Embiotocidae

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Introduction

The surfperch family (Embiotocidae) ranges along the Pacific coast from southern Alaska to central Baja California; there are also 2 species in the Sea of Japan and 1 species in freshwater in California's Central Valley (Tarp 1952, Miller and Lea 1972). Surfperches use a variety of habitats: rocky or sandy surf areas, kelp forests, ocean reefs, and areas around structures such as pilings and piers (Karpov and others 1995). Habitat use often changes during mating and parturition. Surfperches are usually found in shallow water, although silver surfperch and shiner perch have been caught as deep as 110 and 146 m, respectively (Miller and Lea 1984).

Life history strategies vary by species and include differences in fecundity, in age at first reproduction, in longevity, and in size of young at birth (Wiebe 1968, Wilson and Millemann 1969, Shaw 1971). All surfperches are viviparous; small species reproduce at age 1 and large species after age 1 (Baltz 1984). They mate in winter, except for shiner perch and black surfperch, which mate in spring and summer. Sperm is stored for 3 to 9 months before fertilization takes place, except for rainbow seaperch, barred surfperch, and walleye surfperch, which do not store sperm (Carlisle and others 1960, Anderson and Bryan 1970). Gestation lasts 3 to 6 months and the young are born fully developed. Young of all species are born in coastal bays, except those of pink seaperch, which are born in deeper waters. Longevity ranges from 2 to 10 years and growth is indeterminate (Baltz 1984).

Surfperches feed on molluscs, polychaetes, amphipods, copepods, gastropods, crabs, shrimp, and algae (Chu 1989, Holbrook and Schmitt 1986). In turn, they are prey for larger fish such as kelp bass, halibut, sculpins, sturgeon, salmon, barred sand bass, and in San Francisco Bay, striped bass and harbor seals (Thomas 1967, Feder and others 1974).

Many of the larger species of surfperches are commercially important, although some may no longer be targeted due to declines in abundance. All species are important in the sport fishery except dwarf perch, which are too small.

Fourteen species of Embiotocidae were collected in the San Francisco Estuary between 1980 and 1995 (Tables 1, 2, and 3). Length, abundance, and distribution analyses were focused on the commonly caught species: dwarf perch, pile perch, shiner perch, walleye surfperch, and white seaperch. Only life histories and size information were described for the uncommon species. Although, the tule perch is included in the catch tables, it is not described here. Our sampling includes only a small portion of its geographical range.

Table 1 Total catches of surfperches collected at the original stations collected with the midwater trawl from 1980 to 1995

	Year																
Species	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*Total*
Barred surfperch	1	1										1	1				4
Black surfperch						1											1
Calico surfperch														1			1
Dwarf perch			1														1
Pile perch	2	6	5	2	1	4	4	1	1			1					27
Redtail surfperch																1	1
Rubberlip seaperch								4									4
Shiner surfperch	395	1148	790	302	320	826	731	635	665	333	262	211	142	357	29	31	7177
Silver surfperch	1				1												2
Tule perch	1												1	1		1	4
Walleye surfperch	41	207	72	22	78	40	29	67	35	36	26	15	15	21		11	715
White seaperch	9	23	3	3	1	1	1	13	5	5	1		1				66
Totals	450	1385	871	329	401	872	765	720	706	374	289	228	160	380	29	44	8003

Table 2 Total catches of surfperches collected at the original stations in the otter trawl from 1980 to 1995

	Year																
Species	*80*	*81*	*82*	*83*	*84*	*85*	*86*	*87*	*88*	*89*	*90*	*91*	*92*	*93*	*94*	*95*	*Total*
Barred surfperch	18	29	16	48	19	6		7	3	4	4	3	1	1	2	4	165
Black perch		13	3	4	12	4	1	1	3	3	2	1	4	4	3	2	60
Dwarf perch	14	31	50	48	5		3	1	18	5	1	1			2	1	180
Pile perch	35	34	38	35	9	19	19	1	16	3	1						210
Rainbow seaperch				1													1
Rubberlip seaperch	2	3	2		2				1	1						1	12
Shiner perch	1546	1929	3167	1667	1015	1803	2730	1375	1402	433	649	412	283	259	204	413	19287
Silver surfperch	2							2									4
Spotfin surfperch					1												1
Tule perch	10	2	3	1	1	6		1	5	2	1	18	13	21	4	6	94
Walleye surfperch	26	184	91	37	22	16	39	26	24	5	7	7	5	3	2		494
White seaperch	16	35	12	10	24	5	9	7	4	1	4						127
Total	1669	2260	3382	1851	1110	1859	2801	1421	1476	457	669	442	306	288	217	427	20635

Table 3 Total catches of surfperches collected with the beach seine from 1980 to 1986

Species	*1980*	*1981*	*1982*	*1983*	*1984*	*1985*	*1986*	*Total*
Barred surfperch	7	7	1	14	3	17	24	73
Black perch	2	8	1		4		2	17
Calico surfperch				1			1	2
Dwarf perch	467	524	190	135	161	142	317	1936
Pile Perch	3	4		6	7	7	3	30
Rubberlip seaperch	4	1					7	12
Shiner perch	618	529	181	482	248	403	686	3147
Silver surfperch						1	1	2
Tule perch	2	29	1	2	1	14	2	51
Walleye surfperch	67	49	15	166	18	32	122	469
White seaperch	1	7				2	1	11
Total	1171	1158	389	806	442	618	1166	5750

Shiner Perch

Introduction

The shiner perch, *Cymatogaster aggregata,* has the broadest distribution of the Embiotocidae, ranging from Baja California north to Port Wrangell, Alaska (Roedel 1953, Miller and Lea 1972). The shiner perch is most abundant in bays in eelgrass beds and around the pilings of wharfs and piers (Bayer 1981, Baxter 1980), but it can also be found in deeper water in winter (Bane and Bane 1971). It occurs over sandy and muddy bottoms and has been caught from the surface to 146 m (Miller and Lea 1972. The shiner perch is reported to be eurythermal and is caught from 4 to 21 °C. But in Anaheim Bay, California, the catch decreased at 18.5 °C (Odenweller 1975). It is relatively euryhaline, tolerating salinities as low as 1 to 3‰ but is most often found in polyhaline and euhaline salinities.

In California, mating occurs in late spring and summer. Sperm is stored for 5 to 6 months and fertilization takes place in winter. Gestation takes approximately 6 months and the females migrate to shallow water to give birth from June to August. However, in Anaheim Bay, shiner perch bear young as early as May (Odenweller 1975). This earlier birth date may be attributed to a faster gestation rate resulting from warmer water temperatures and a more productive environment.

At birth, the young are fully developed and both the males and females may be mature, although sexual maturity in females may be size-dependent (Wilson and Millemann 1969). Shiner perch may produce a brood at age 1 except under circumstances that result in a slow growth rate (Gordon 1965). Average fecundity is 8 young, and fecundity and embryo size are positively correlated with female parental size (Wiebe 1968, Wilson and Milleman 1968). The young grow rapidly in the 1st year of life, especially females, which grow faster and have a longer life span than males (Anderson and Bryan 1970). Although the shiner perch can live for 8 years, most studies report it to be shorter lived, from 2.5 to 5 years (Gordon 1965, Odenweller 1975, Baxter 1980). Adults may reach a maximum length of 203 mm TL (Miller and Lea 1972). Because of its small size, it is not commercially important, although it is an important sport fish and may be used as bait (Frey 1971).

