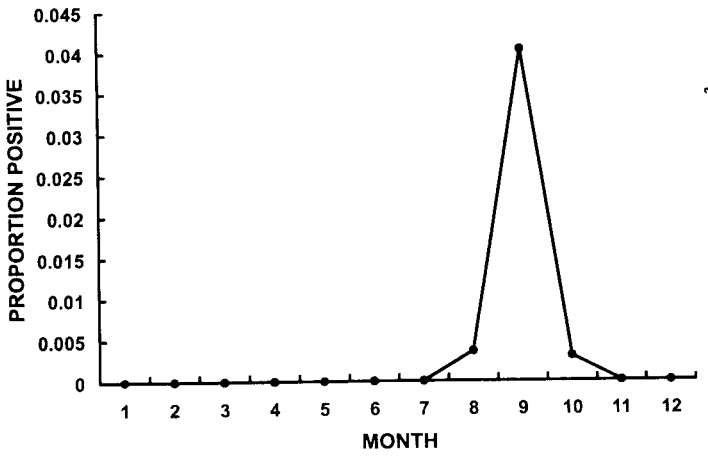

LARVAE PER 100 m³
MONTH

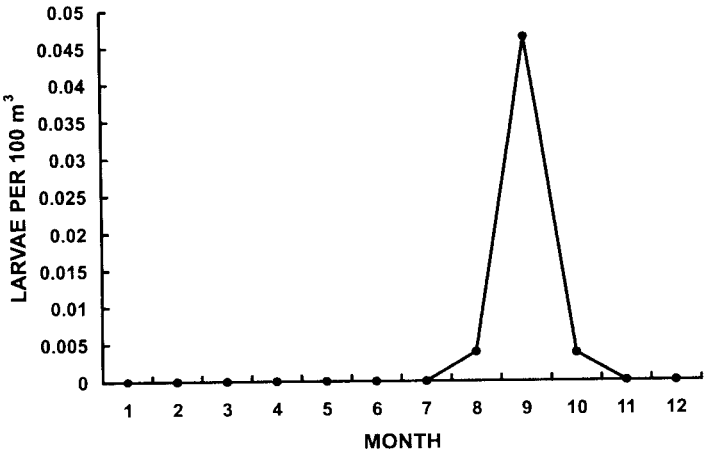

PROPORTION POSITIVE
YEAR

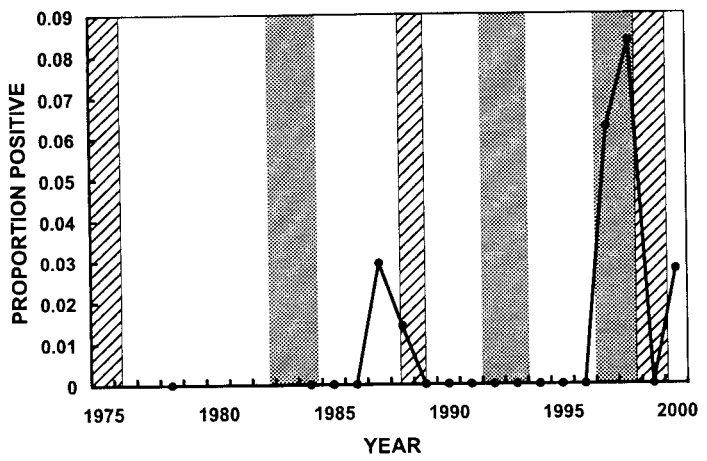

LARVAE PER 100 m³
YEAR

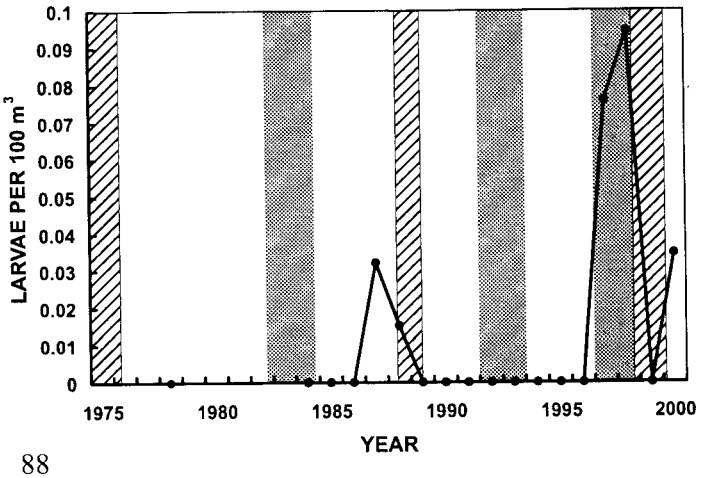

CalCOFI: 1977 - 1984
Total Larvae 44
San Diego
3.2 1.6 .8 .2 <.2
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 8
San Diego
.007 .01 .03
Average Larvae per 100 m³

