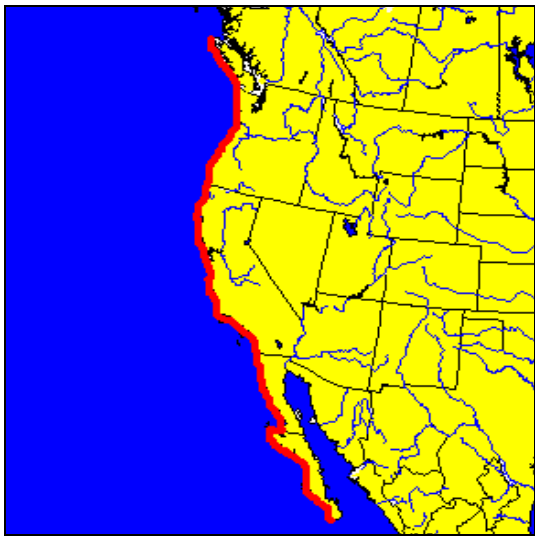
3.3.11 Cancer Crabs

All species of cancer crabs share certain fundamental life history traits. Eggs are extruded from the ovaries through an oviduct and are carried in a sponge-like mass beneath the abdominal flap of the adult female. After a development period of several weeks, the eggs hatch and a pre-zoea larva emerges, beginning the planktonic life history phase. As in all crustaceans, growth progresses through a series of molts. The planktonic larvae advance through six stages of successive increases in size: five zoea (not including the brief pre-zoea stage) and one megalopal. After several weeks as planktonic larvae, the crabs metamorphose into the first crab stage (first instar) and settle out to begin their benthic life history phase. Maturity is generally attained within one to two years. Mature females mate while in the soft-shell molt condition and extrude fertilized eggs onto the abdominal pleopods. Females generally produce one or two batches per year, typically in winter. Fecundity per batch increases significantly with female body size (Hines 1991).

Each species in the genus has characteristic differences in distribution, preferred habitat, growth rates, and demographic parameters. For example, brown rock crab *Cancer antennarius* is a relatively large species (CW up to 200 mm [8 in.]) that lives primarily on sand and mud substrata in estuarine and coastal shelf areas. The slender crab *Cancer gracilis* is a smaller species (CW up to 130 mm [5 in.]) associated with mixed rock-sand substrata in shallow outer coast habitats. Maximum clutch sizes in cancer crabs can range from as many as 5,000,000 eggs in yellow crab *C. anthonyi* to approximately 50,000 in *C. oregonensis*, one of the smaller species (Hines 1991). These types of differences imply that specific information on life history parameters cannot readily be generalized among cancer species.

Cancer crabs are fished along the entire California coast (Leet et al. 1992). Three species are harvested commercially in central California: brown rock crab, red rock crab *Cancer productus*, and yellow crab. There is no commercial fishery for the slender crab. The rock crab fishery is most important in southern California (from Morro Bay south), which produces a majority of the landings, and of lesser importance in northern areas of California where a fishery for the more desirable Dungeness crab *Cancer magister* takes place. Recreational crabbing is popular in many areas and is often conducted in conjunction with other fishing activities. The commercial harvest has been difficult to assess on a species-by-species basis because the fishery statistics are combined into the general “rock crab” category. Rock crab landings in California in 1990 were 818 metric tons (MT), including the landings of crab claws only that were converted to whole weight (Leet et al. 1992). Rock crab landings from five ports near the Monterey Bay National Marine Sanctuary averaged 92 MT/year from 1980 – 1995 (Starr et al. 1998).

3.3.11.1 Brown Rock Crab *Cancer antennarius*



Distribution map for adult brown rock crab

***Adult Range*:** From Queen Charlotte Sound, British Columbia to Cabo San Lucas, Mexico.

***Life History*:** Adult crabs sexually dimorphic; Size: males to 178 mm (7 in.), females to 148 mm (5.8 in.); Size at maturity: 60 to 80 mm (2.4 in. to 3.1 in.); Fecundity: 156,000 to 5 million eggs; Life span: estimated to be five to six years.

***Adult Habitat*:** A variety of substrates including rock, gravel, sand, and sandy-silt. Occurs from the lower intertidal to depths exceeding 100 m (328 ft).

***Adult Fishery*:** Small recreational fishery; moderate commercial fishery.

The brown rock crab *Cancer antennarius* is distributed in nearshore waters along the Pacific coast of North America from British Columbia to Mexico (Jensen 1995). Their range of peak abundance extends from San Francisco Bay to coastal areas south of the U.S.-Mexico border (Carroll and Winn 1989). Brown rock crab are a marine species that inhabit nearshore coastal regions but may also be found in sloughs and estuaries. They are, however, unable to osmoregulate and do not tolerate brackish conditions well (Garth and Abbott 1980).

Brown rock crab inhabit a variety of substrata including rock, gravel, sand, and sandy-silt (Winn 1985). They occur from the lower intertidal zone to depths exceeding 100 m (330 ft) but are typically found near the rock-sand interface in depths of less than 55 m (180 ft) (Carroll and Winn 1989). Ovigerous brown rock crabs have been observed buried in sand at the base of rocks in shallow water. Juvenile brown rock crab inhabiting the intertidal zone survive exposure to the air during low tide by sheltering themselves under rocks and algae (Ricketts et al. 1985).

Brown rock crab fecundity varies with female body size. Brown rock crab females can extrude between approximately 156,000 and five million eggs per batch (Hines 1991). Females on average produce a single batch per year. However, due to occasional multiple spawning, the average number of batches per year may be greater than one (Carroll 1982). Brown rock crab eggs require a development time of approximately seven to eight weeks from extrusion to hatching (Carroll 1982). Brown rock crab are between 60 to 80 mm (2.4 to 3.1 in.) CW at maturity (Carroll 1982).

Larval development in the brown rock crab was described by Roesijadi (1976). Eggs hatch into pre-zoea larvae that molt to first stage zoea in less than one hour. Average larval development time (from hatching through completion of the fifth stage) was 36 days at 13.8 °C (56.8 °F). Although some crabs molted to the megalopal stage, none molted to the first crab instar stage, so the actual duration of the megalopal stage is unknown. A reasonable estimate can be derived from studies of slender crab by Ally (1975), who found an average duration of megalopal stage of 14.6 days. Therefore, the estimated length of time from hatching to settling for brown rock crab is assumed to be approximately 50 days.

During their planktonic existence, crab larvae can become widely distributed in nearshore waters. In a study in Monterey Bay, Graham (1989) found that brown rock crab stage 1 zoeae are most abundant close to shore and that subsequent zoeal stages tend to remain within a few kilometers of the coastline. The adult population primarily resides in relatively shallow rocky areas, and the nearshore retention of larvae in Graham's study (1989) was related to the formation of an oceanographic frontal zone in northern Monterey Bay that prevented substantial offshore transport during upwelling periods.

The nearshore distribution of crab larvae depends upon developmental stage. Shanks (1985) presented evidence that early stage larvae of rock crabs (probably yellow crab in his southern California study) generally occur near the bottom, in depths up to 80 m (264 ft); late stage larvae, however, were more abundant near the surface. He suggested that a combination of physical factors (primarily including wind-generated surface currents and

tidally forced internal waves) caused megalopae to be transported shoreward. Late stage larvae (megalopae) generally begin to recruit to the nearshore habitat in spring (Winn 1985).

Brown Rock Crab Results

Brown rock crab megalopae were collected episodically at the MBPP intake station (Figure 3-48). They were collected in winter and again in the late-spring and summer with peak concentrations in June 2000. The concentrations during the late-spring through summer period were much greater than those during the winter in 1999 and 2000.

While concentrations of brown rock crab megalopae peaked in June 2000 at the MBPP intake station, their greatest abundance occurred in Estero Bay during April and May (Figure 3-49). Megalopal brown rock crabs were consistently most abundant in the paired surveys in Estero Bay during the course of the study. Early life stages of cancer crabs are often distributed along gradients perpendicular to shore (Tenera, unpubl. data, Carrasco et al. 1985).

Concentration (#/m^3) of megalopal brown rock crab was compared among stations for samples collected at ebb and flood tides (Figure 3-50). The highest brown rock crab megalopae concentrations were recorded in Estero Bay (Station 5) where tidal currents would be expected to have little effect on larval concentrations. The concentrations at this station were an order of magnitude or more greater than concentrations at stations inside the bay.

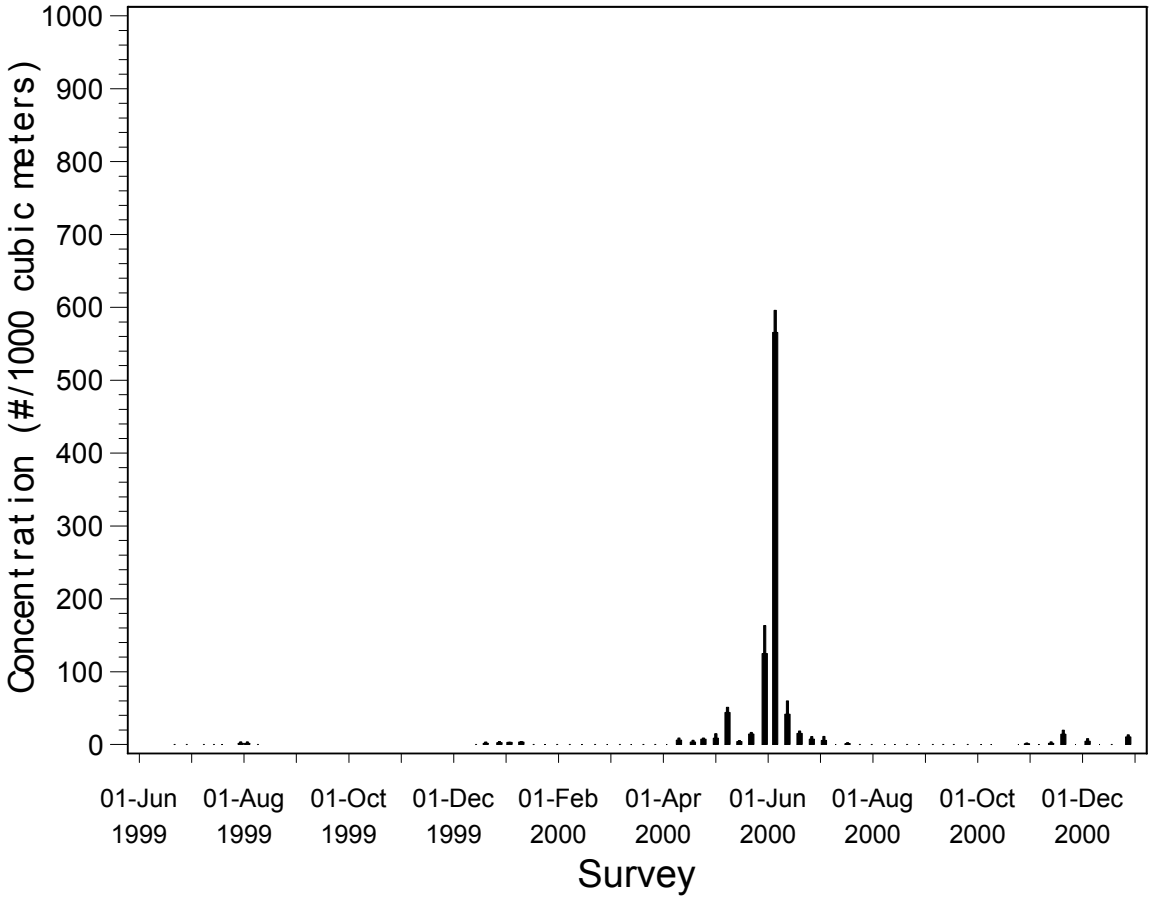


Figure 3-48. Weekly survey mean concentrations of megalopal brown rock crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