In the San Francisco Estuary, shiner perch consume primarily epibenthic invertebrates including crustaceans, amphipods, bivalves, and polychaetes (Boothe 1967). Food items differ with sex, age, and season (Gordon 1965). Juveniles feed mainly on copepods and switch to mussels, algae, and barnacles as they grow. Hobson and others (1981) found 2 feeding modes in southern California based on size. Shiner perch <65 mm standard length (SL) were primarily diurnal feeders preying on crustaceans in the water column. Fish > 65 mm fed during the day but also fed on benthic organisms at night. In turn, shiner perch are prey for larger marine fishes including sturgeon, salmon, barred sand bass, and in San Francisco Estuary, striped bass and harbor seals (Thomas 1967, Feder and others 1974). In Yaquina Bay, Oregon, they are also eaten by great blue herons (Bayer 1981).

Methods

Beach seine (1981 to 1986) and otter trawl (1980 to 1995) data were used for the analyses. Beach seine data were analyzed for seasonal distribution and abundance and the otter trawl data were used for seasonal and annual abundance and distribution analyses. Data from both gear types were used for salinity and temperature distributions.

Fish were classified into 2 age groups: age 0 and age 1+ by visual inspection of length frequencies. A January 1 birth date was assumed, but this corresponds to the date of fertilization, not the actual birth date. Cutoff lengths for the separation of age 0 and age 1+ were as follows: 55 mm FL for January through May, 70 mm for June, 85 mm for July, 95 mm for August, 100 mm for September and October, and 105 mm for November and December.

The age–0 annual abundance index period was May to October for the beach seine and the otter trawl. The age–1+ annual abundance index was February to June in the otter trawl and March to July in the beach seine. We did not sample with the otter trawl in January from 1990 to 1994, and therefore, this month is not included in the age–1+ index period.

Results

Length Analyses

In the otter trawl, the minimum length of shiner perch was 25 mm FL, although fish <30 mm were rare (Figure 1). The maximum length was 235 mm, which is larger than the reported maximum length of 203 mm TL (Miller and Lea 1972). Very few fish >145 mm were collected in the otter trawl. Modal length from January to March was 80 to 90 mm; these are age–1+ fish. In April, the mode increased to 90 to 100 mm. In summer, when parturition occurred, smaller fish were collected and 2 modes appeared in June and July. There were very few fish >2 years old (110 mm) entering the estuary for parturition. This agrees with other studies which report shiner perch to be short-lived (Gordon 1965, Odenweller 1975).

In the beach seine, fish ranged from 31 to 150 mm, although very few fish >80 mm were collected (Figure 2). From February to April, mostly larger fish ranging from 95 to 135 mm were found. In May and June, during parturition, the modal length was 35 to 45 mm and the fish grew quickly to 55 and 65 mm during summer. A few small fish remained in the shallows in winter and the larger fish disappeared in August and September.

Abundance

In the otter trawl, age–0 shiner perch were most abundant in 1982, followed closely by 1981 (Figure 3A, Table 4). Abundance was low from 1988 to 1995; the lowest indices were in 1991 and 1994.

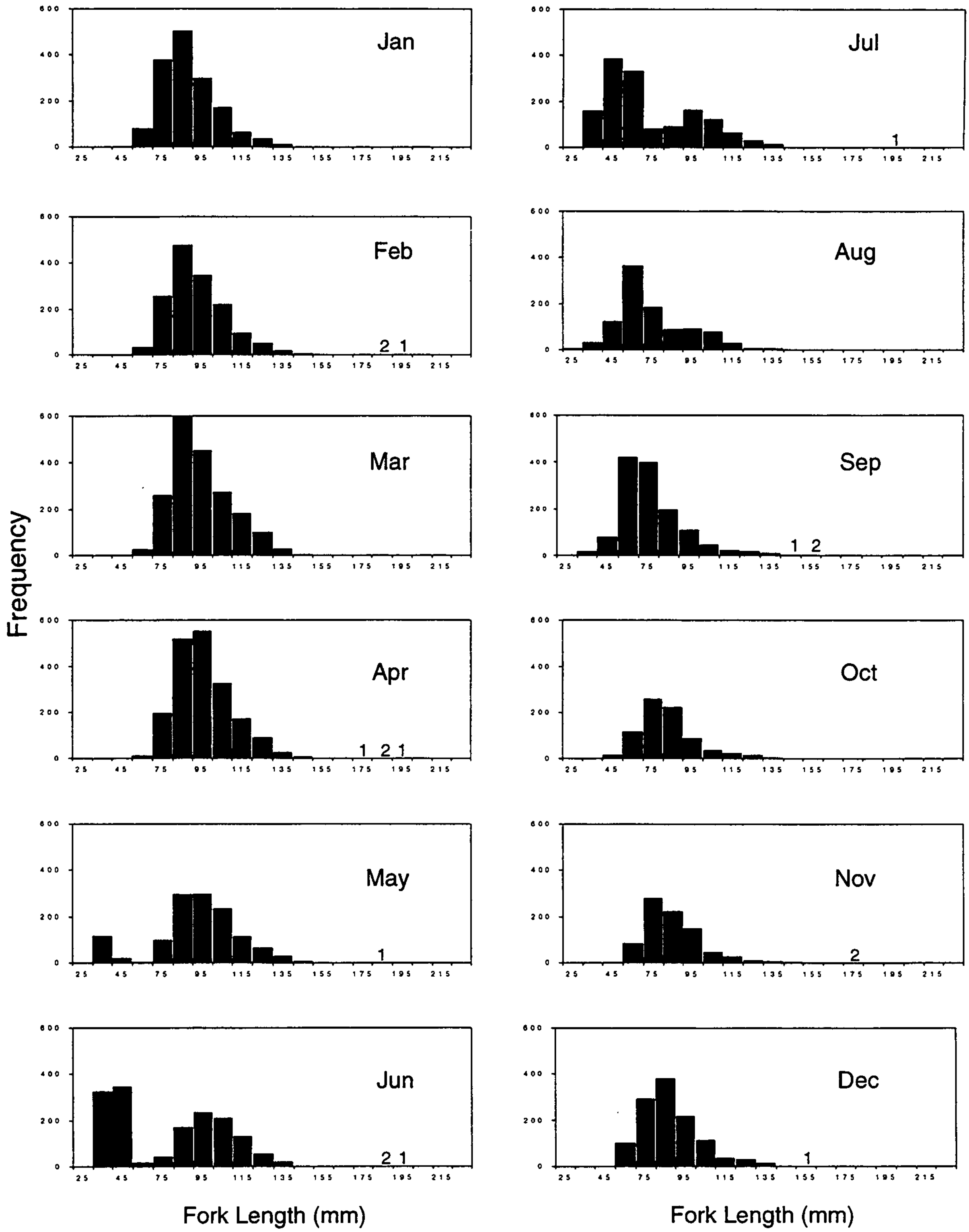

Figure 1 Monthly length frequencies of shiner perch collected with the otter trawl from 1980 to 1995. Numbers on x-axis are lower class limits.