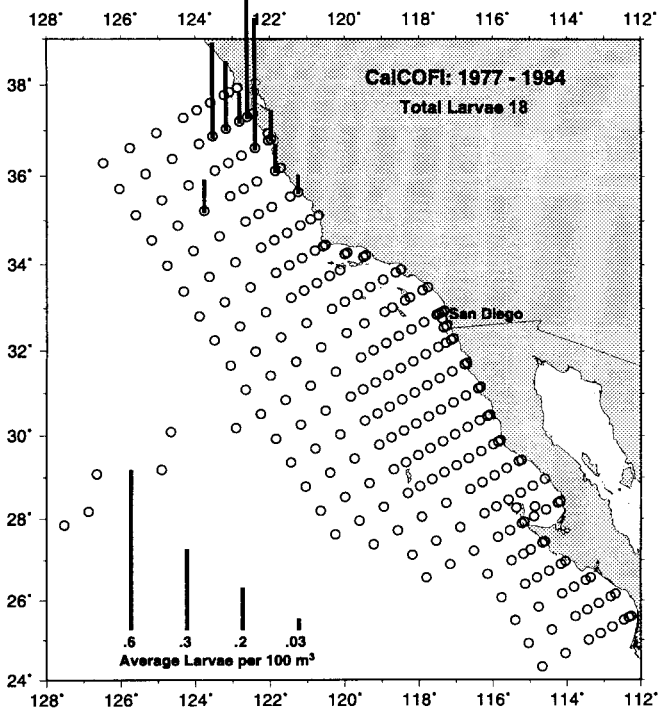

PROPORTION POSITIVE
MONTH

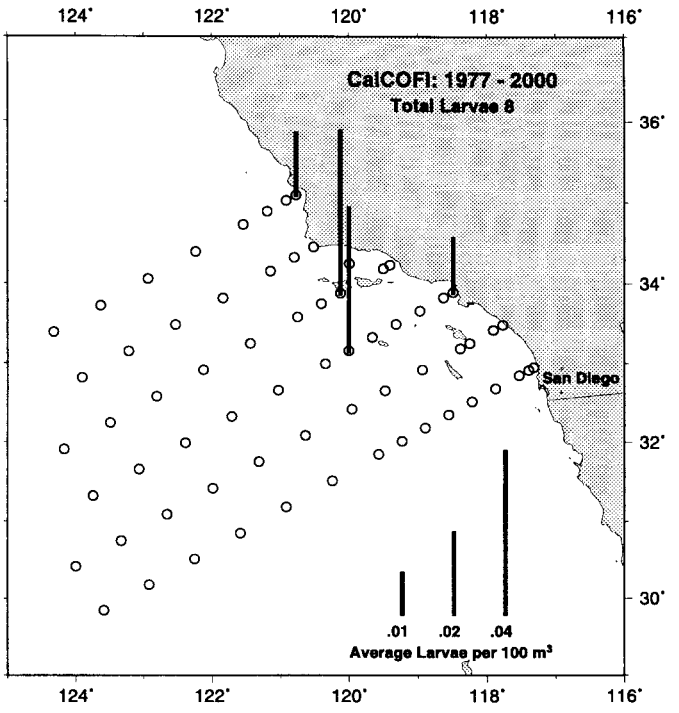

LARVAE PER 100 m³
MONTH

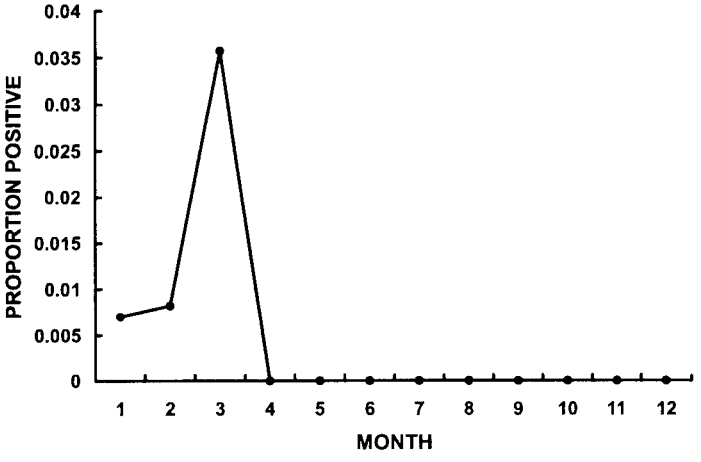

PROPORTION POSITIVE
YEAR

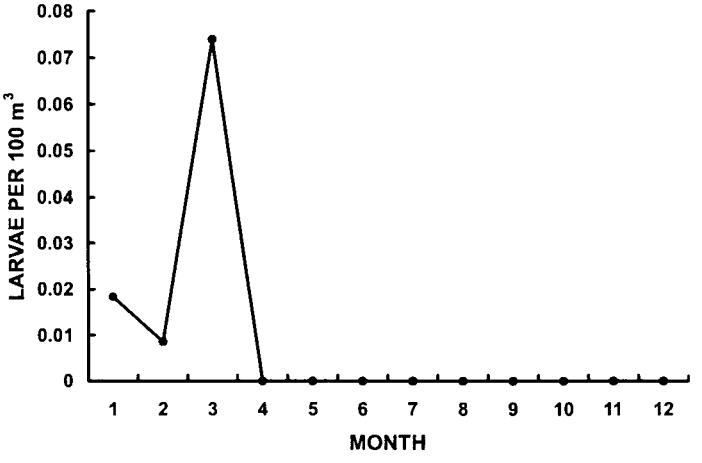

LARVAE PER 100 m³
YEAR

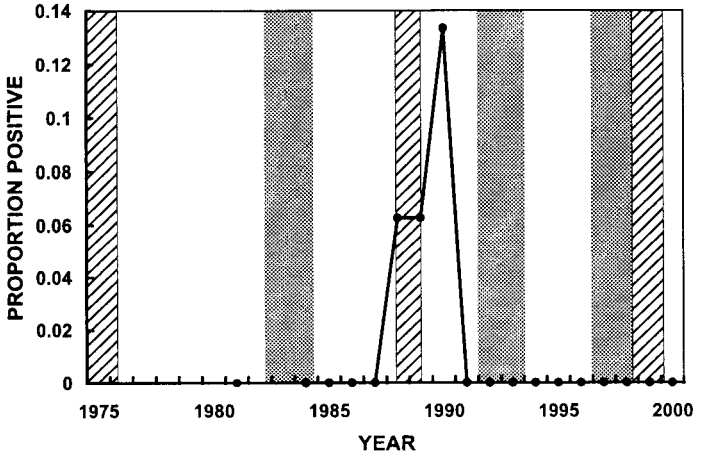
HEXAGRAMMIDAE Rock greenling ***Hexagrammos lagocephalus***