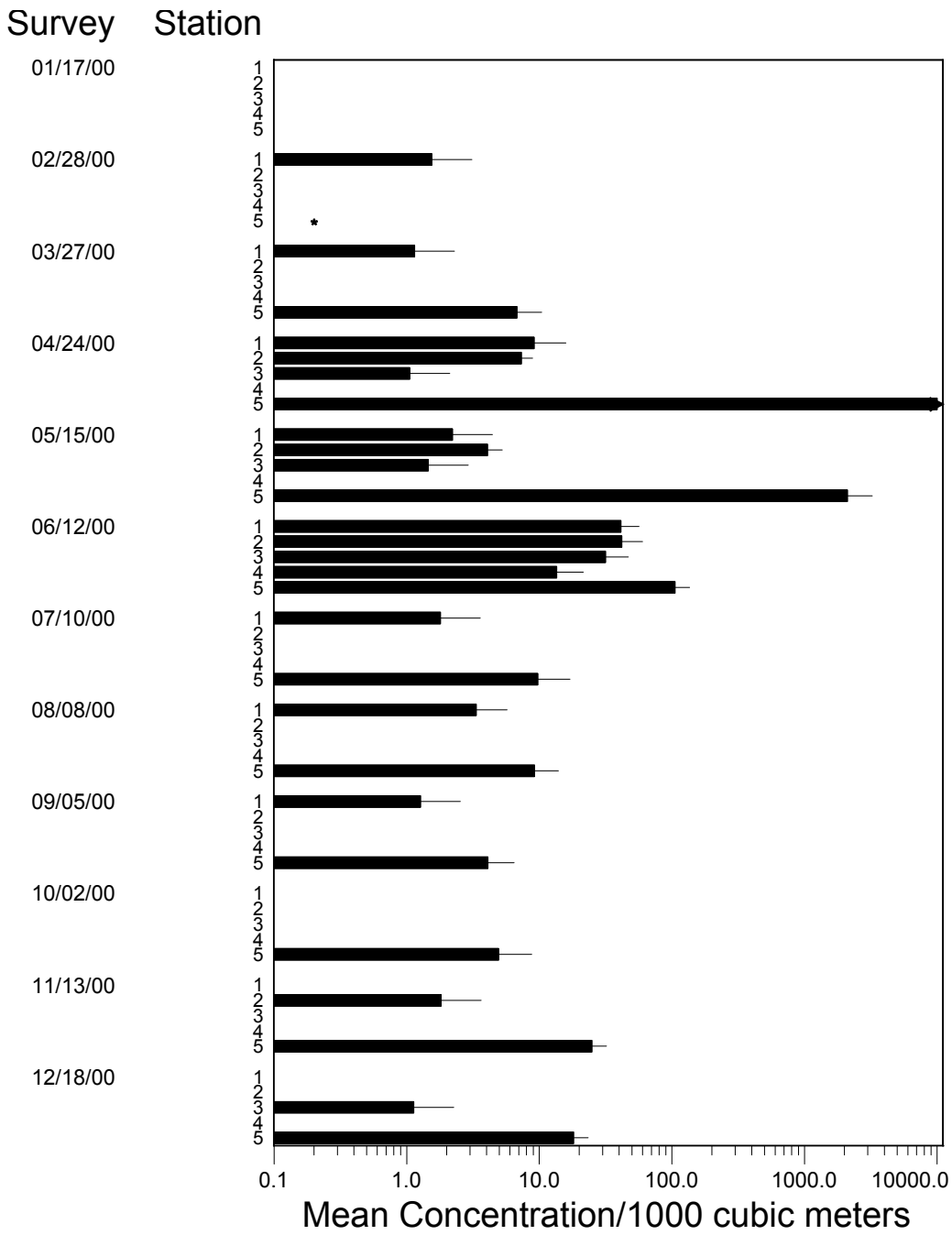


Figure 3-49. Mean megalopal brown rock crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

* Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

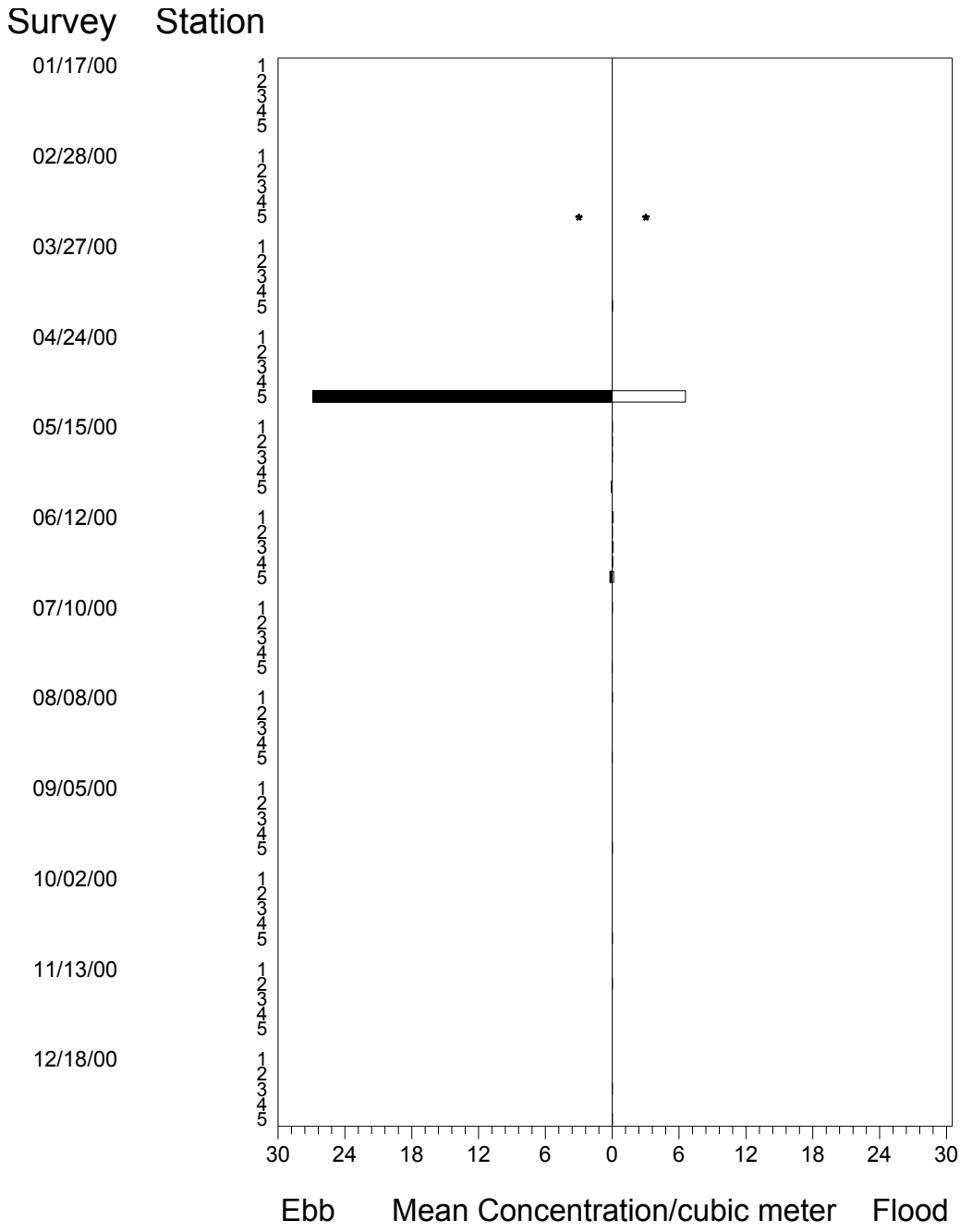
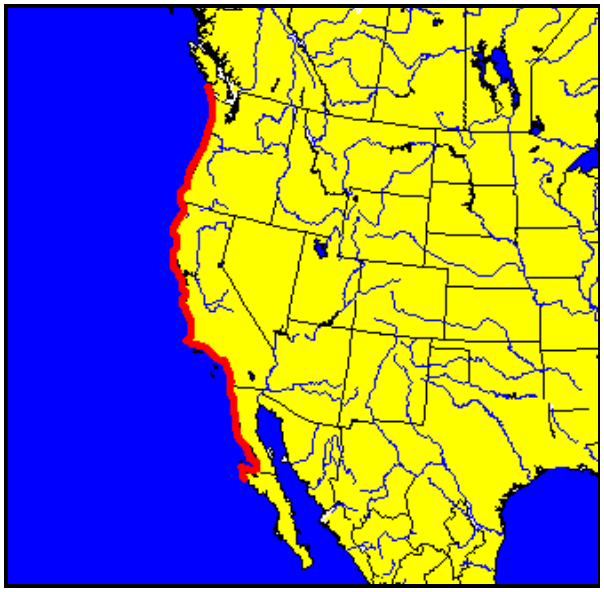


Figure 3-50. Mean concentration of megalopal brown rock crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

3.3.11.2 Hairy Rock Crab *Cancer jordani*



Distribution Map for adult hairy rock crab

Adult Range: From Neah Bay, Washington to Bahía de Tortuga, Baja California.

Life History: Size: males up to 39.3 mm (1.5 in.); females to 19.5 mm (0.7 in.); Size at maturity: no information available; Fecundity: no specific information available; Life span: no estimate available.

Adult Habitat: Under rocks in shallow bays, subtidally in kelp holdfasts; intertidally to depths of 104 m (340 ft).

Adult Fishery: No commercial or recreational fishery.

The hairy rock crab is one of the smallest members of the family Cancridae. The species ranges from Baja California to Washington (Jensen 1995). Hairy rock crab occur from the intertidal zone down to depths of 104 m (340 ft) (Garth and Abbott 1980). They are most often observed under rocks in the shallow waters of bays, but may also be found subtidally in the holdfasts of kelp. In Monterey Bay, up to 78 hairy rock crab have been documented per square meter of kelp holdfast (Garth and Abbott 1980).

Hairy Rock Crab Results

Similar to the brown rock crab, the collection of hairy rock crab megalopae at the MBPP intake station was episodic during the study (Figure 3-51). The periodicity of hairy rock crab abundance at the MBPP intake was also similar to that of brown rock crab megalopae with highest concentration occurring in the late spring. Despite the similarities, hairy rock crab megalopae were collected in markedly lower concentrations than brown rock crab megalopae.

Hairy rock crab megalopae were most abundant at Estero Bay Station 5 during monthly paired surveys (Figure 3-52). In months following high megalopal abundance in Estero Bay, hairy rock crab megalopae were abundant and common at the stations within Morro Bay suggesting onshore movement of the megalopal hairy rock crabs from Estero Bay. Greater abundance of megalopal hairy crabs in Estero Bay follow the pattern for Dungeness crab (Carrasco et al. 1985) and other megalopal cancrid crabs in central California (Tenera, unpubl. data).

Concentration (#/m^3) of megalopal hairy rock crab was compared among stations for samples collected at ebb and flood tides (Figure 3-53). Hairy rock crab megalopal abundance was greatest in Estero Bay (Station 5) where tidal currents have little effect.