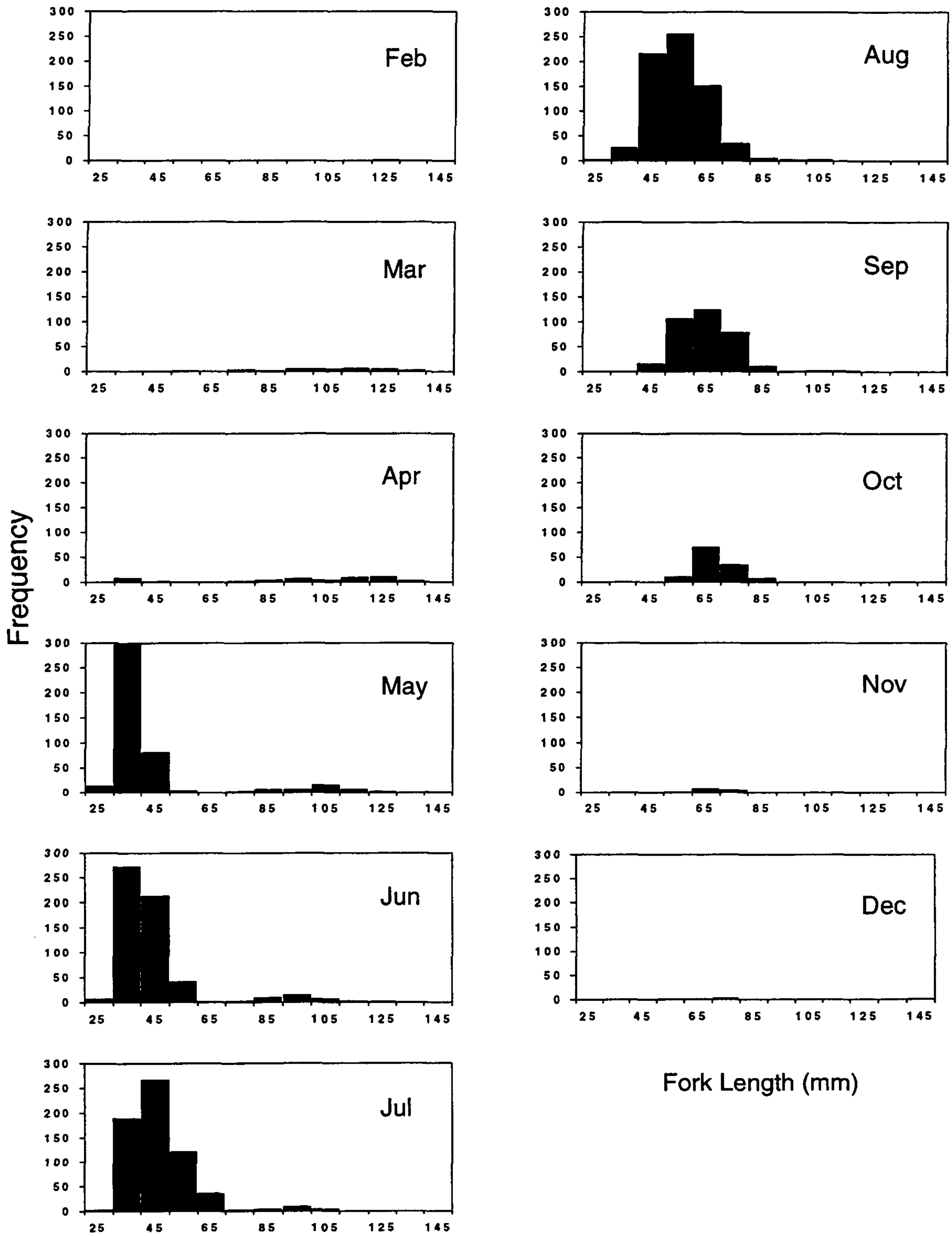

Figure 2 Monthly length frequencies of shiner perch collected with the beach seine from 1980 to 1986. No shiner perch were collected in January. Numbers on the x-axis are lower class limits.

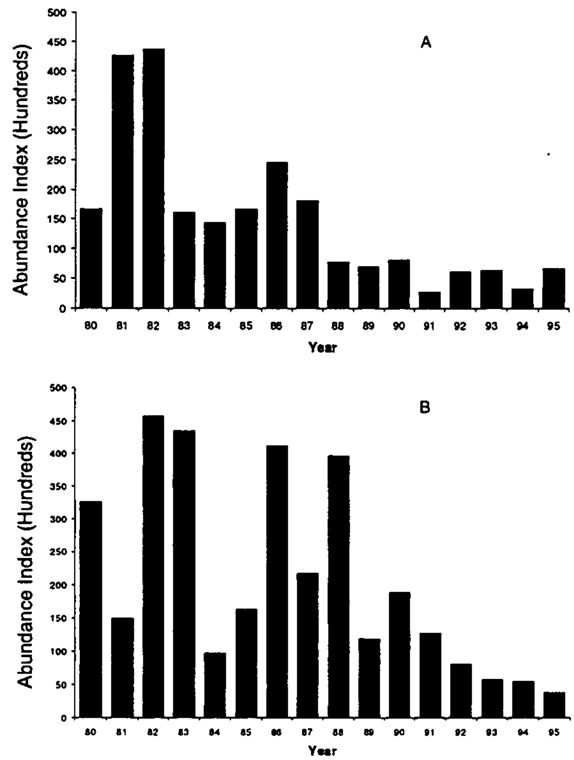

Figure 3 Annual abundance indices of shiner perch collected with the otter trawl from 1980 to 1995: (A) age 0, index period was May to October; (B) age 1+, index period was February to June

Table 4 Monthly abundance indices (in hundreds) of age–0 shiner perch collected with the otter trawl from 1980 to 1995. The annual index period was May to October. In 1989 the annual index period was May to August.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual Index*
1980		0	0	0	5	11	194	431	259	101	193	46	167
1981	0	0	0	0	126	144	1143	825	215	107	311	177	426
1982	0	0	5	0	10	1191	390	369	480	182	244	354	437
1983	0	0	0	0	5	538	122	47	88	169	76	36	161
1984	0	0	0	0	0	54	251	272	164	122	248	257	144
1985	0	0	4	0	0	104	403	82	201	208	321	869	166
1986	0	0	0	0	0	47	157	406	769	96	129	396	246
1987	0	0	0	0	0	54	113	242	522	152	191	204	181
1988	0	0	0	0	34	74	181	102	72	2	84	63	77
1989	0	0	0	0	5	46	100	127					70
1990		0	0	0	9	82	169	36	53	142			82
1991		0	0	0	0	7	46	33	72	7			27
1992		0	0	0	56	228	31	15	23	15			61
1993		0	0	0	14	215	124	17	9	2			63
1994		0	0	0	7	87	37	27	21	16			32
1995	0	0	0	0	0	0	251		61	22	128	148	67
1981–1988	0	0	1	0	22	276	345	293	314	130	200	294	