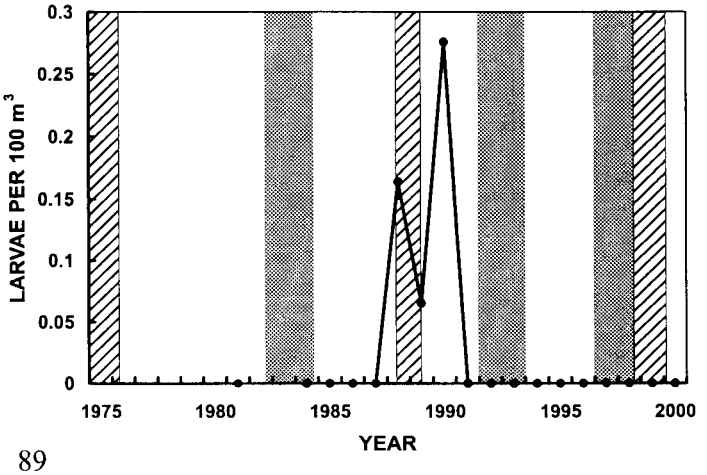


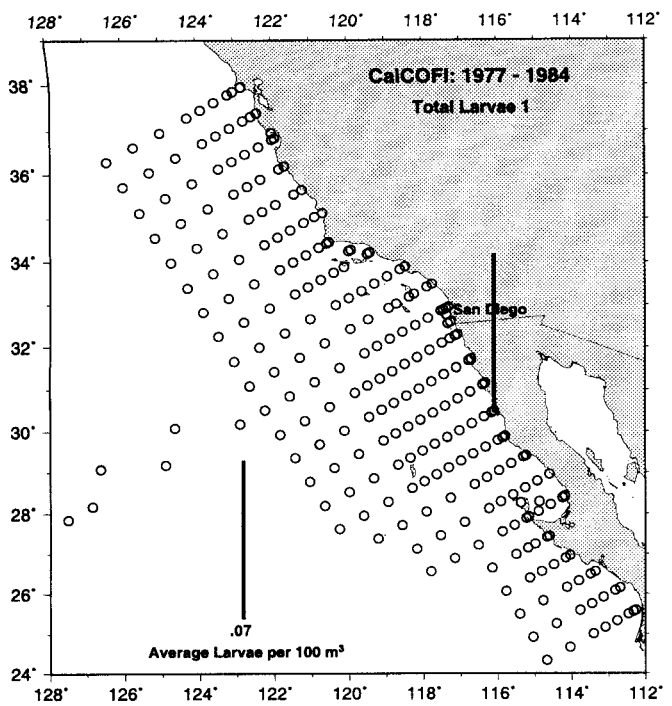

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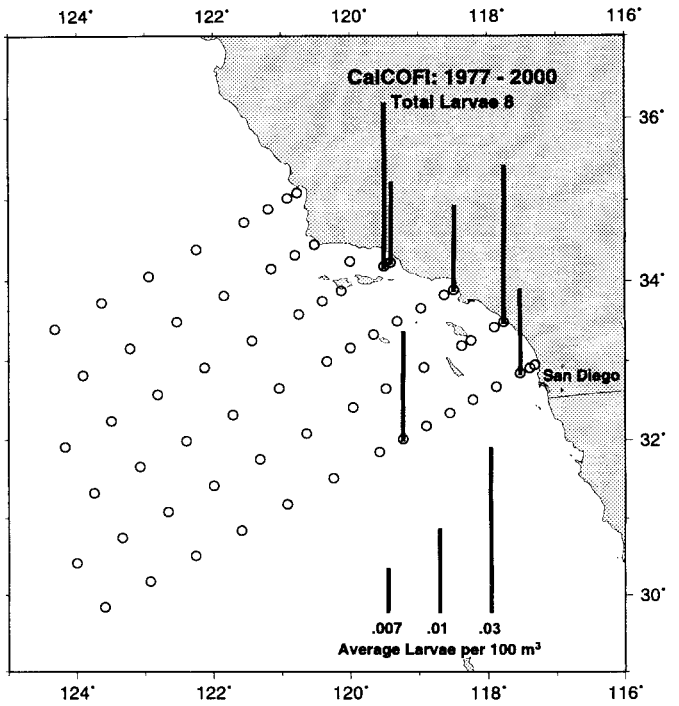
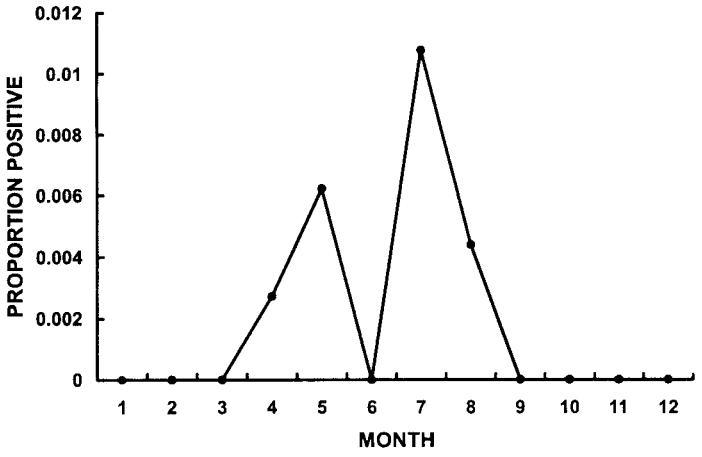
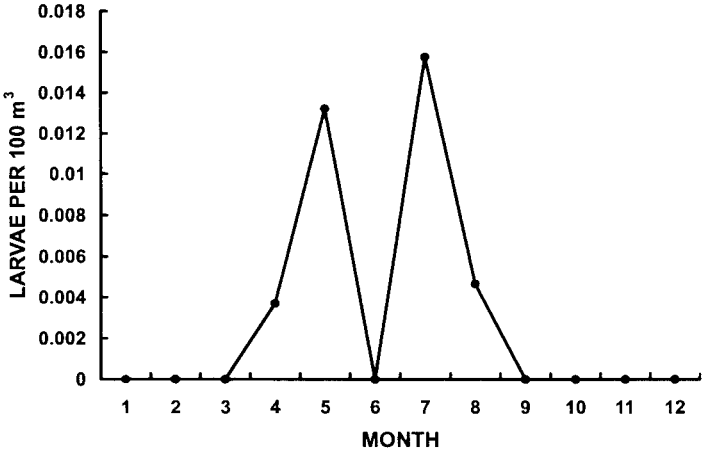
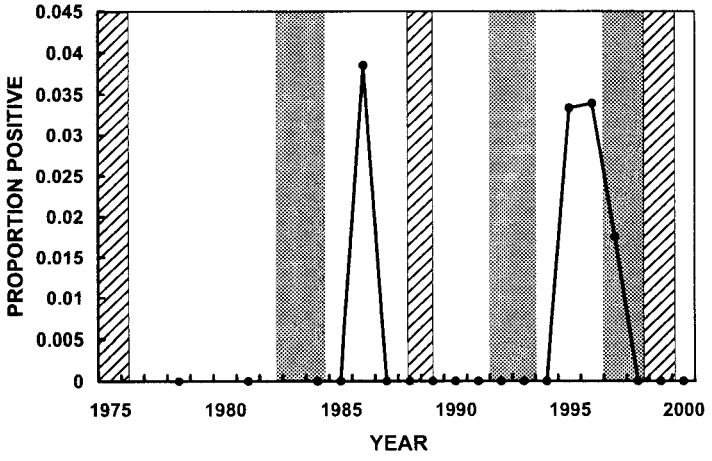
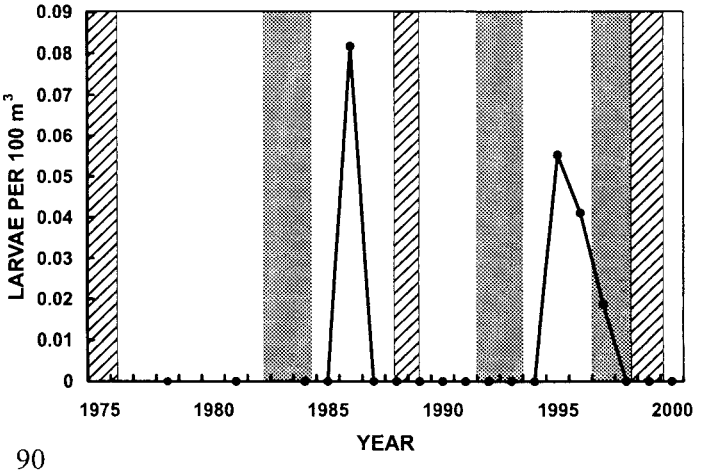
San Diego
.07
Average Larvae per 100 m³

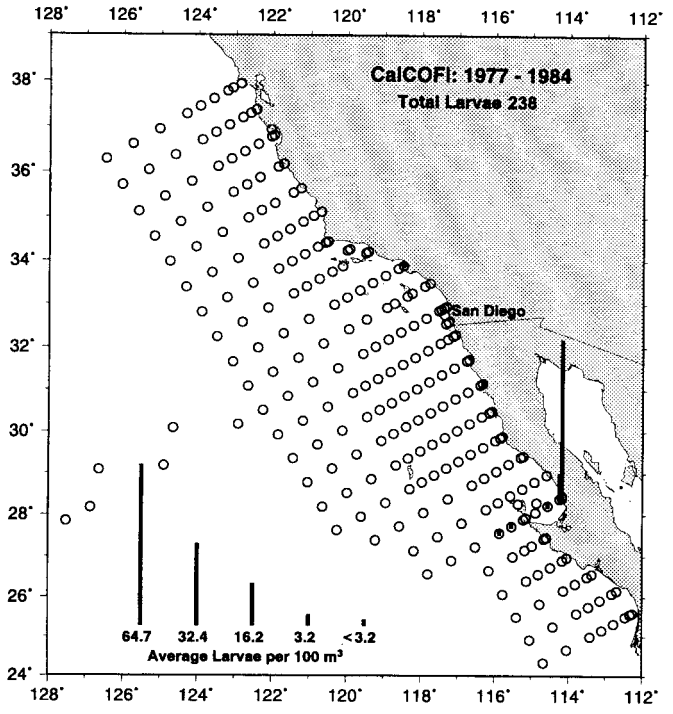

CalCOFI: 1977 - 2000
Total Larvae 8
San Diego
.007 .01 .03
Average Larvae per 100 m³