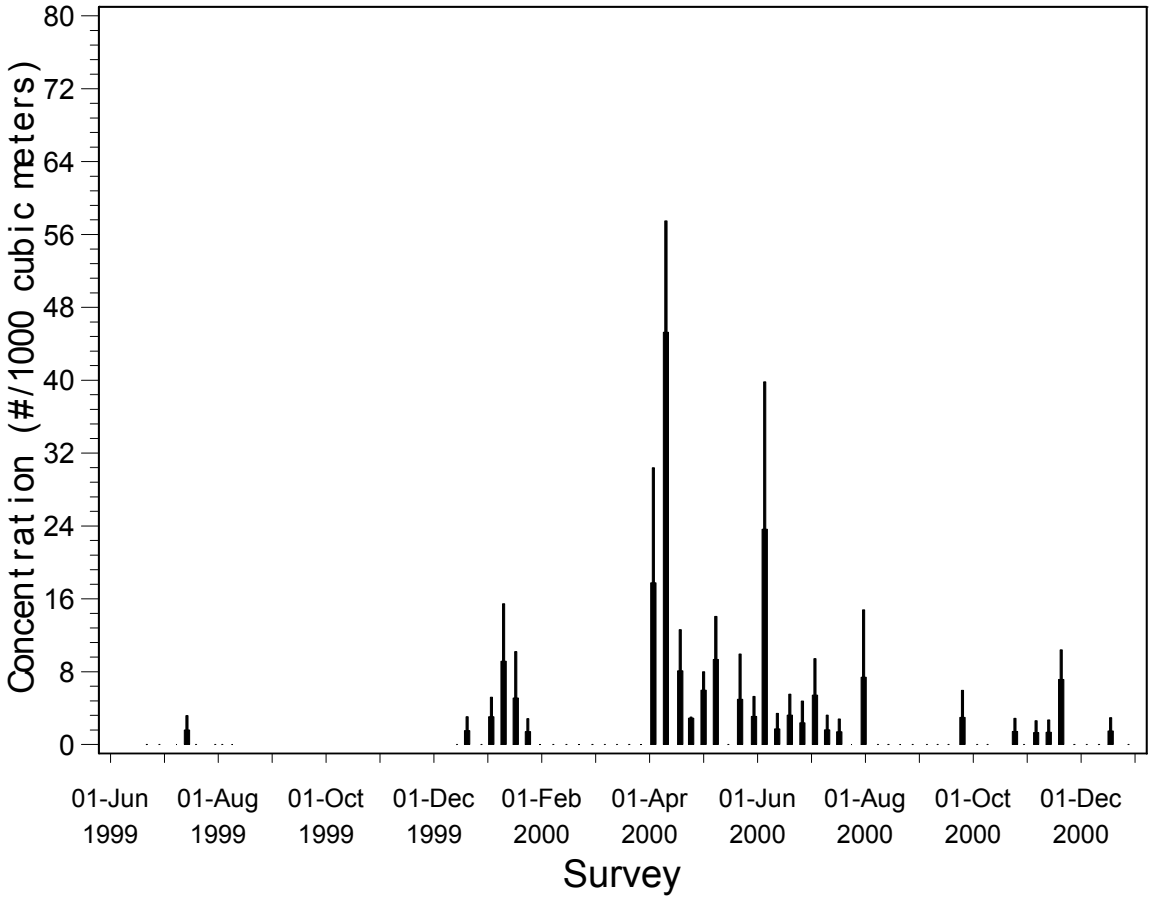


Figure 3-51. Weekly survey mean concentrations of megalopal hairy rock crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

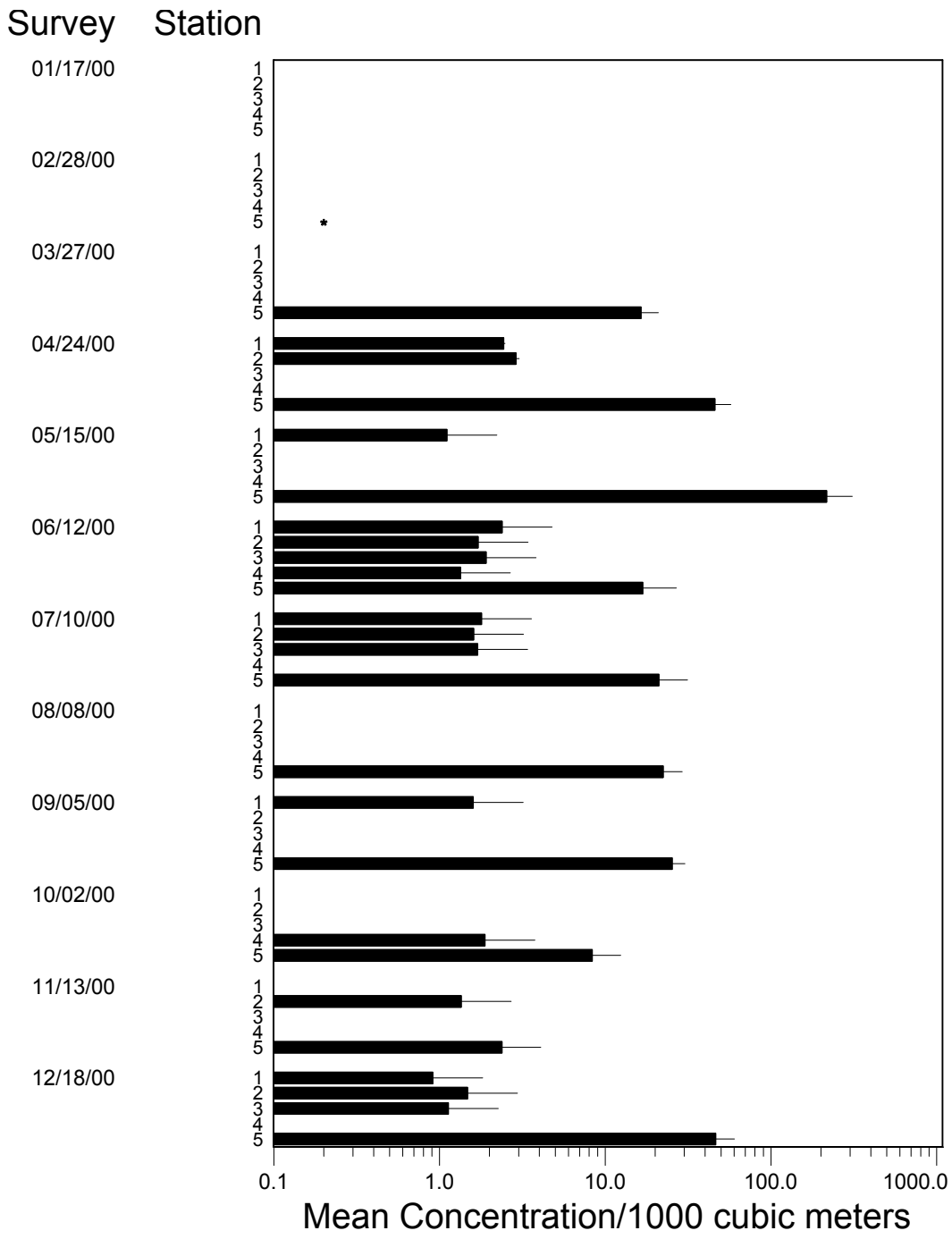


Figure 3-52. Mean megalopal hairy rock crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

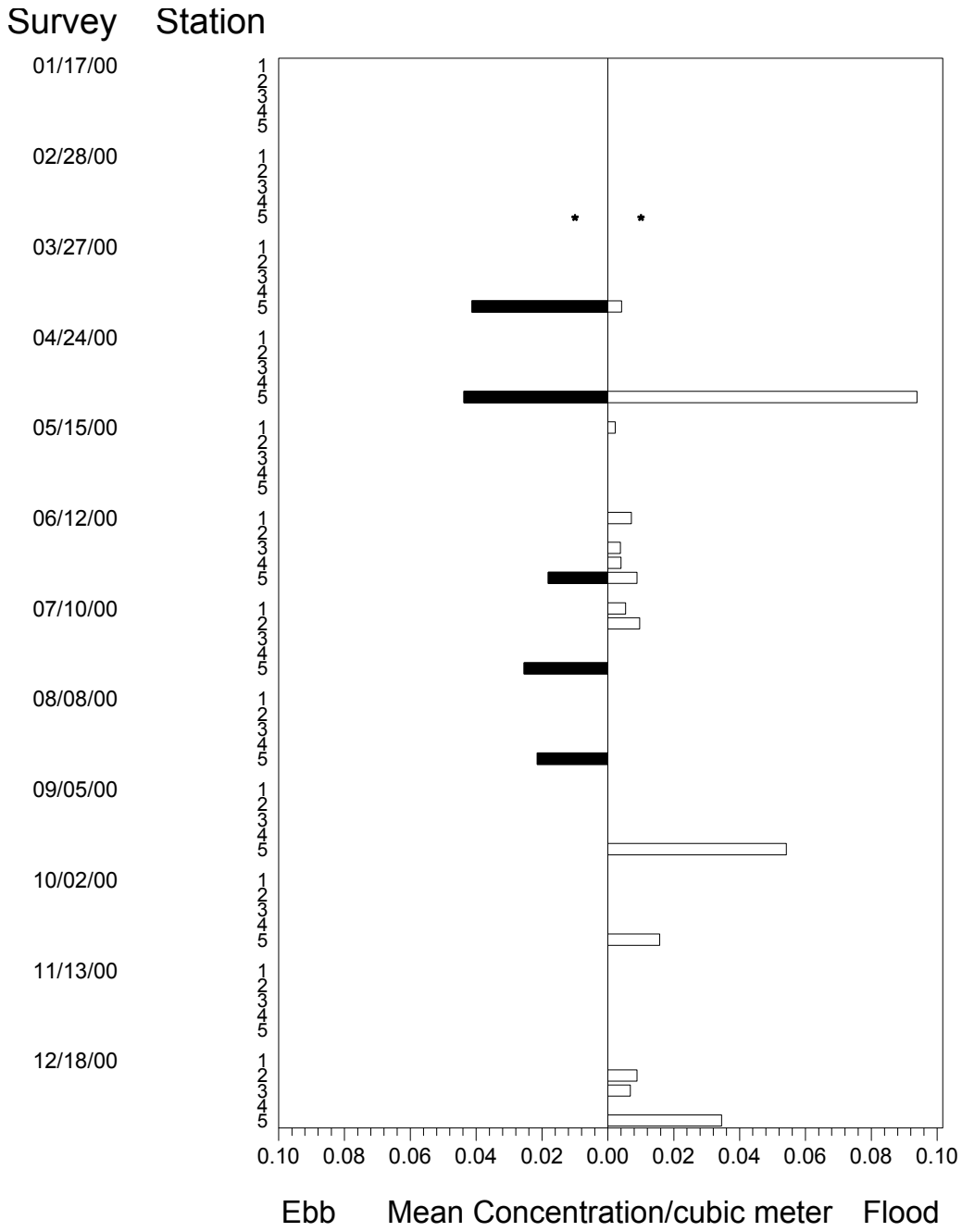
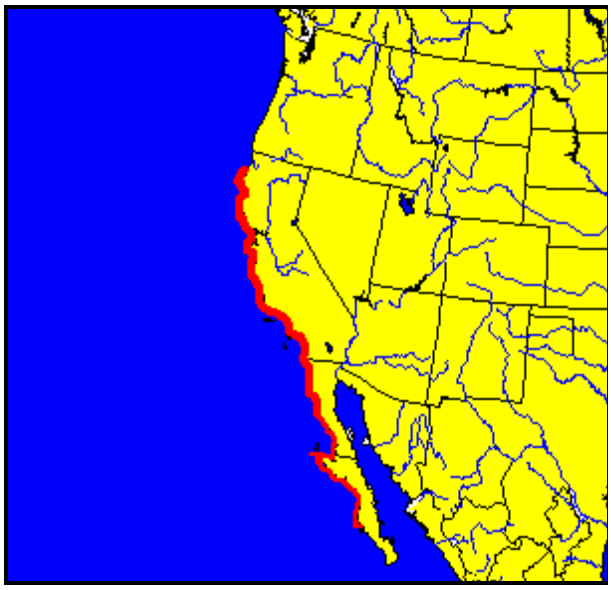


Figure 3-53. Mean concentration of megalopal hairy rock crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

3.3.11.3 Yellow Crab *Cancer anthonyi*



Distribution map for adult yellow rock crab

***Adult Range*:** From Humboldt Bay, California to Bahía Magdalena, Baja California.

***Life History*:** Adult crabs sexually dimorphic; Size: males to 176 mm (6.9 in.), females reach 144 mm (5.6 in.); Size at maturity: 90 to 100 mm (3.5 to 3.9 in.) for laboratory-reared animals; Fecundity: 680,000 to 3.85 million eggs; Life span: no estimate available.