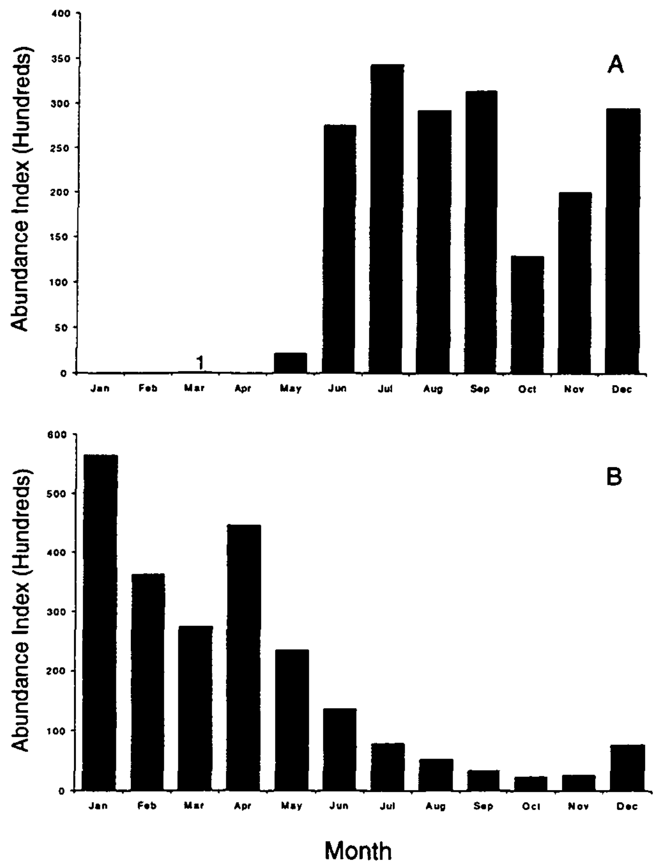

Figure 4 Seasonal abundance of shiner perch collected with the otter trawl from 1981 to 1988: (A) age 0 and (B) age 1+

Table 5 Monthly abundance indices of age–0 shiner perch collected with the beach seine from 1981 to 1986. The annual index period was May to October.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual Index*
1981	0	0	0	3	122	432	458	395	140	34	11	9	264
1982	0	0	0	0	36	82	248	117	2	3	0	0	81
1983	0	0	0	0	321	88	212	48	95	33	0	0	133
1984	0	0	0	0	11	208	159	58	43	1	0	0	80
1985	0	0	0	3	551	84	121	52	47	3	0	0	143
1986	0	0	0	10	20	356	464	116	47	70	9	0	179
1981–1986	0	0	0	3	177	208	277	131	62	24	3	2	

In the otter trawl, age–0 fish were first collected in May and June, except in 1995 when they were not collected until July (Figure 4A, see Table 4). Monthly abundance of age–0 fish peaked from June to September, and in many years there was a 2nd and smaller peak in winter. But in 1985, the winter peak was higher than the summer peak (see Table 4). In the beach seine, age–0 fish were first collected as early as April but did not become abundant until May (Figure 5A, Table 5). Abundance peaked in July and declined sharply in August to lows in November and December.

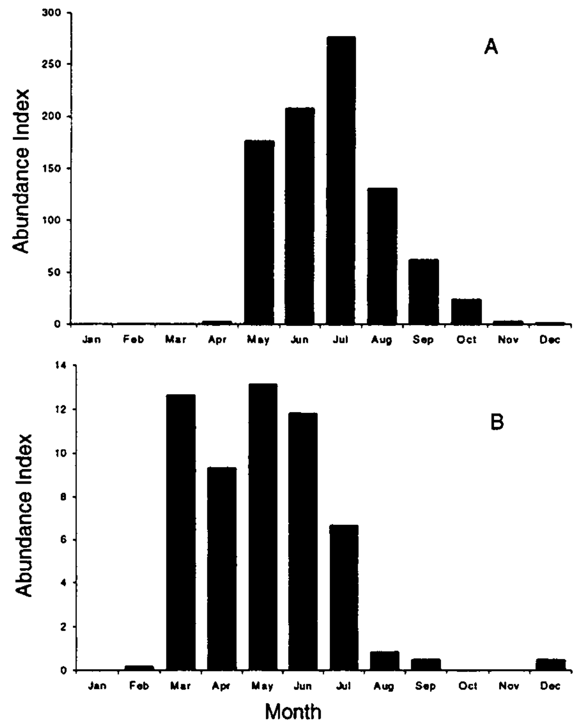

Figure 5 Seasonal abundance of shiner perch collected with the beach seine from 1981 to 1986: (A) age 0 and (B) age 1+

Table 6 Monthly abundance indices (in hundreds) of age–1+ shiner perch collected with the otter trawl from 1980 to 1995. The annual index period was February to June.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980		632	284	374	266	74	82	35	28	12	5	4	326
1981	275	110	220	336	52	38	146	46	33	45	32	38	151
1982	1703	533	256	1061	242	194	84	101	66	12	37	111	457
1983	526	326	491	961	264	139	56	15	5	24	15	14	436
1984	112	225	136	44	44	39	39	13	24	8	11	78	98
1985	303	219	289	151	60	97	37	9	26	15	81	301	163
1986	971	689	214	626	326	206	122	79	19	7	12	7	412
1987	276	590	250	46	66	133	62	124	88	73	20	59	217
1988	360	215	342	349	829	245	87	30	8	0	0	13	396
1989	182	140	95	90	56	215	38	18					119
1990		271	225	156	131	163	54	12	8	35			189
1991		232	175	79	141	14	129	6	6	4			128
1992		173	50	97	44	40	9	0	3	0			81
1993		29	171	15	47	28	27	3	2	0			58
1994		42	78	38	31	87	10	14	3	4			55
1995	114	25	117	41	7	5	12		3	2	51	51	39
1981–1988	566	364	275	447	235	136	79	52	34	23	26	78	

In the otter trawl, the highest annual abundance indices of age–1+ shiner perch were in 1982 and 1983 (Figure 3B, Table 6). These lagged the highest age–0 indices by 1 year. Abundance indices declined from 1990 to 1995, and the lowest indices were from 1992 to 1995.