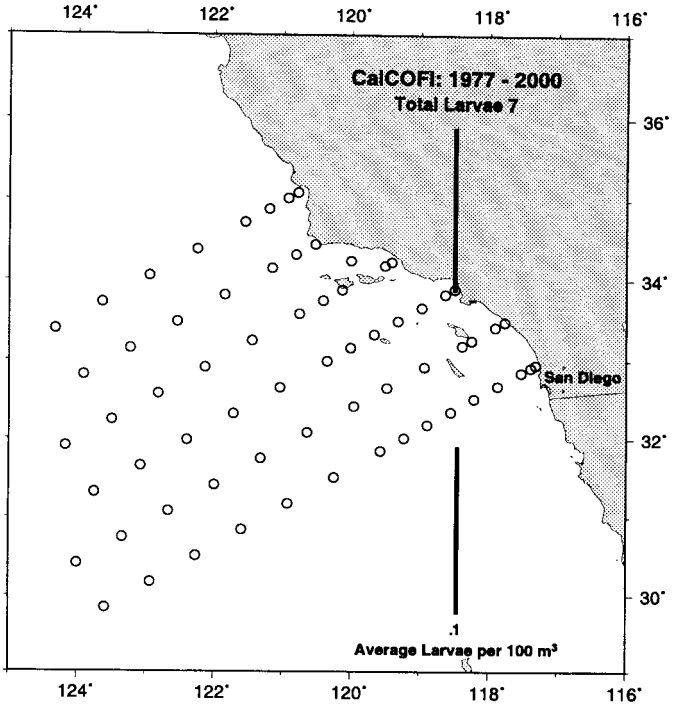

PROPORTION POSITIVE
MONTH

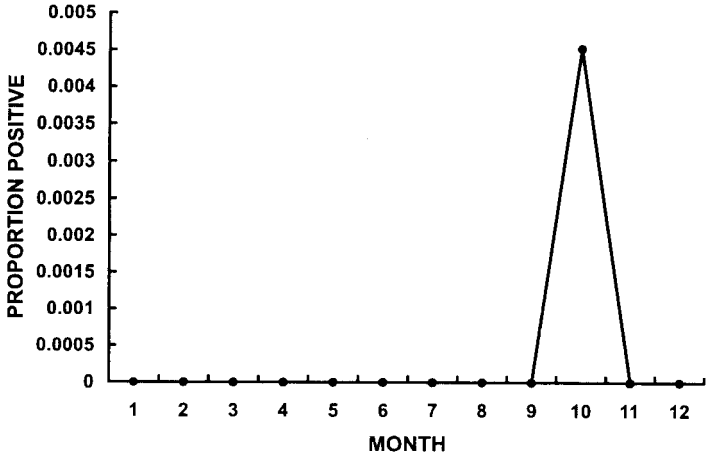

LARVAE PER 100 m³
MONTH

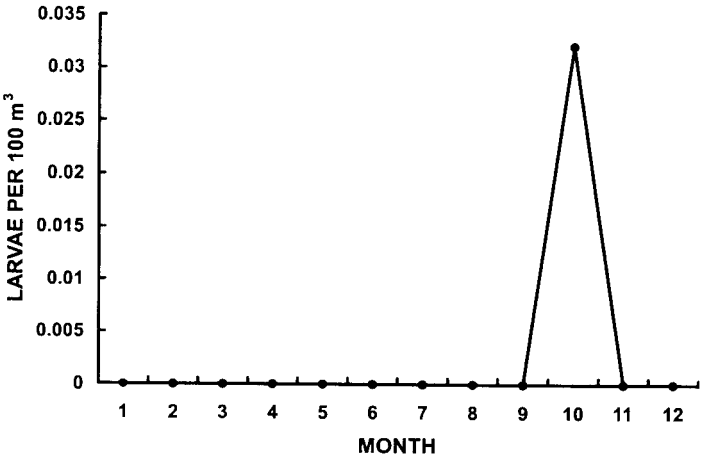

PROPORTION POSITIVE
YEAR

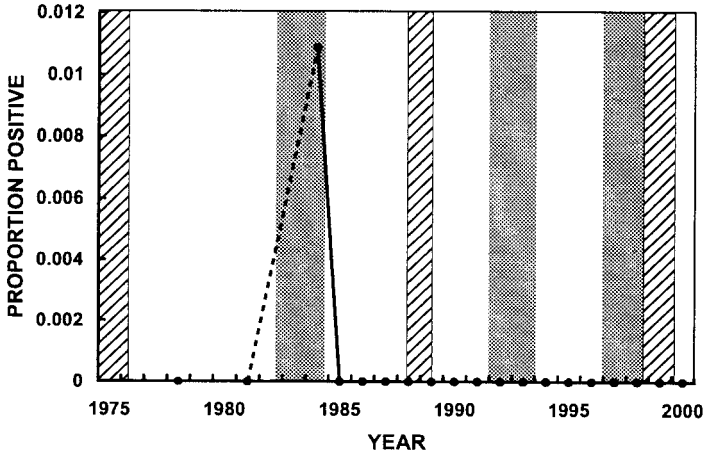

LARVAE PER 100 m³
YEAR

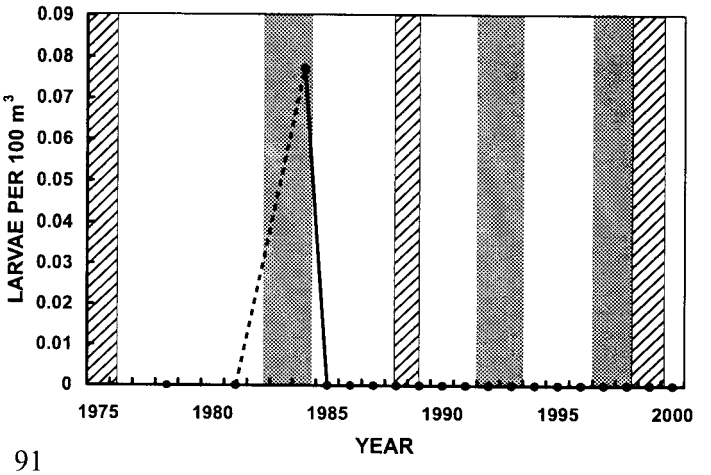

CalCOFI: 1977 - 1984
Total Larvae 238
San Diego
64.7 32.4 16.2 3.2 <3.2
Average Larvae per 100 m³