***Adult Habitat*:** Soft substrates such as sand, sandy-silt, and mud; occur in the vicinity of rock reefs or artificial structures; the lower intertidal zone to depths exceeding 130 m (427 ft).

***Adult Fishery*:** Moderate commercial fishery, small recreational fishery.

The yellow crab *Cancer anthonyi* occurs along the Pacific coast of North America from Humboldt Bay, California to Bahía Magdalena, Baja California (Jensen 1995). Their distribution is almost exclusively associated with sand habitat within this range (Winn 1985, Carroll and Winn 1989). The species is most abundant on the expanses of open, sandy substrata, although it is also commonly encountered near the rock-sand interface of natural and artificial reefs (Morris et al. 1980, Carroll and Winn 1989). Yellow crab are also common underneath and in the vicinity of offshore oil and gas platforms south of Point Conception (Page et al. 1999). In the northern parts of their range, where rocky

benthic substrata predominate, their distribution appears to be confined to bays, sloughs, and estuaries (Jensen 1995). Yellow crab occur from the lower intertidal zone to depths exceeding 130 m (427 ft) but are most commonly found in depths between 18 to 55 m (59 to 180 ft) (Morris et al. 1980, Winn 1985, Carroll and Winn 1989, Jensen 1995). They are the most abundant cancer crab species harvested in southern California, often comprising 70 to 95 percent of the total crab catch in the region (Carroll and Winn 1989).

Yellow Crab Results

Yellow crab megalopae were collected at the MBPP intake station almost year-round (Figure 3-54). There may be two spawning peaks during the year analyzed; June through July and November through December. Their highest concentrations occurred during winter.

Yellow crab megalopae occurred between April and December 2000 in the monthly source water surveys (Figure 3-55). Unlike brown and hairy rock crabs, their abundance appeared, in most cases, to be about equally distributed between Estero and Morro bays. In May and September they were collected only in Estero Bay.

Concentration (#/m^3) of megalopal yellow crab was compared among stations for samples collected at ebb and flood tides (Figure 3-56). Yellow crab megalopal abundance patterns were unique among the crabs examined. In particular, yellow crab megalopae occurred in relatively high abundance inside of Morro Bay on flood tides, although their greatest concentrations were recorded from the sampling station in Estero Bay, generally on ebb tides.

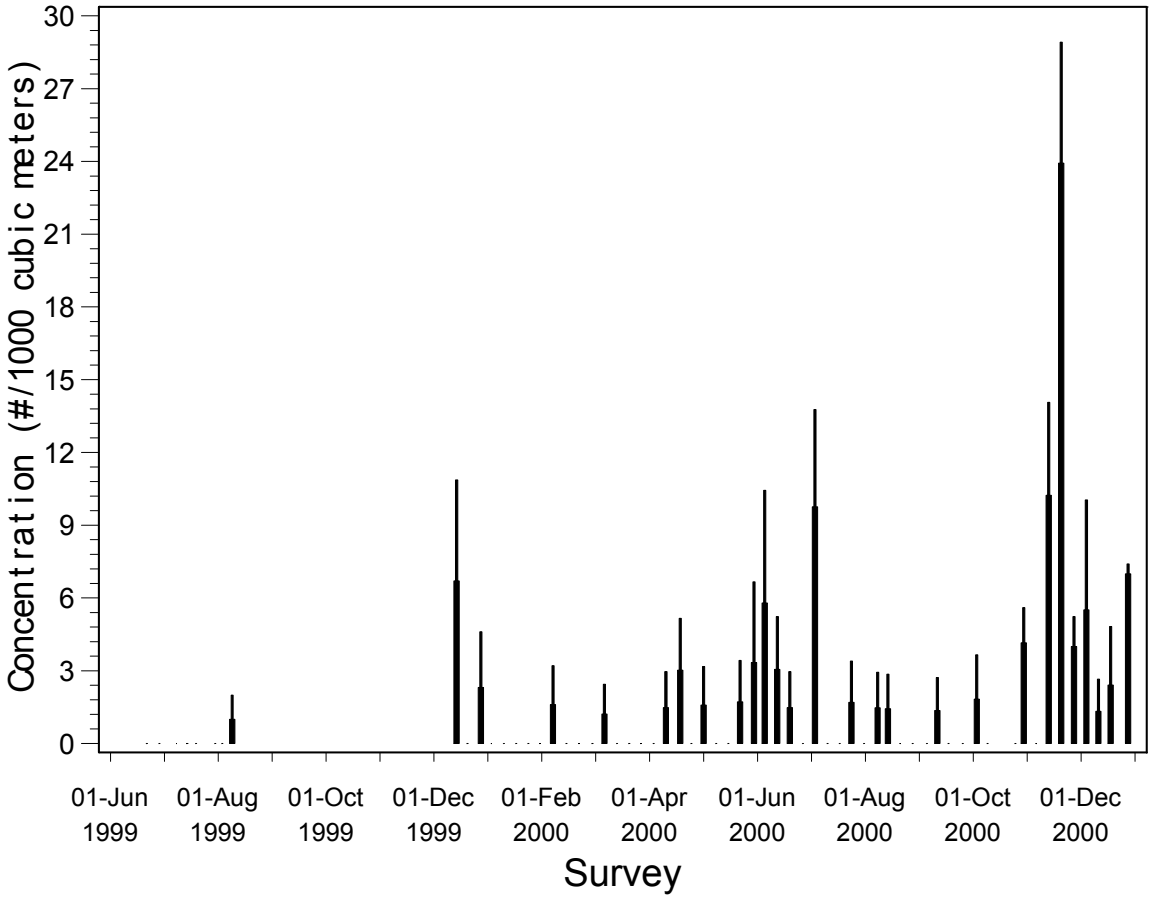


Figure 3-54. Weekly survey mean concentrations of megalopal yellow crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

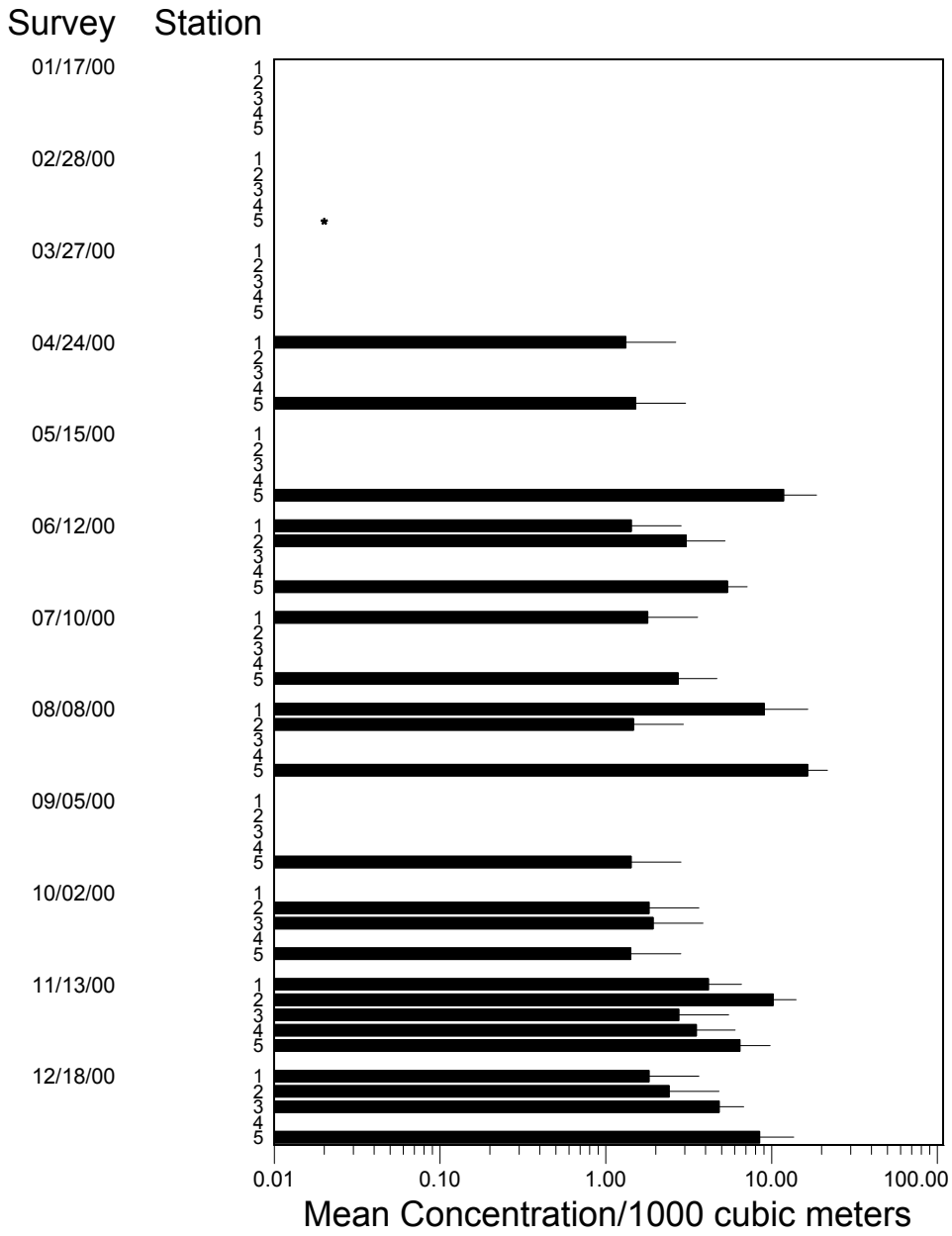


Figure 3-55. Mean megalopal yellow crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

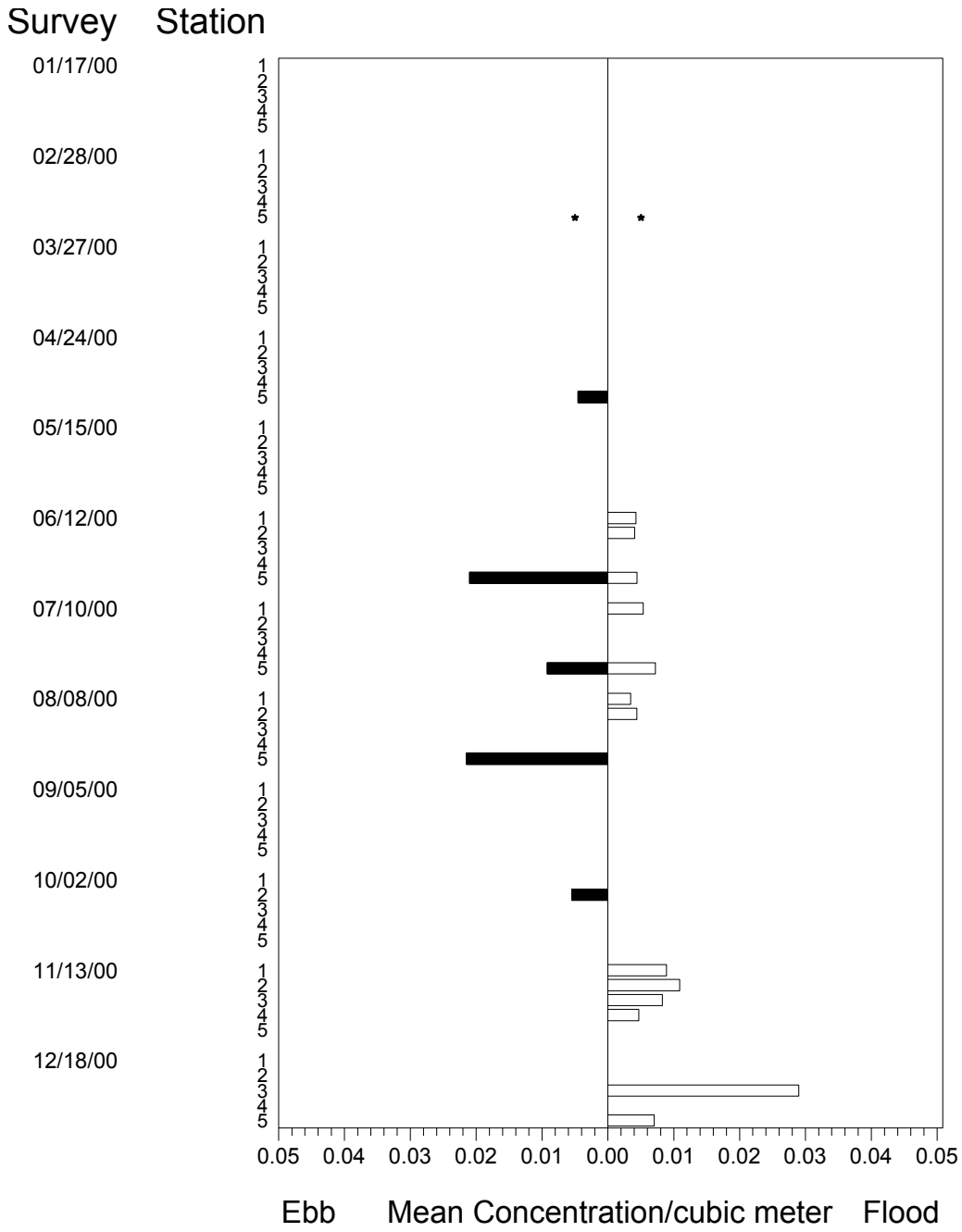
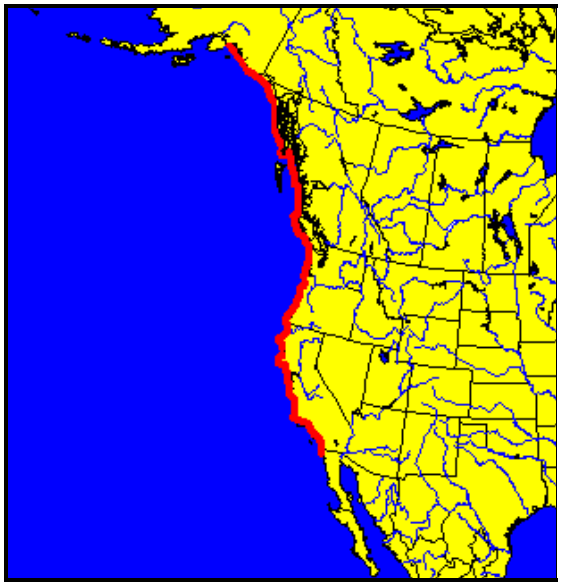