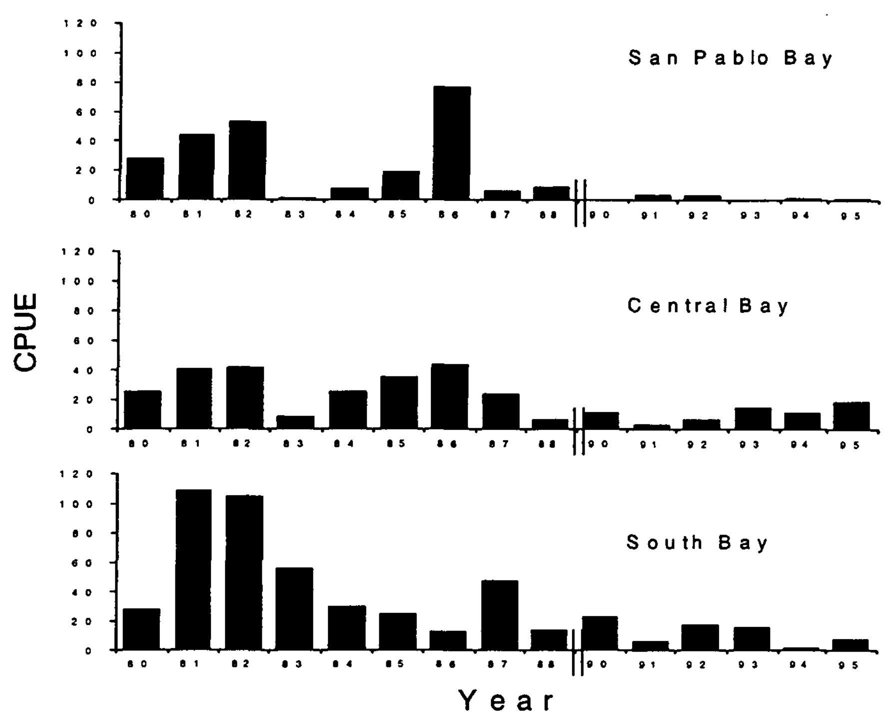

Figure 6 Annual distribution of age–0 shiner perch collected with the otter trawl from 1980 to 1988 and 1990 to 1995. Annual CPUE was calculated from May to October. CPUE was <1 in Suisun Bay and no shiner perch were collected in the west delta.

In the otter trawl, age–1+ shiner perch were collected in all months (Figure 4B, see Table 6). Abundance was low in summer and fall, rose to a peak in winter, usually in January, then declined and often rose to a 2nd mode in April. Since a January 1 birth date was assumed, the winter mode was probably composed of overwintering juveniles. During the winter mode from January to March, young fish ranging from 75 to 105 mm fish were abundant. In the beach seine, age–1+ fish were present from February to September and were most abundant from March through June (Figure 5B). This contrasts with the otter trawl, in which age–1+ shiner perch were also abundant in winter (see Figure 4B).

Distribution

In the otter trawl, age–0 shiner perch ranged from South to Suisun bays (Figure 6). In most years, CPUE was usually highest in South Bay, although in 1985, 1994, and 1995 it was highest in Central Bay, and in 1986 in San Pablo Bay. In 1980, CPUE was equal in South, Central, and San Pablo bays. Very few age–0 shiner perch were collected in Suisun Bay.

In the otter trawl, age–0 CPUE was highest in South Bay in June and July and in San Pablo Bay in August and September (Figure 7). CPUE decreased in South and San Pablo bays in October and increased in Central Bay from October to December. This suggests a movement of age–1+ fish to Central Bay where they may remain in the estuary or emigrate to the ocean. In the beach seine, age–0 fish ranged from South to Suisun bays (Figure 8). The CPUE was highest in South and Central bays. It decreased significantly in South Bay in October, Central Bay in November and San Pablo Bay in August. This contrasted with the otter trawl, in which the CPUE remained relatively high in winter.

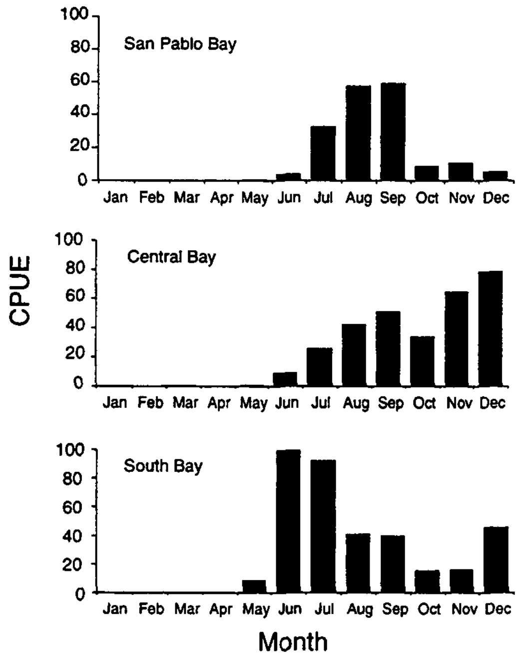

Figure 7 Seasonal distribution by bay of age–0 shiner perch collected with the otter trawl from 1981 to 1988. Values are CPUE x 10. CPUE was <1 in August and November in Suisun Bay. No shiner perch were collected in the west delta.

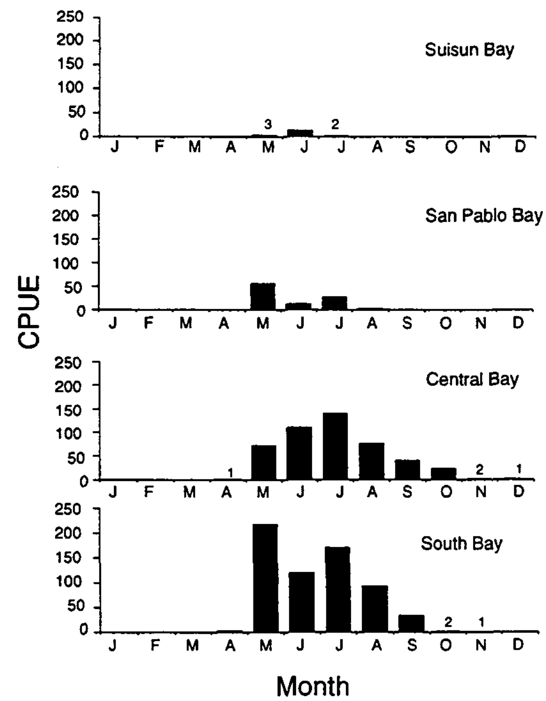

Figure 8 Seasonal distribution of age–0 shiner perch collected with the beach seine from 1981 to 1986