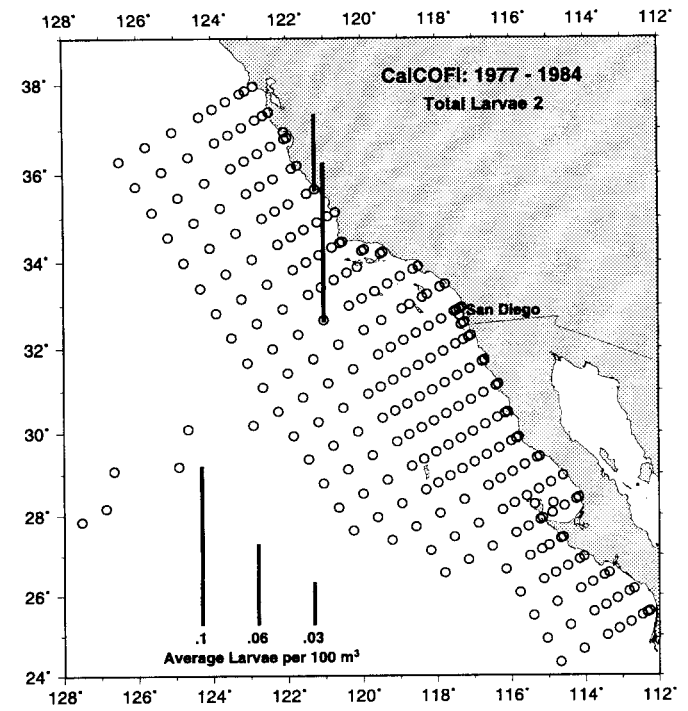

CalCOFI: 1977 - 2000
Total Larvae 7
San Diego
.1
Average Larvae per 100 m³

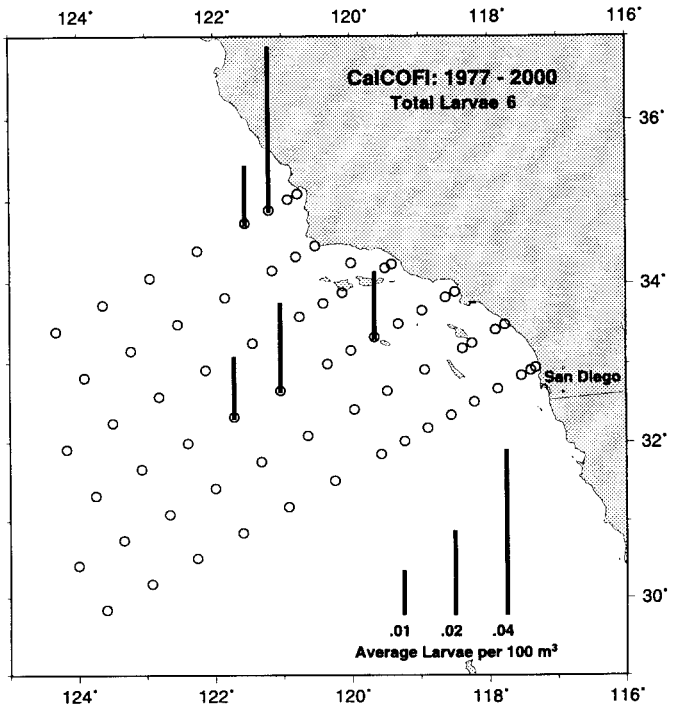

PROPORTION POSITIVE
MONTH

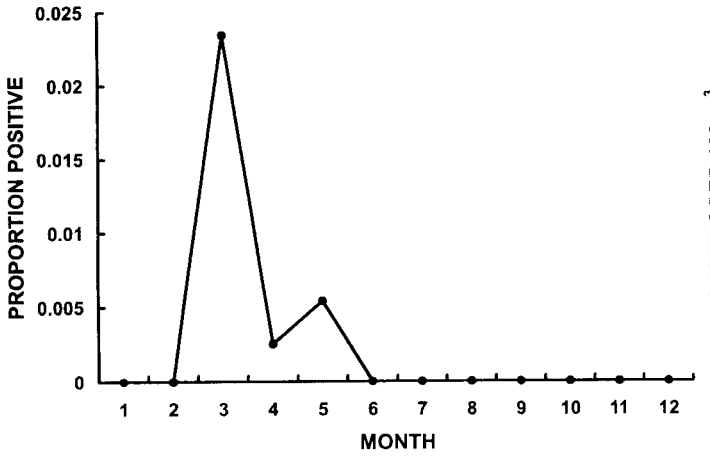

LARVAE PER 100 m³
MONTH

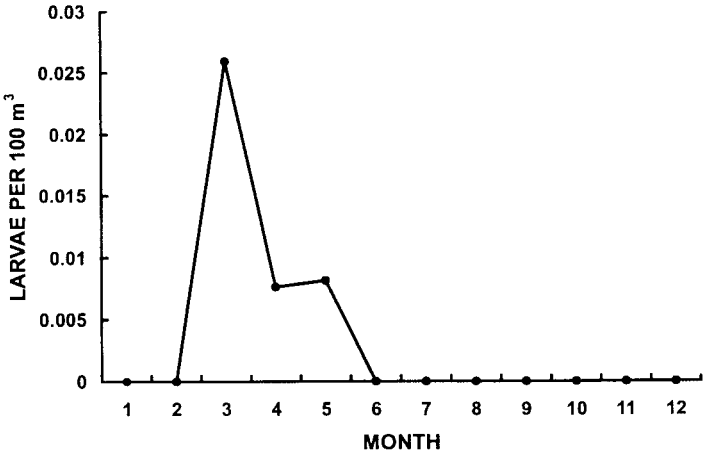

PROPORTION POSITIVE
YEAR

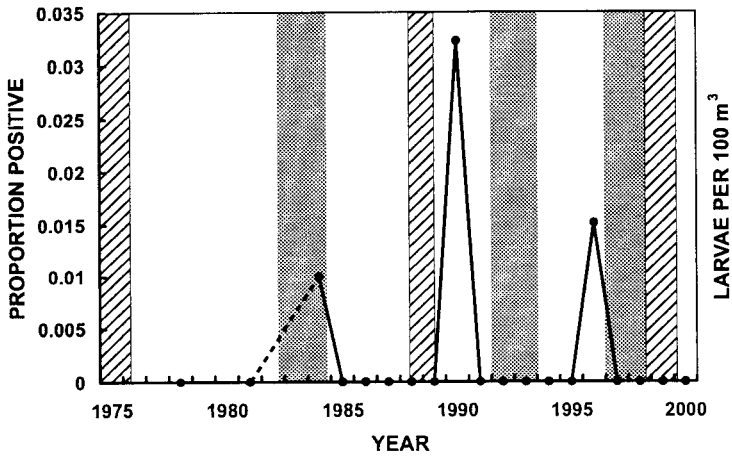

LARVAE PER 100 m³
YEAR

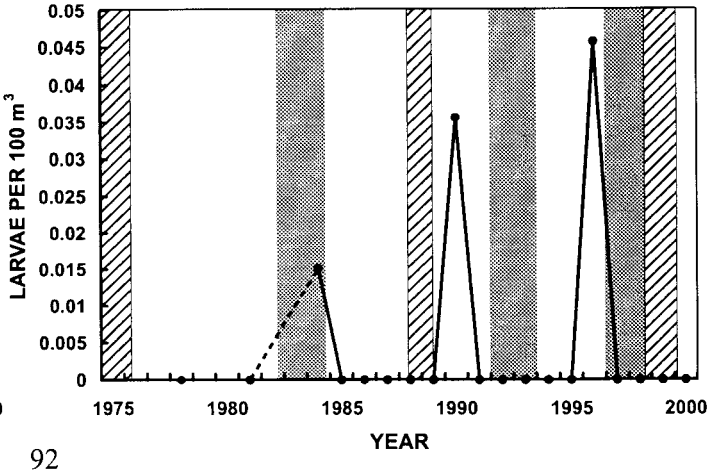

CalCOFI: 1977 - 1984
Total Larvae 2
San Diego
.1 .06 .03
Average Larvae per 100 m³