Figure 3-56. Mean concentration of megalopal yellow crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

3.3.11.4 Slender crab *Cancer gracilis*



Distribution map for adult slender crab

Adult Range*:* From Prince William Sound, Alaska to Bahía Playa Maria, Mexico.

Life History: Size: males to 115 mm (4.5 in.), females to 87 mm (3.4 in.); Age at maturity: approximately 10 months of age (post-settlement), about 60 mm (2.4 in.); Fecundity: spawns once a season, 143,000 to one million eggs; Life span: approximately three years.

Adult Habitat: Sandy and muddy bottoms of intertidal areas to 174 m (571 ft), kelp and eelgrass beds, seasonally in bays and sloughs.

Adult Fishery: Occasionally taken in the sport fishery.

Slender crab are found from Prince William Sound, Alaska to Bahía Playa Maria, Mexico (Jensen 1995). They inhabit the sandy and muddy bottoms of intertidal areas and are found subtidally, often in kelp beds to depths of 174 m (571 ft) and in eelgrass beds (Garth and Abbott 1980). Slender crab do not osmoregulate and therefore cannot tolerate low salinity brackish environments. They are usually not found in estuaries, but may be found seasonally in bays and sloughs (Jensen 1995).

Slender crab are often misidentified as Dungeness crab, but are much smaller in size. Their carapace width measures up to 115 mm (4.5 in.) in males and up to 87 mm (3.4 in.) in females (Jensen 1995). Their white-tipped claws lack the serrations belonging to Dungeness crab and their walking legs are slender.

In Monterey Bay, spawning of slender crab has been reported to occur in the spring and fall (Graham 1989). Females produce one batch per year, although in a laboratory setting, some females produced a small second batch. The number of eggs extruded per female can range from 143,000 to one million. Females are able to spawn for at least two, and possibly three seasons, over their lifetime (Orensanz and Gallucci 1988).

After hatching, slender crab exist in a pre-zoeal stage for a very short time before molting to first stage zoeae. Slender crab progress through five zoeal stages to a megalopal stage in an average of 48.9 days at 17 ºC (63 ºF); each stage lasting approximately one week (Ally 1975). All larval stages are planktonic and the crab larvae may become widely distributed. It is estimated that slender crab mature at a size of about 60 mm (2.4 in.) CW and at approximately 10 months of age (post-settlement) (Orensanz and Gallucci 1988). Slender crab molt approximately 11 to 12 times, and live for about four years.

Slender Crab Results

Slender crab megalopae were collected at the MBPP intake station during all months (Figure 3-57). Their highest concentration at the intake station occurred during the late spring and summer months and their lowest concentrations were observed from November through January.

Slender crab megalopae were collected in monthly paired surveys during nine of the twelve months (Figure 3-58). They were collected at all sampling stations (although not every month) except Station 3 and were typically found in the highest concentrations at the Estero Bay station (Station 5) and harbor mouth station (Station 1). During eight of the nine months that slender crab megalopae were present in samples, the highest mean concentrations were collected at the Estero Bay station (Station 5). Slender crab megalopae were collected at the back bay Station (Station 4) only during the late fall and winter months and were collected at the intake station (Station 2) only during the March, June, and December 2000 monthly paired surveys.

Concentration (#/m^3) of megalopal slender crab was compared among stations for samples collected at ebb and flood tide (Figure 3-59). The highest concentrations of slender crab megalopae were typically recorded at the Estero Bay station (Station 5) where tidal currents would be expected to have little effect on megalopal concentrations. Slender crab megalopae mainly collected during flood tides at all stations except Station 3 in December 2000.

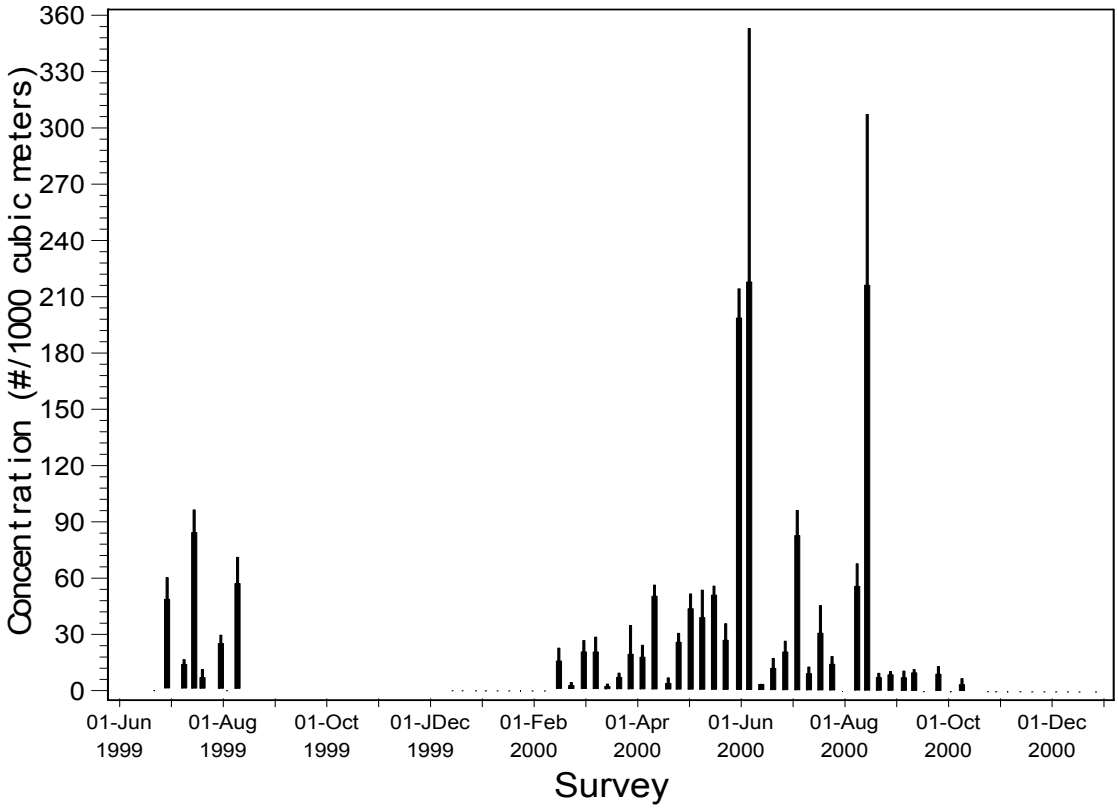


Figure 3-57. Weekly survey mean concentrations of megalopal slender crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

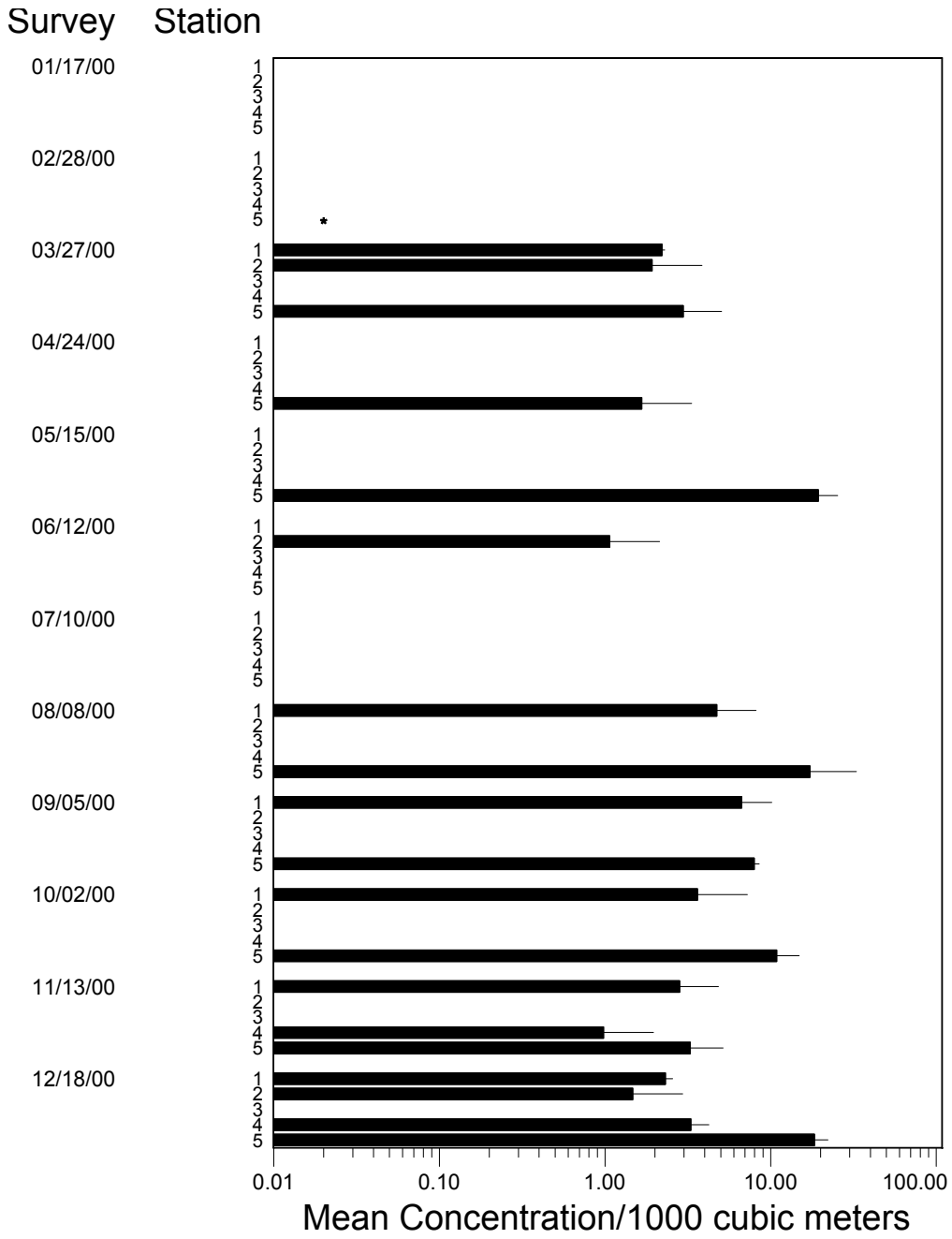


Figure 3-58. Mean megalopal slender crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

* Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

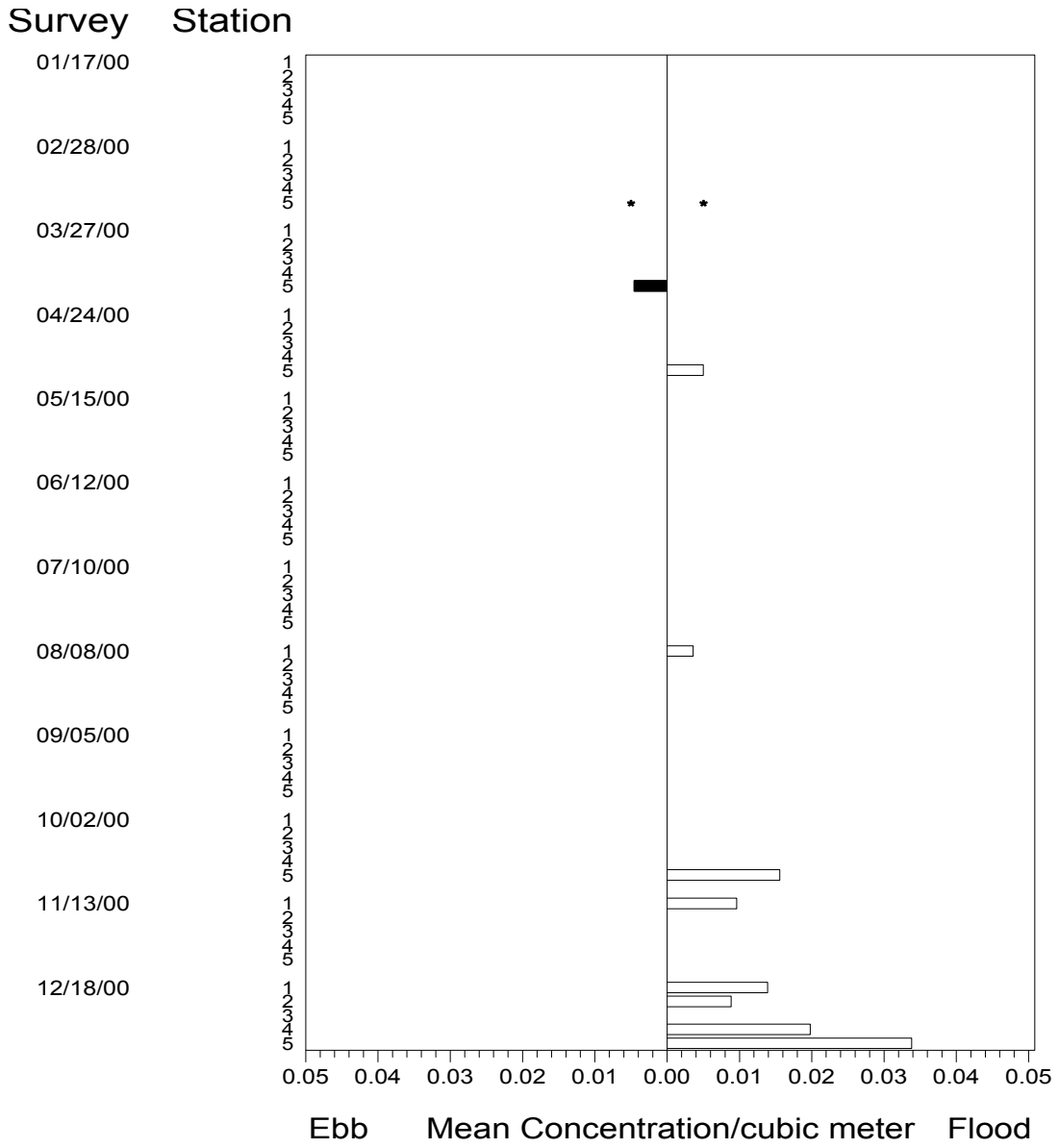


Figure 3-59. Mean concentration of megalopal slender crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

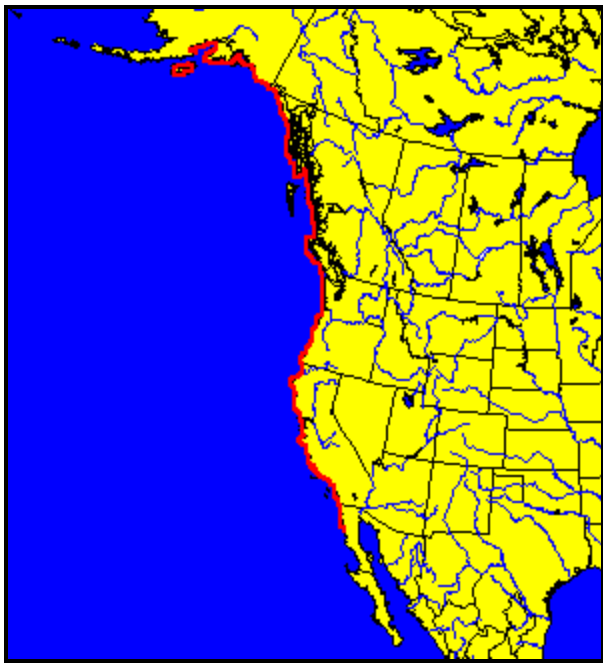
Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

3. 3.11.5 Red Rock Crab *Cancer productus*

Source: CDFG

Cancer productus



Distribution map for red rock crab

***Adult Range*:** From Kodiak Island, Alaska to Isla San Martin, Baja California.

***Life History*:** Adult crabs sexually dimorphic; Size: males to 200 mm (7.8 in.), females to 158 mm (6.2 in.); Fecundity: up to 1.5 million eggs.

***Adult Habitat*:** Hard substrate such as rocky reefs, well-protected boulder-strewn beaches, and gravel beds. Occur from the lower intertidal zone to depths of at least 91 m (299 ft).

***Adult Fishery*:** Recreational; small commercial fishery.

The red rock crab *Cancer productus* occurs along the Pacific coast of North America from Kodiak Island, Alaska to Isla San Martin, Baja California (Jensen 1995). The southern extent of the species is in southern California, based on low densities of red rock crabs collected during trapping studies in San Diego County (Carroll and Winn 1989). The abundance of red rock crab, relative to the other rock crab species, increases with

latitude within the state. Red rock crab inhabit a variety of substrata including intertidal and subtidal rocky areas, gravel, coarse sand, and mud (Carroll and Winn 1989). They are commonly found in close association with hard substratum such as rocky reefs, well-protected boulder-strewn beaches, and gravel beds (Morris et al. 1980, Carroll and Winn 1989, Jensen 1995). Red rock crab occur from the lower intertidal zone to depths of at least 91 m (299 ft) (Winn 1985, Carroll and Winn 1989). Juvenile red rock crab inhabiting the intertidal zone survive exposure to the air during low tide by sheltering themselves under rocks and algae (Ricketts et al. 1985). Red rock crab are often collected in bays, estuaries, and sloughs, however, their distribution in these areas is affected by salinity gradients because the species lacks the ability to osmoregulate (Garth and Abbott 1980).

Like the brown rock crab and yellow crab, adult red rock crab are sexually dimorphic, with males attaining a larger size and growing larger, more robust chelae (claws). Male crabs grow to a maximum size (CW) of 200 mm (7.8 in.), while females reach 158 mm (6.2 in.) (Jensen 1995). No estimates of the life span of red rock crab were cited in the literature reviewed.

The size of a female's egg mass is variable and can contain from over one million eggs (Carroll and Winn 1989). No information about the development and subsequent hatching of red rock crab eggs was available in reviewed literature. Trask (1970) found that red rock crab larvae developed to the megalopal stage in 97 days at a temperature of 11° C (52° F), however, none of his laboratory-reared larvae survived to the first crab instar.

Red Rock Crab Results

Red rock crab were collected in very few of the entrainment surveys (Figure 3-60) and comprised less than 1 percent (0.6) of the total number of entrained *Cancer* spp. megalopae (Figure 3-3). Although they are reported as inhabitants of bays and estuaries (Morris et al. 1980) they were most abundant at the Estero Bay station (Station 5) and were never collected from the stations in the interior portions of the bay (stations 3 and 4) during the source water surveys (Figure 3-61). Although their abundances are probably too low to draw any conclusions, they were more abundant on flood tides, which is consistent with their higher Estero Bay abundances (Figure 3-62).

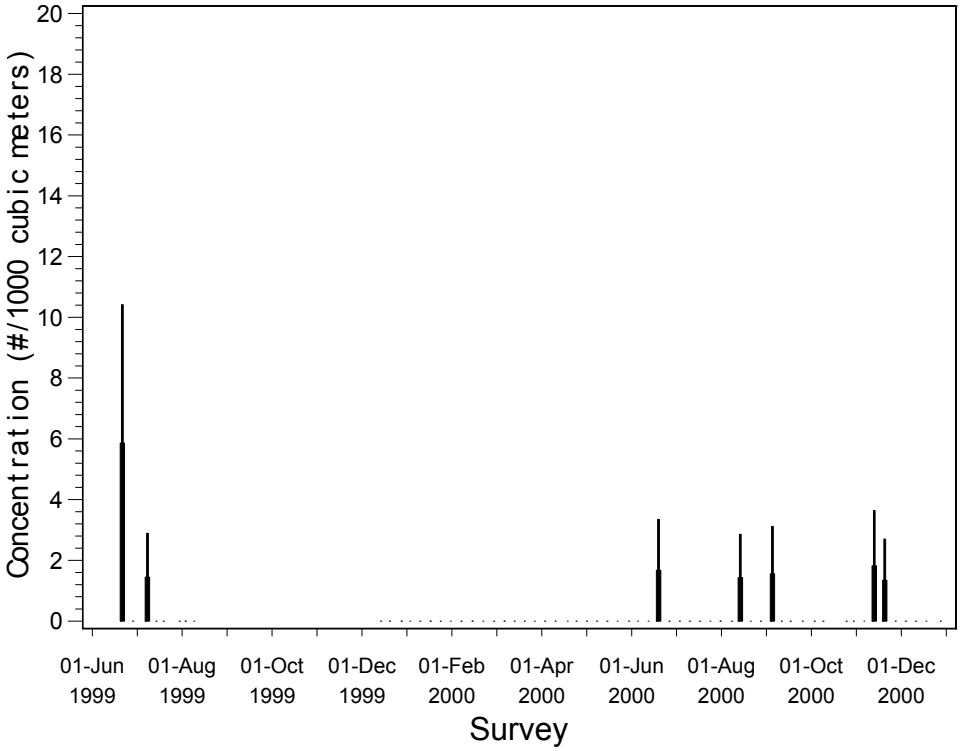


Figure 3-60. Weekly survey mean concentrations of megalopal red rock crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