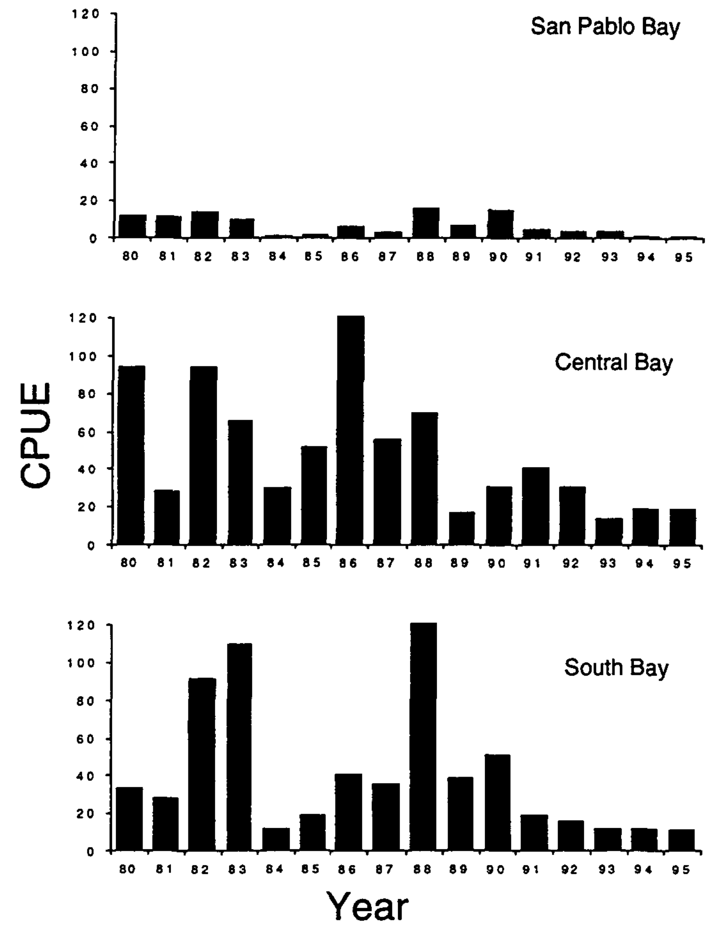

Figure 9 Annual distribution of age–1+ shiner perch collected with the otter trawl from 1980 to 1995. Values are annual CPUE from February to June. No shiner perch were collected in Suisun Bay and the west delta.

Age–1+ fish were collected from South to San Pablo bays in all years with the otter trawl (Figure 9). The highest CPUE usually occurred in Central Bay except in 1983 and 1988 to 1990 when CPUE was highest in South Bay. In 1981 and 1993, CPUE was equal in South and Central bays.

In the otter trawl, age–1+ shiner perch were collected from South to San Pablo bays from January to September and from South and Central bays from October to December. The CPUE was highest in Central Bay in January and February. From March to May, CPUE increased in South Bay and the distribution expanded to San Pablo Bay. They moved back to Central Bay in summer and remained there for the rest of the year (Figure 10). In the beach seine, age–1+ shiner perch were also collected from South to San Pablo bays (Figure 11). They were collected from February to September and in December, but were most abundant from March to July. The CPUE was usually highest in South Bay except in May and August when it was highest in Central Bay. The CPUE decreased in June in San Pablo Bay, July in Central Bay, and August in South Bay.

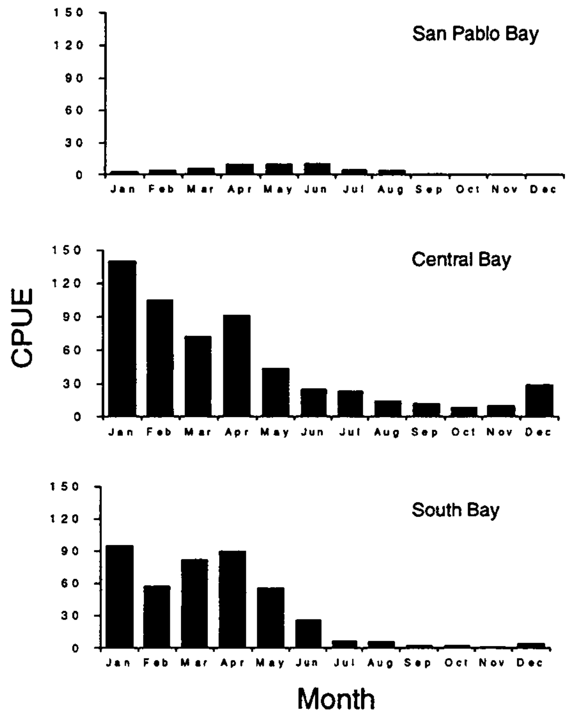

Figure 10 Seasonal distribution by bay of age–1+ shiner perch collected with the otter trawl from 1981 to 1988. No shiner perch were collected in Suisun Bay and the west delta.

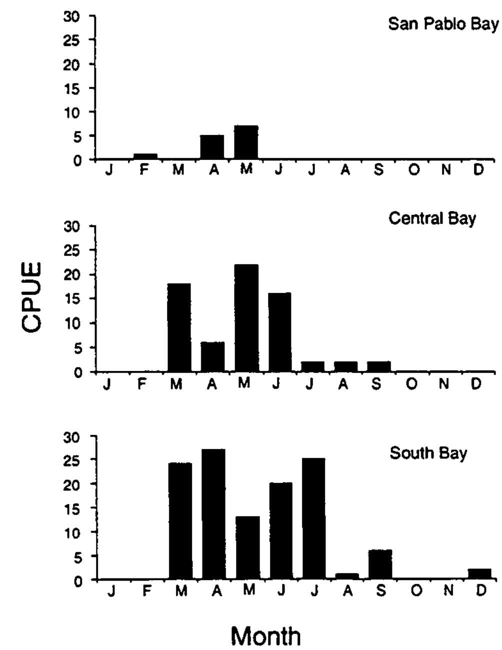

Figure 11 Seasonal distribution of age–1+ shiner perch collected with the beach seine from 1981 to 1986. None were collected in Suisun Bay or the west delta.

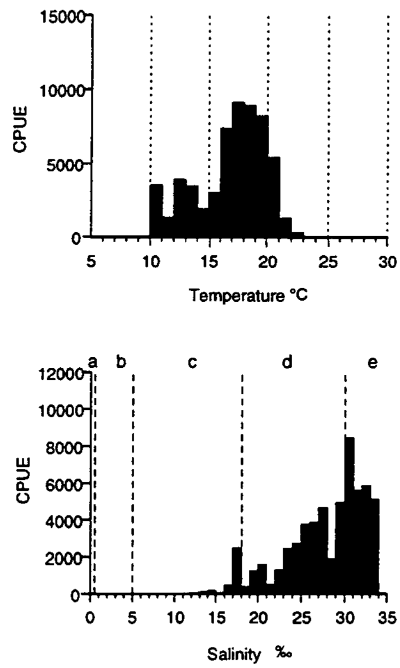

Figure 12 Temperature and salinity distributions for age–0 shiner perch collected with the otter trawl. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Temperature and Salinity

In the otter trawl the temperature range for age–0 shiner perch was 10.4 to 22.5 °C, $\bar{\chi}$ = 16.6 °C (Figure 12), and 12.4 to 25.5 °C, $\bar{\chi}$ = 19.6 °C in the beach seine (Figure 13). Age–1+ fish were collected at lower temperatures than age–0 fish in the otter trawl: 7.5 to 22.6 °C, $\bar{\chi}$ = 13.3 °C (Figure 14). In the beach seine, temperatures ranged from 12.0 to 25.7 °C, $\bar{\chi}$ = 18.6 °C for age–1+ fish (Figure 15). In both the otter trawl and beach seine, temperature ranges decreased with increased size of fish (Figures 16 and 17).

In the otter trawl, age–0 shiner perch were collected at salinities from 8.4 to 34.4‰, $\bar{\chi}$ = 27.9‰ (see Figure 12). Beach seine salinities for age–0 fish were similar: range 9.1‰ to 33.3‰, $\bar{\chi}$ = 27.4‰ (see Figure 13).