CalCOFI: 1977 - 2000
Total Larvae 6
San Diego
.01 .02 .04
Average Larvae per 100 m³


PROPORTION POSITIVE
MONTH


LARVAE PER 100 m³
MONTH

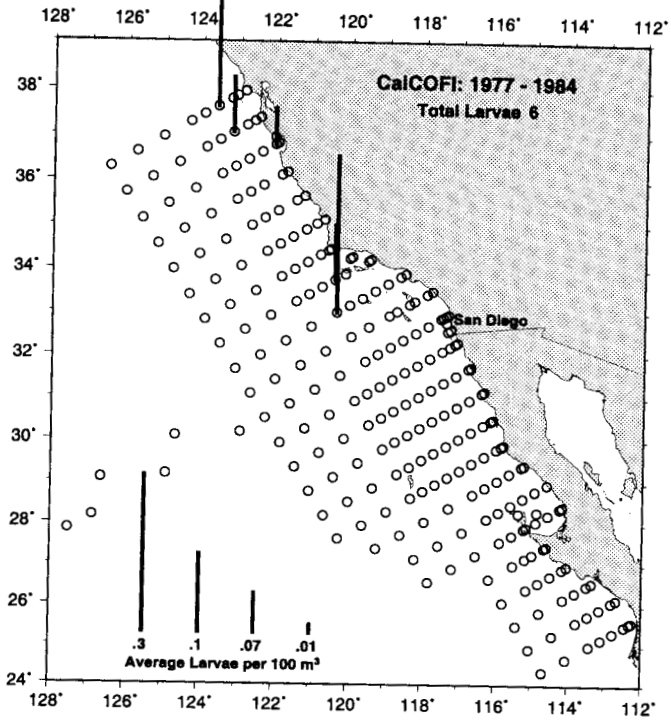

PROPORTION POSITIVE
YEAR

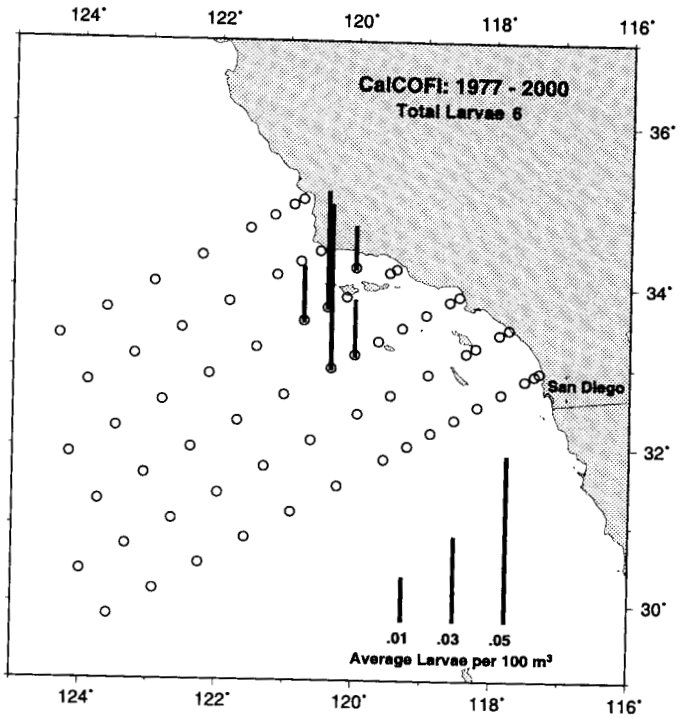

LARVAE PER 100 m³
YEAR

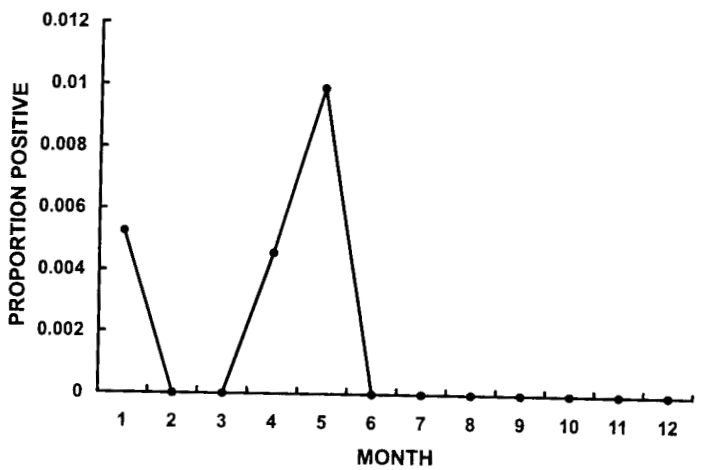
SEBASTIDAE

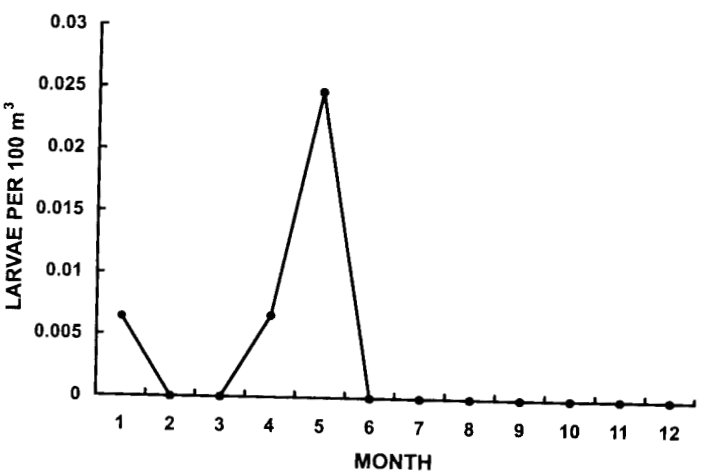
Cowcod

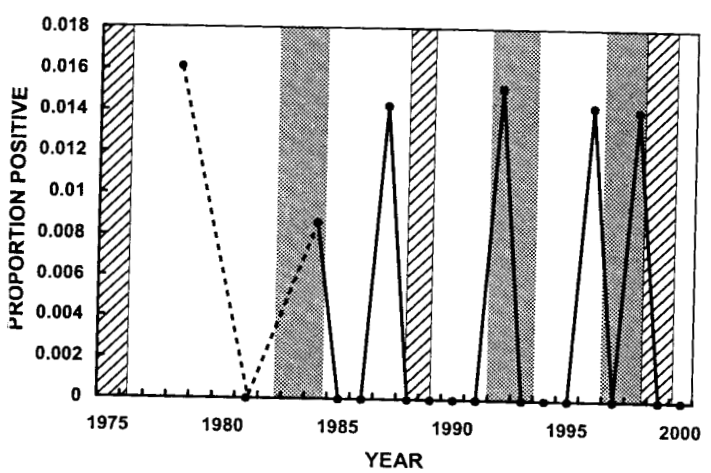