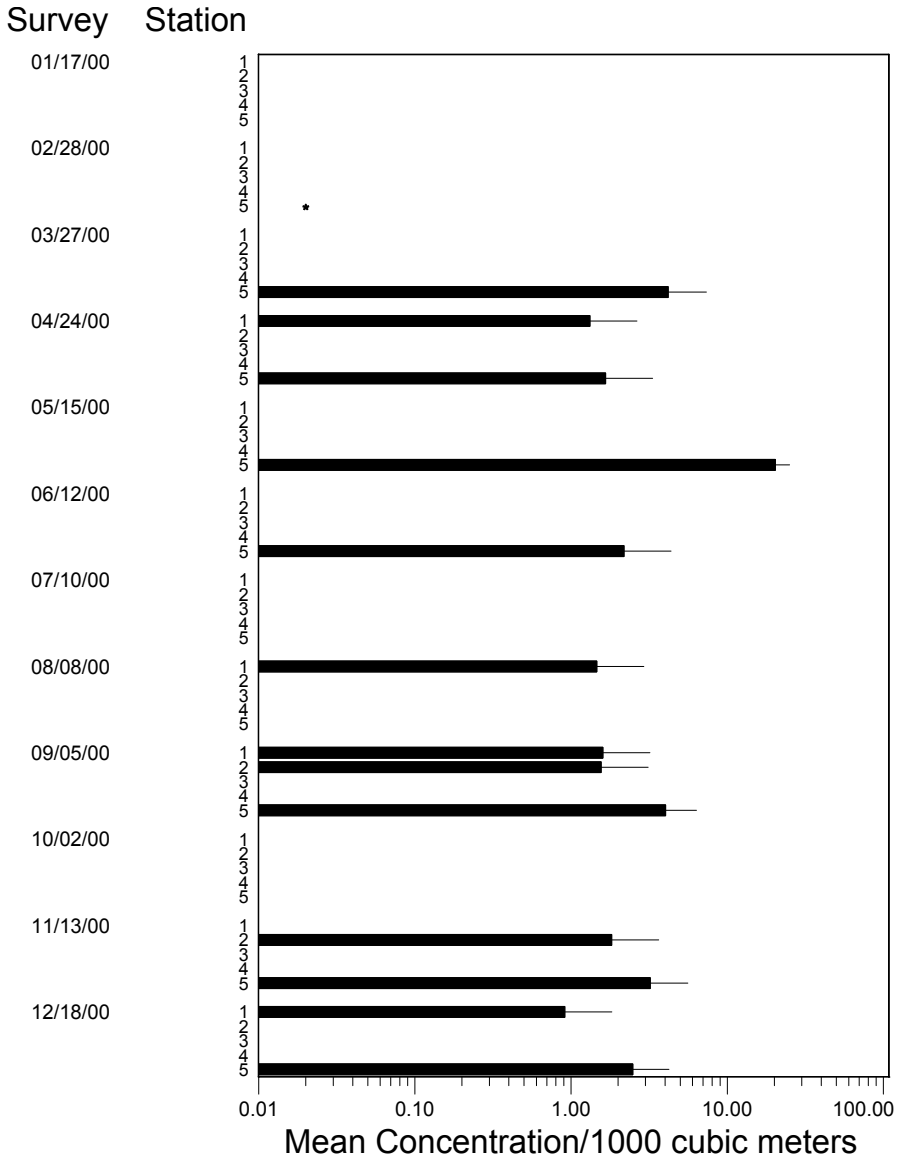


Figure 3-61. Mean megalopal red rock crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

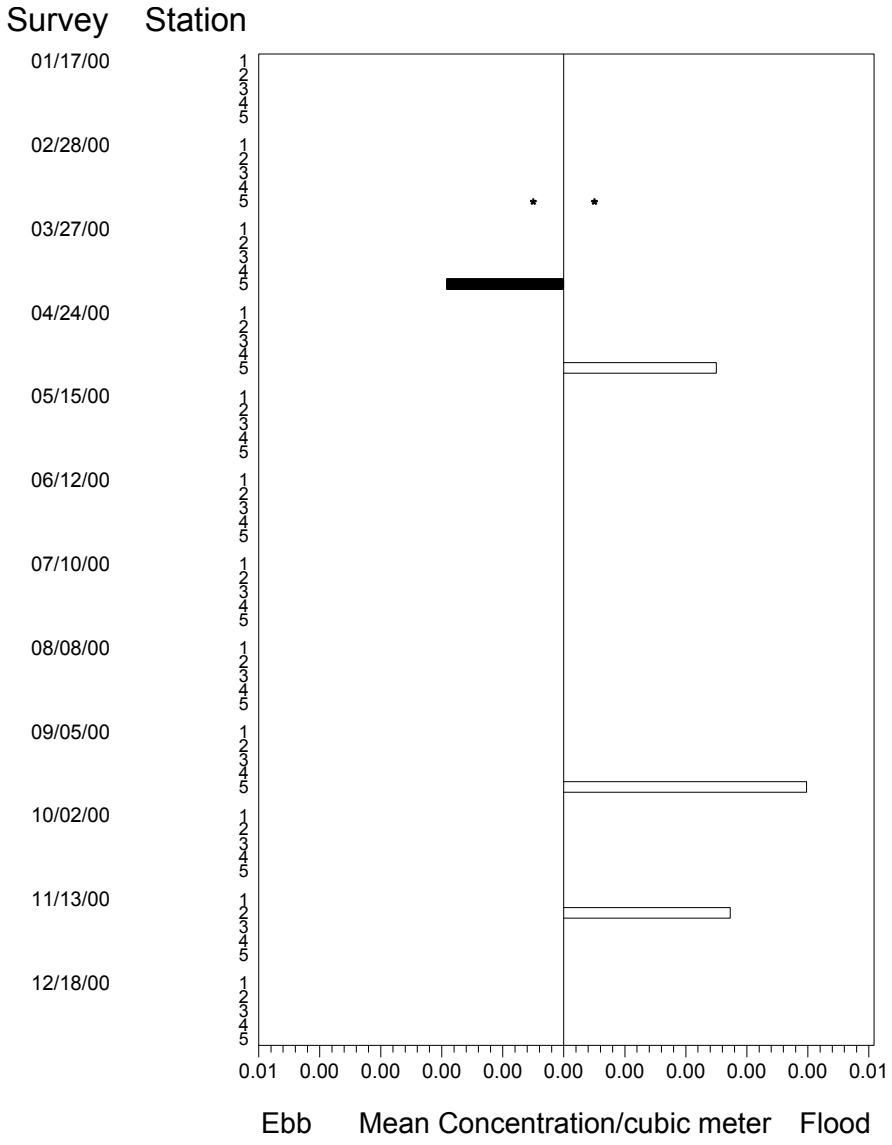
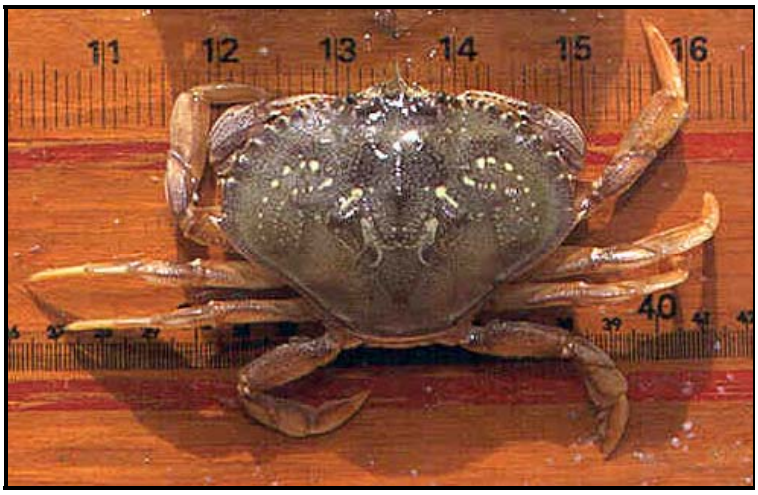


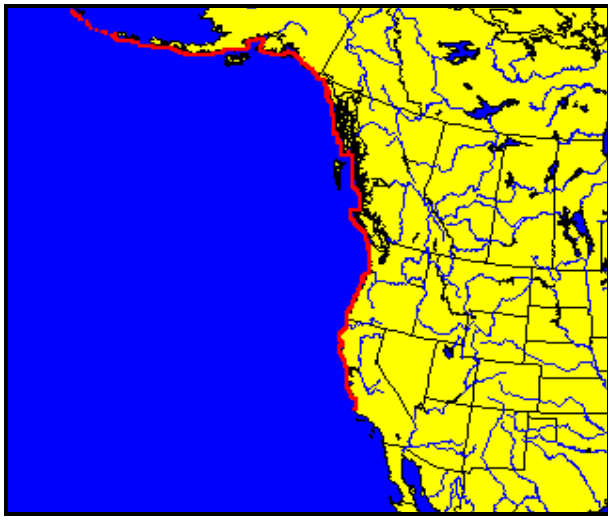
Figure 3-62. Mean concentration of megalopal red rock crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

3.3.11.6 Dungeness Crab *Cancer magister*





Distribution map for adult Dungeness crab

Adult Range: From Pribilof Islands, Alaska to Point Conception, California.

Life History: Size: males to 230 mm (9 in.), females to 165 mm (6.5 in.); Age at maturity: two years; Fecundity: up to 1.3 million eggs, spawns once a year; Life span: to six years.

Adult Habitat: Common sub-tidally to 90 m (295 ft); as deep as 230 m (750 ft).

Adult Fishery: Recreational, large commercial market.

Dungeness crab occur in Pacific coastal waters from Alaska to near Santa Barbara, California (Jensen 1995). They are one of the largest and most commercially important crabs along the Pacific coast. The northern coast of California, including Bodega Bay and the San Francisco area, supports a sizable Dungeness crab population, while smaller populations occur in the Monterey Bay and Morro Bay/Avila Beach area (Dahlstrom and Wild 1983).

Dungeness crab are confined mainly to cold and temperate waters with annual mean temperatures ranging from 4° to 24° C (40° to 75° F) (Garth and Abbott 1980). Adult Dungeness crab commonly occur subtidally to 90 m (295 ft), residing on sandy bottoms

and in eelgrass beds, but they may be found as deep as 230 m (750 ft) (Jensen 1995). Estuaries are important to their life cycle, and Dungeness crab are thought to inhabit all estuaries from Morro Bay, California north to Puget Sound, Washington (PSMFC 1999b).

Dungeness crab early life stages are meroplanktonic and, like most crustaceans, consist of a series of molts during these early life stages (Poole 1966, Reed 1969). Dungeness are thought to undergo a brief (10 to 15 minute) pre-zoeal period following hatching (Reilly 1983). The remainder of the planktonic life phase until juvenile settlement at the first instar stage takes approximately four to five months to complete (Lough 1976, Reilly 1983). Dungeness crab may have a larval duration of up to 115 days. This estimate is based on *in situ* development for Dungeness crab showing 80 to 95 days through five zoeal stages and 25 to 30 days for the megalopal stage (Reilly 1983, in Carroll and Winn 1989). The value of 115 days is the average of 105 to 125 days.

Juvenile settlement occurs in estuaries and coastal waters from May to June, occasionally followed by a second smaller pulse later that year (Stevens and Armstrong 1984, Gunderson et al. 1990). Ovigerous (egg-bearing) female Dungeness crab have been found as early as late September in the Gulf of the Farallones, but most spawn in October and November (Reilly 1983). Larvae are released in January to mid-March off of Washington state (McConnaughey et al. 1992) and from December to mid-April in the Gulf of the Farallones (Reilly 1983).

Dungeness Crab Results

Dungeness crab megalopae were collected at the MBPP intake station during the late spring and early summer (Figure 3-63). They were not collected in high concentrations at the MBPP intake station during the course of the study and only occurred in a single source water survey in May 2000 (Figure 3-64). They occurred both inside of Morro Bay and in Estero Bay in approximately equal concentrations. Dungeness crab early life stages are known to move into estuaries and bays as they develop (Carrasco et al. 1985) similar to the abundance distribution observed here.

Dungeness crab megalopae were collected in nearly the same concentrations on ebb and flood tides at Station 2 (Figure 3-65). Samples from stations 3 and 5 in May 2000 were collected on slack tide and therefore data were not graphed.