A higher percentage of age–1+ fish were at lower salinities than age–0 fish. The salinity range for age–1+ fish was 0.1 to 34.3‰, $\bar{\chi}$ = 25.0‰ in the otter trawl (see Figure 14). Only 23 fish were collected at <5.0‰. In the beach seine, age–1+ fish were found at 0.6 to 33.3‰, $\bar{\chi}$ = 23.1‰ (see Figure 15).

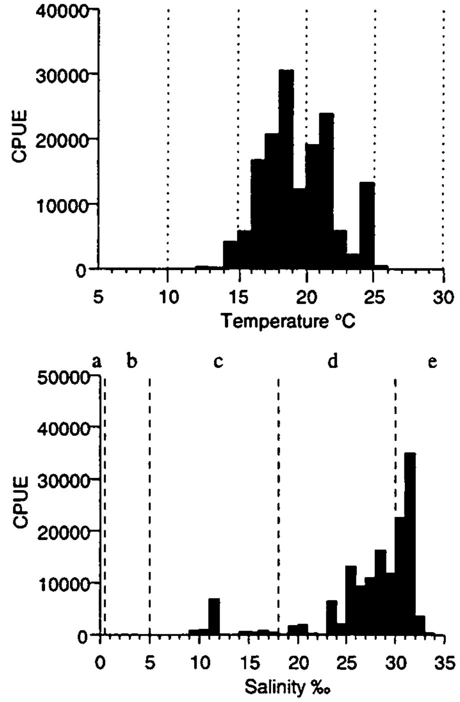

Figure 13 Temperature and salinity distributions for age–0 shiner perch collected with the beach seine. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

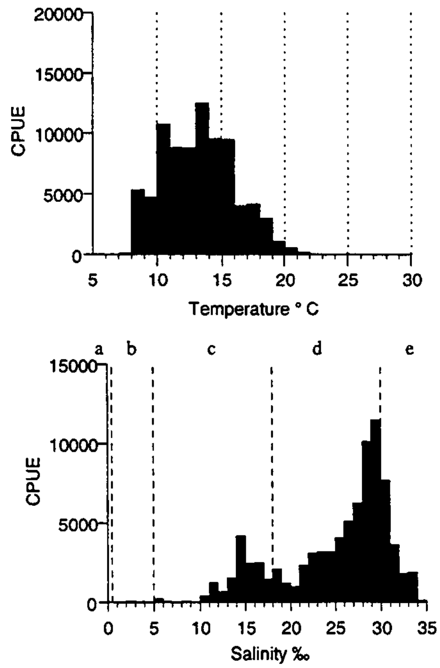

Figure 14 Temperature and salinity distributions for age–1+ shiner perch collected with the otter trawl. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

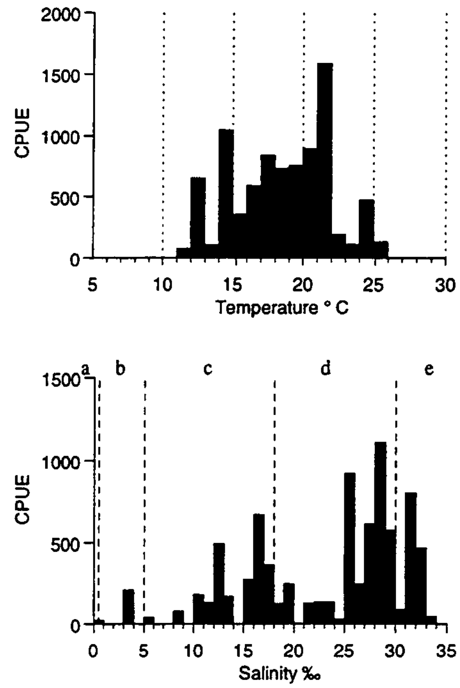

Figure 15 Temperature and salinity distributions for age-1+ shiner perch collected with the beach seine. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

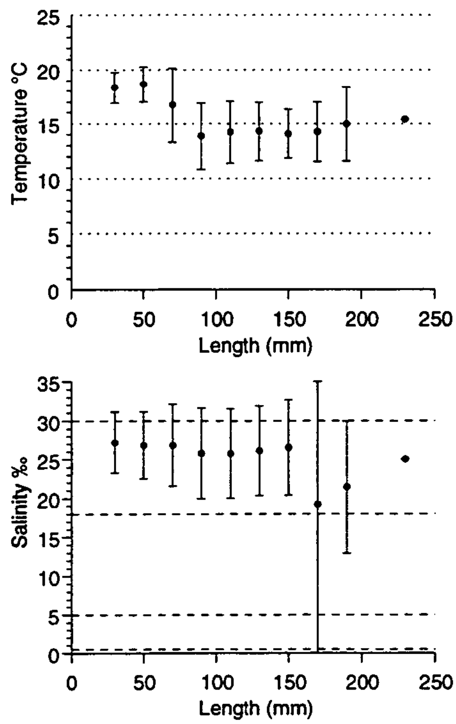

Figure 16 Temperature and salinity by length of shiner perch collected with the otter trawl from 1980 to 1995. Values are mean ±1 standard deviation.

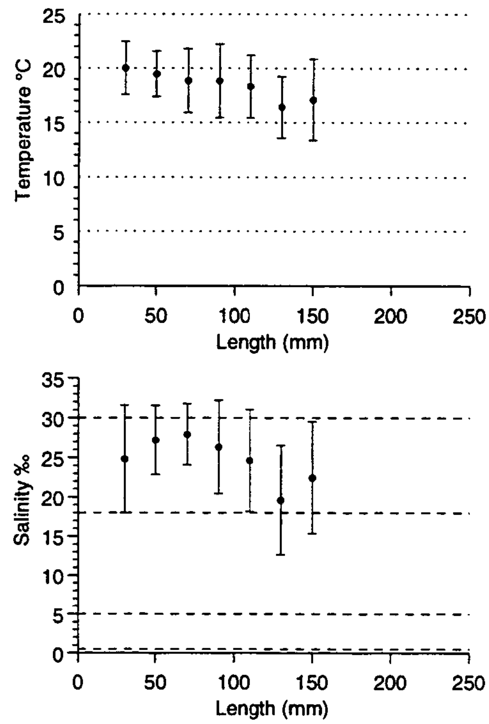

Figure 17 Temperature and salinity by length of shiner perch collected with the beach seine from 1980 to 1986. Values are the mean ±1 standard deviation.

Discussion

Shiner perch were found in the estuary throughout the year and used it primarily for parturition and as a nursery area. Both age groups migrated in the estuary and emigrated to the ocean. Our data and other research indicate that complex migrations occur relative to season, sex, and age of fish. Age–0 fish first appeared in the estuary in May and were most abundant in June, indicating that parturition occurred during or just prior to these months. Abundance decreased in late fall and early winter in the beach seine but remained relatively high in the otter trawl. This suggests the young shiner perch moved from shallow to deeper waters in fall, but did not leave the estuary. This seems to be true in other areas also. In Newport Bay, Oregon, juveniles do not emigrate until after their 1st year (Bane and Robinson 1970).