***Sebastes levis***

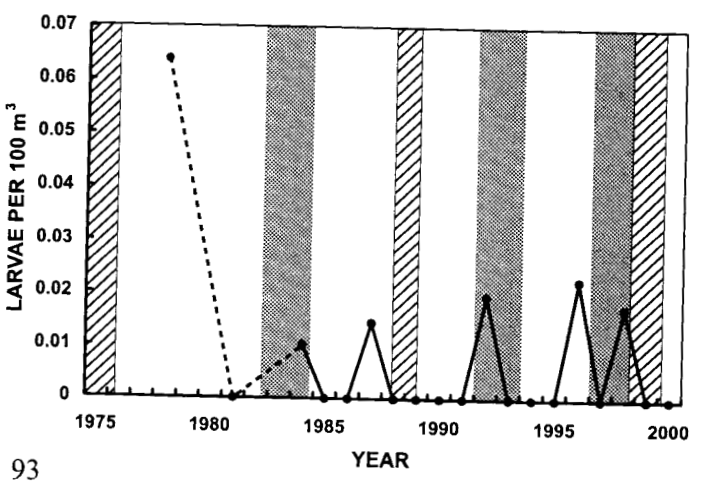


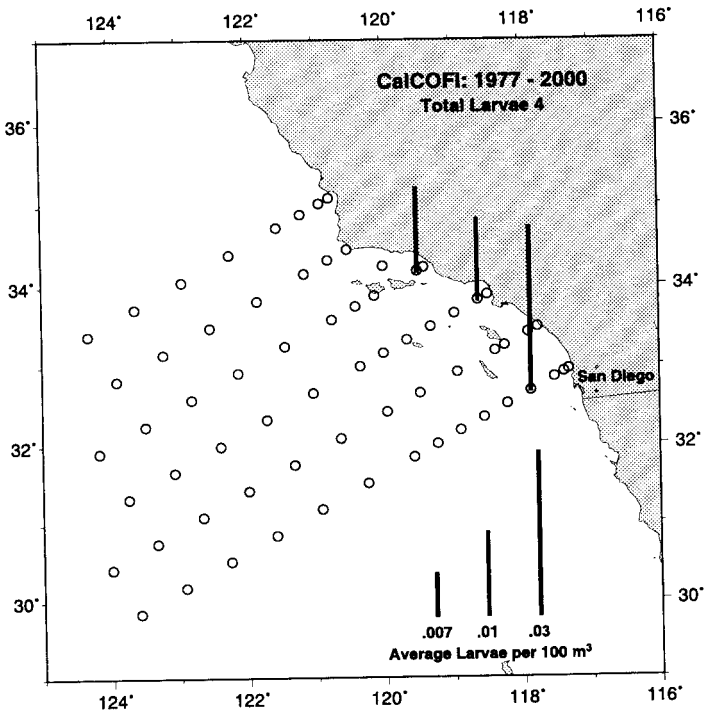



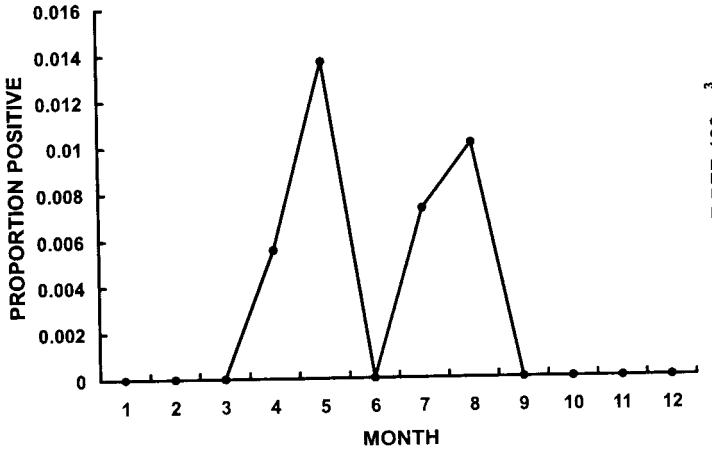



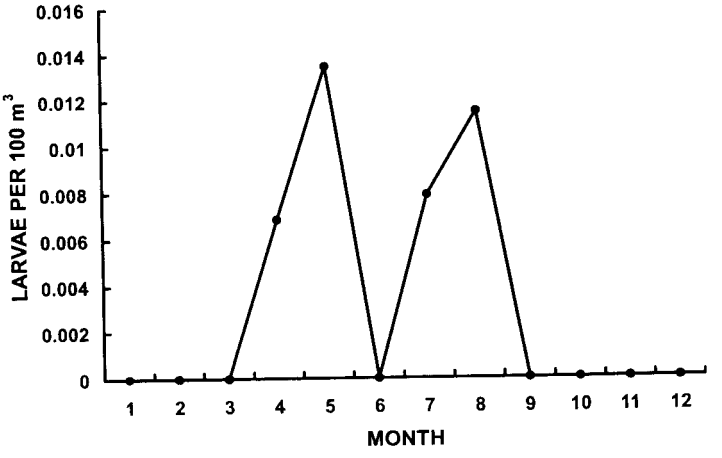



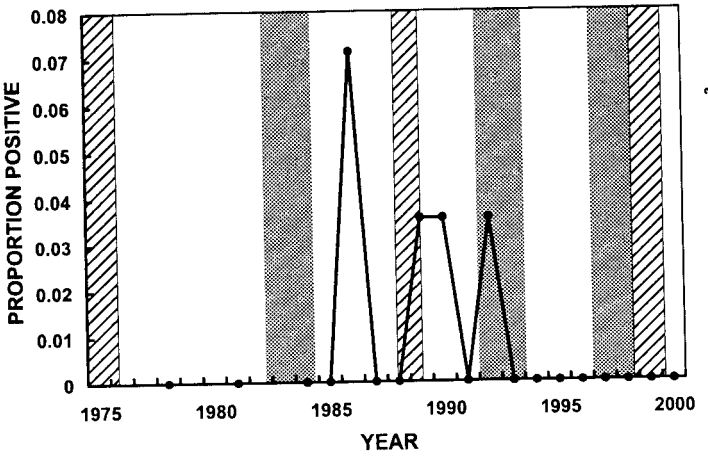



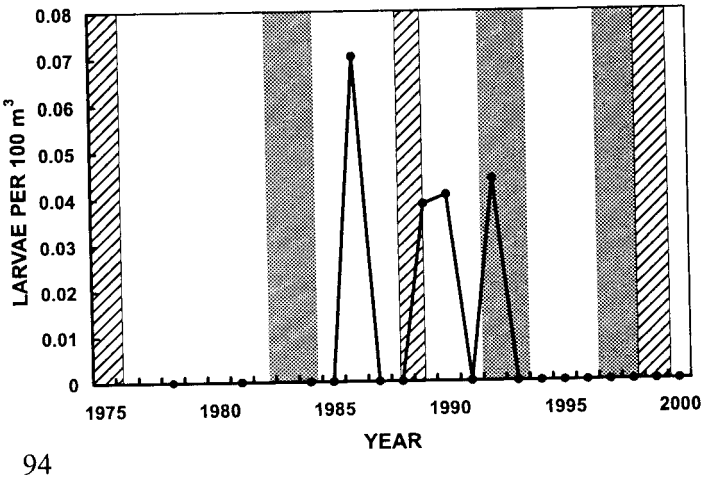




CalCOFI: 1977 - 2000
Total Larvae 4
San Diego
.007 .01 .03
Average Larvae per 100 m³
124° 122° 120° 118° 116°
36° 34° 32° 30°