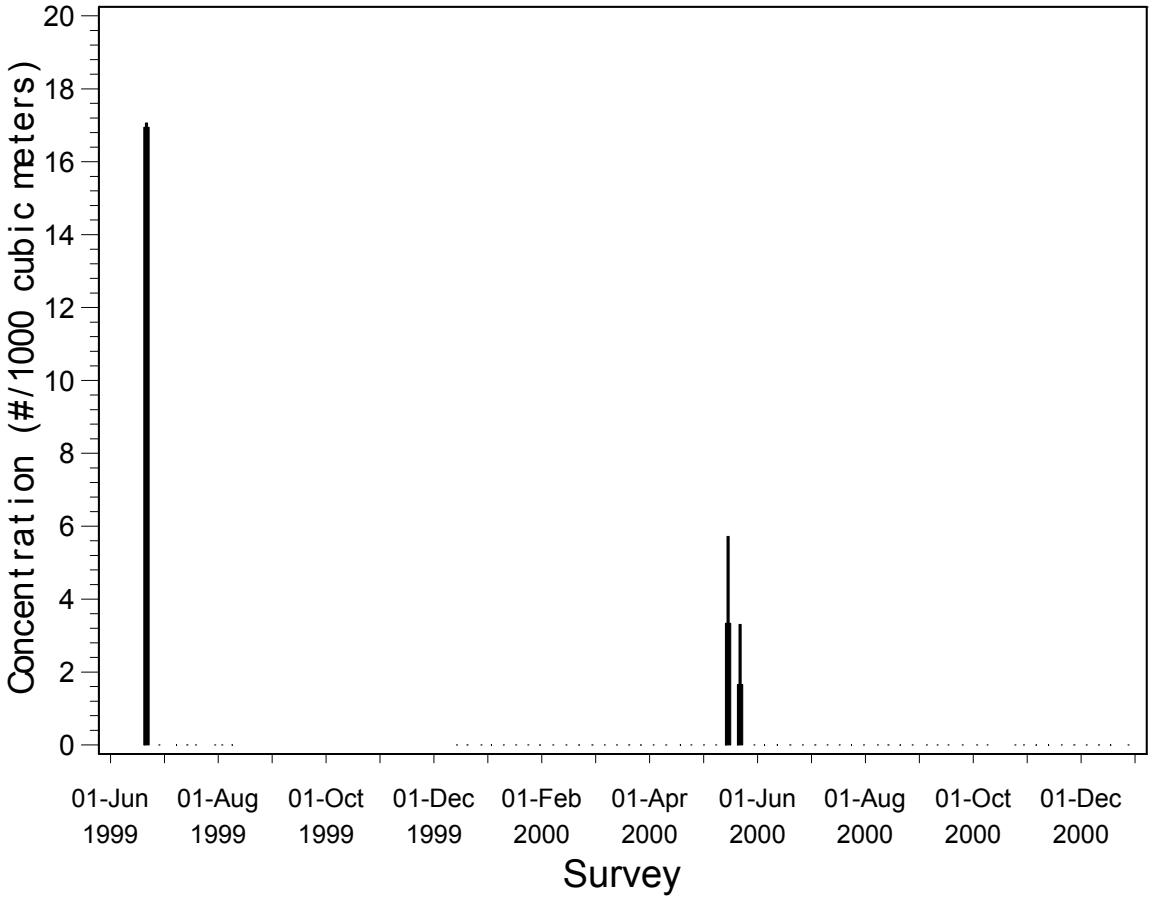


Figure 3-63. Weekly survey mean concentrations of megalopal Dungeness crab collected at the MBPP intake station with standard error indicated (+1 SE). Weekly surveys were collected from June 21 through August 10, 1999 and from December 14, 1999 through December 29, 2000.

Note: The October 16, 2000 survey was cancelled due to the unavailability of a boat.

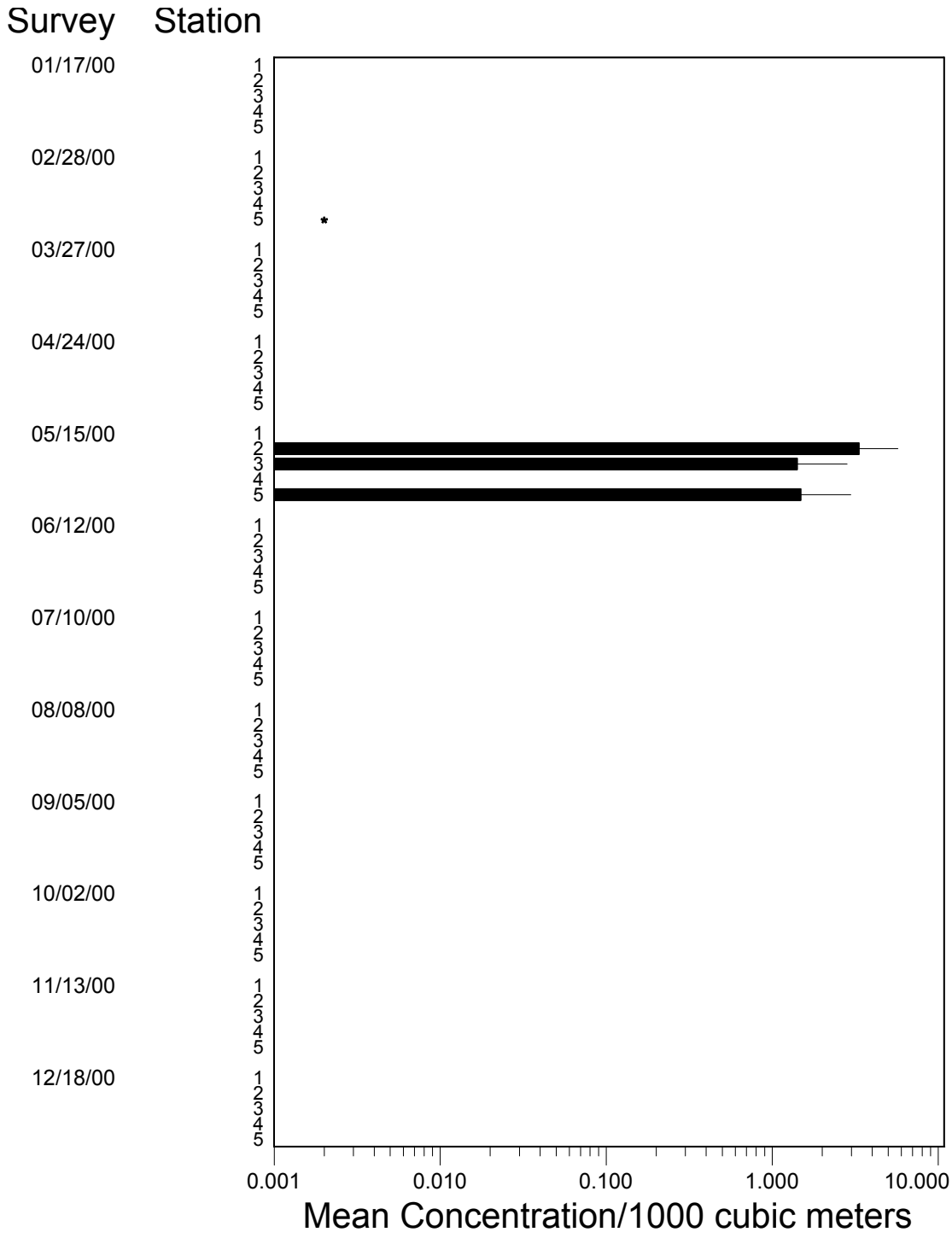


Figure 3-64. Mean megalopal Dungeness crab concentration in monthly paired surveys at the MBPP intake (Station 2), Morro Bay source water (Stations 1, 3, and 4), and Estero Bay (Station 5) from January – December 2000 with standard error indicated (+1 SE).

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.

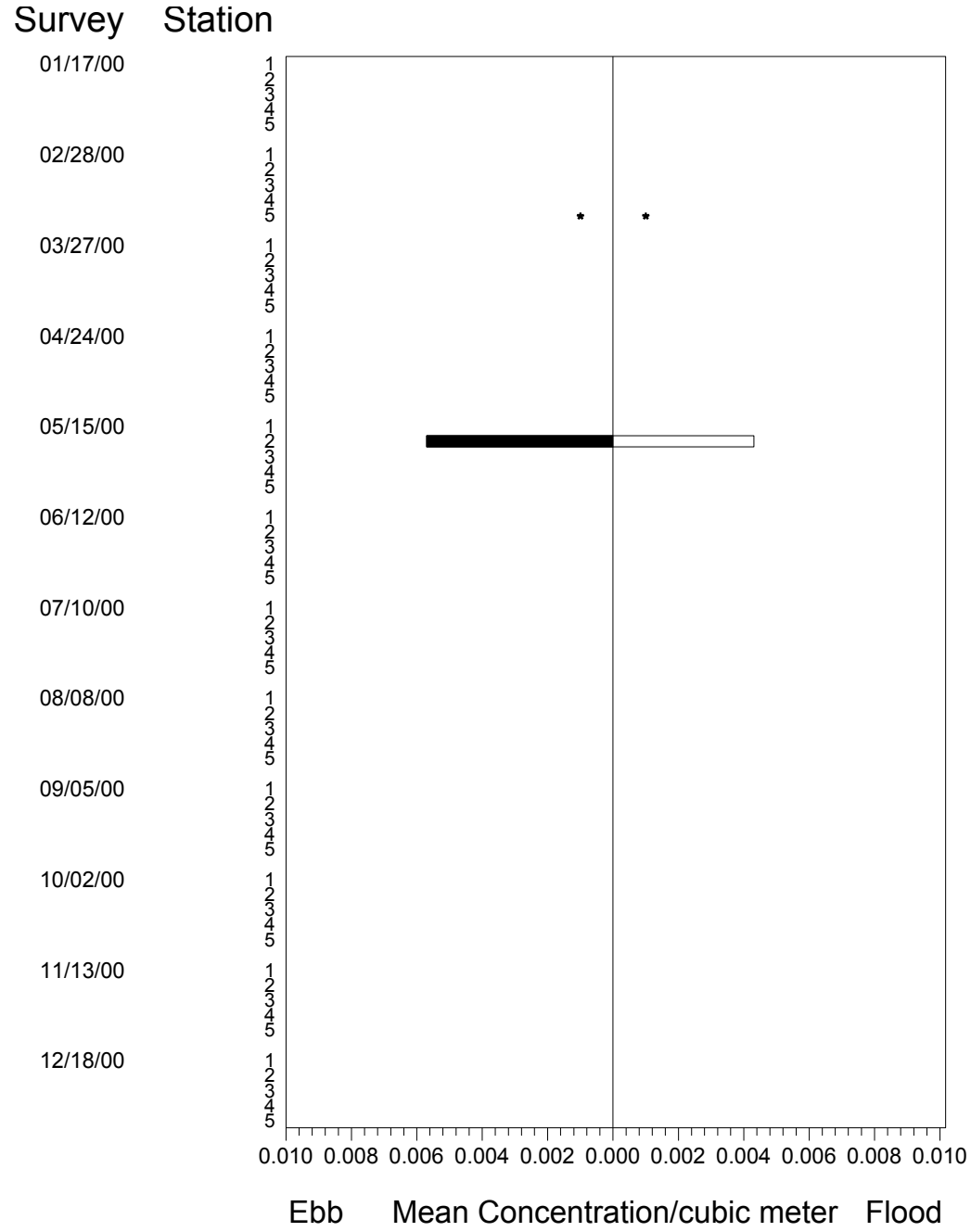


Figure 3-65. Mean concentration of megalopal Dungeness crab from monthly paired surveys by tidal current (ebb – solid bars; flood – clear bars) and sampling station (Morro Bay stations 1–4 and Estero Bay Station 5) from January – December 2000.

Note: During the January 17, 2000 survey, source water stations 1, 3, 4, and 5 were sampled only in daylight hours. Beginning in February 2000 the sampling frequency was increased to cover a 24-hour period.

*Estero Bay Station 5 could not be sampled in February 2000 due to unsafe sea conditions.