PROPORTION POSITIVE
MONTH

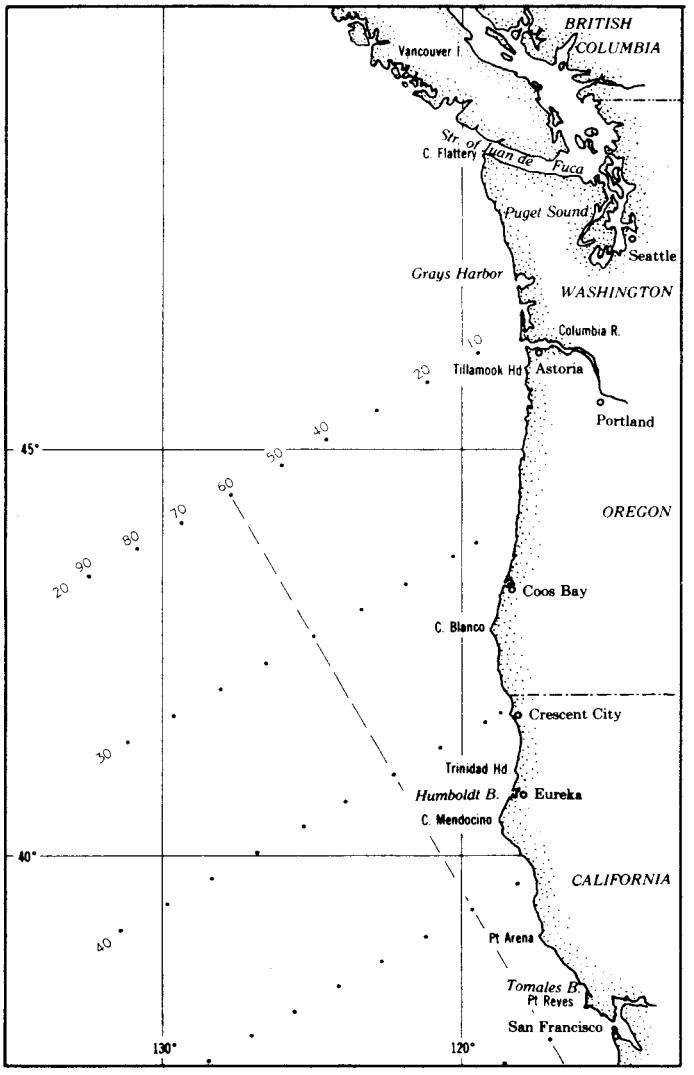

LARVAE PER 100 m³
MONTH

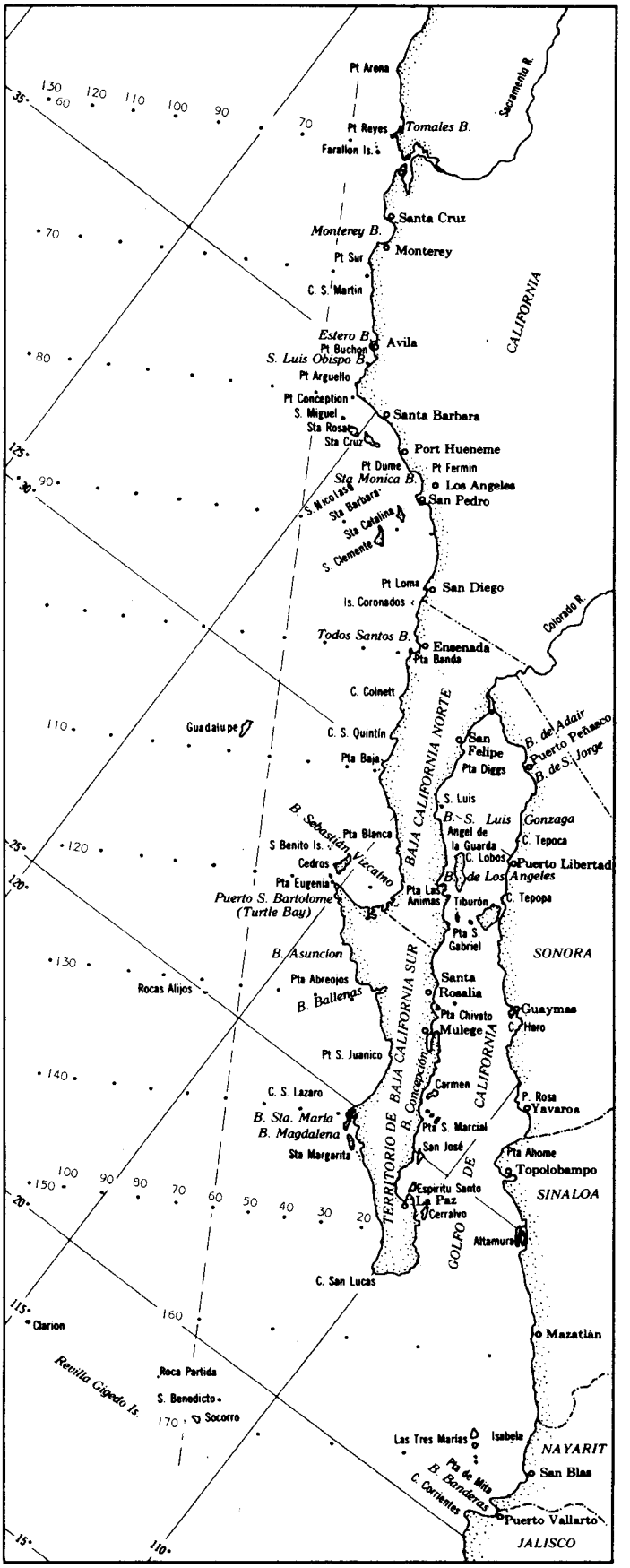

PROPORTION POSITIVE
YEAR


LARVAE PER 100 m³
YEAR

## Alphabetical Index

## Phylogenetic Index




These maps are designed to show essential details of the area most intensively studied by the California Cooperative Oceanic Fisheries Investigations. This is approximately the same area as is shown in color on the front cover. Geographical place names are those most commonly used in the various publications emerging from the research. The cardinal station lines extending southwestward from the coast are shown. They are 120 miles apart. Additional lines are utilized as needed and can be as closely spaced as 12 miles apart and still have individual numbers. The stations along the lines are numbered with respect to the station 60 line, the numbers increasing to the west and decreasing to the east. Most of them are 40 miles apart, and are numbered in groups of 10. This permits adding stations as close as 4 miles apart as needed. An example of the usual identification is 120.65. This station is on line 120, 20 nautical miles southwest of station 60.

The projection of the front cover is Lambert's Azimuthal Equal Area Projection. The detail maps are a Mercator projection.

CONTENTS

Moser H.G., R.L. Charter, P.E. Smith, D.A. Ambrose, W. Watson,
S.R. Charter, and E.M. Sandknop

Distributional atlas of fish larvae and eggs from Manta (surface) samples collected on CalCOFI surveys from 1977 to 2000.