Age–1+ shiner perch were collected in the beach seine mostly from March to July, and in the otter trawl were most abundant from late winter through June. This indicates that some age–1+ fish move into shallow water throughout summer. Age–1+ fish are known to move to shallow, protected areas for parturition, but this movement may also be due to higher temperatures and better feeding conditions in the shallows, which could help shorten the development time of the young. However, Gordon (1965) found that the depth distribution of shiner perch in British Columbia may be related to light intensity rather than feeding habits. In winter, shiner perch move into deeper water. This has also been reported in other areas. Adults leave Anaheim Bay in August and migrate to the deeper water in the nearshore ocean during winter (Odenweller 1975).

Age–1+ shiner perch were found primarily in deeper areas of Central Bay in winter and moved to the shallows of South and Central bays from March to June, when parturition occurred, and then returned to Central Bay from late summer to winter. The monthly length frequency data shows this movement to the shallows is comprised of age–1+ fish migrating from the ocean to Central Bay, and juveniles which over-wintered in the estuary. Both age groups then return to Central Bay in late summer and either remain there through the winter or emigrate to the ocean. In Bodega Bay, males enter birthing areas and 1 week later the females arrive to give birth. They are immediately inseminated after parturition and both sexes of adults then leave the area (Shaw and others 1974).

Age–1+ shiner perch were collected at lower salinities and temperatures than age–0 fish. This contradicts laboratory studies which found that juveniles preferred colder temperatures than adults and age–0 fish preferred the coldest temperatures of any age group (Shrode and others 1983). In the field, juveniles are observed in warm shallow waters, although they are not restricted to this habitat. The temperature preferences of both age classes may be affected by other factors such as timing of parturition, habitat selection, and food availability. For example, age–0 fish may not be in warm water because they preferentially migrated to it, rather they were born there and have not dispersed. They may then remain in protected areas with greater food availability. McCauley and Huggins (1979) found no consistent pattern of seasonal differences in temperature preference of shiner perch.

Abundance of age–0 fish has declined since 1987 and abundance of age 1+ since 1988. Although these declines were concurrent with the drought, abundance remained low through 1995.

Factors which may have contributed to the shiner perch decline include degradation of nursery habitat, low fecundity, and overharvest. Urbanization, flood control, ports, marinas, and water development projects have caused a decline in nearshore habitat in the San Francisco Estuary (SFEP 1991). Shiner perch may be affected by loss of this habitat, which they use as nursery and rearing areas. They are also vulnerable to overharvest by angling because there are no bag, possession, or size limits on them, and they can be taken any time of the year. Their low fecundity exacerbates the effects of heavy angling pressure.

Walleye Surfperch

Introduction

The walleye surfperch, *Hyperprosopon argenteum*, ranges from Vancouver Island, British Columbia to Point Santa Rosarita, central Baja California, including Guadalupe Island (Miller and Lea 1972). It can be found from the surface to 18 m but is most abundant from 1.5 to 6.7 m (Feder and others 1974). It is common along sandy beaches (Roedell 1953), over flat rocks, in the surf, around piers and jetties (Bane and Bane 1971, Baxter 1980), and in kelp beds (Baltz 1984). The walleye surfperch congregates in dense schools composed of several hundred to several thousand fish when not breeding. Its temperature range is primarily from 7 to 21 °C (Tarp 1952).

During mating, large schools break up into isolated pairs or schools of 4 to 10 females attended by 1 male (Rechnitzer and Limbaugh 1952). Mating takes place from October to December (Rechnitzer and Limbaugh 1952). Like all surfperch, the walleye surfperch is viviparous. It is 1 of 3 species of embiotocids that does not store sperm; therefore, fertilization occurs when mating. Gestation lasts 5 to 6 months and the young are born from April through June. The average fecundity is 5 to 12 young and the number and size of young are correlated with maternal weight and age (DeMartini and others 1983, Rechnitzer and Limbaugh 1952).

Mean size at birth is 40 mm SL (Rechnitzer and Limbaugh 1952). The walleye surfperch grows fastest in its 1st year of life (Anderson and Bryan 1970). Most males mature 4 to 6 months after birth at 65 to 95 mm

SL, and most females mature about 7 months after birth at 100 to 110 mm SL (DeMartini and others 1983). Slow growing males and females may mature in their 2nd year. Geographic factors may influence these differences in age, growth, and sexual maturation patterns (DeMartini and others 1983). Northern populations live longer and have delayed maturity and greater fecundity (Baltz 1984). Maximum age of walleye surfperch is reported as 6 years. Eckmayer (1979) reported that males and females have similar life spans, but according to DeMartini and others (1983) females may live longer than males. Maximum size is 305 mm TL (Miller and Lea 1972).

The walleye surfperch is a benthic or near bottom feeder (Morning 1984) and preys on squid eggs and crustaceans including isopods and amphipods (Bane and Bane 1971, Feder and others 1974). Kelp bass, sculpin, and halibut prey on walleye surfperch. It was formerly the most commonly caught surfperch in California's commercial and sport fisheries. Sport anglers catch walleye surfperch from shores, jetties, and piers (Fritzsche and others 1992).

Methods

Fish were classified as age 0 or age 1+ by visual inspection of length frequencies. The cutoff lengths for this separation were as follows: 115 mm FL from January through July, 120 mm for August and September, and 125 mm from October through December. The midwater trawl index period was May through August for age–0 fish, and March through October for age–1+ fish. The beach seine age–0 index period was May through October.

The 1980 to 1995 midwater trawl data were used for annual abundance and distribution analyses of age–0 and age–1+ fish. For seasonal abundance and distribution analyses, the 1981 to 1988 midwater trawl data were used. The 1981 to 1986 beach seine data were also used for seasonal distribution of age–0 fish. No age–1+ fish were collected in the beach seine. Data from both gear types were used for salinity and temperature distributions.

Results

Length Analyses

In the midwater trawl, walleye surfperch ranged from 42 to 285 mm FL (Figure 18). At least 2 year classes were collected in the estuary. The first length mode was 50 to 80 mm FL, and a second smaller mode was >130 mm FL. Year classes older than 1 were difficult to distinguish as catches of fish >200 mm were sporadic. Age–0 fish grew quickly in spring and summer after parturition. Modal length in May was 50 to 70 mm, in June 60 to 80 mm, in July 70 to 90 mm, and in August 90 to 100 mm.

Only very young fish ranging from 47 to 110 mm were usually collected with the beach seine (Figure 19).

Abundance

In the midwater trawl, annual age–0 walleye surfperch abundance indices varied from a high of 11,600 in 1981 to <100 in 1991 (Figure 20A, Table 7). Abundance declined dramatically in 1982 and 1983, then increased slightly in 1984. A steady decline occurred from 1990 to 1995. In 1994, midwater trawl sampling ended in April and there was no index due to insufficient data. In 1995, no age–0 fish were collected during the index period.

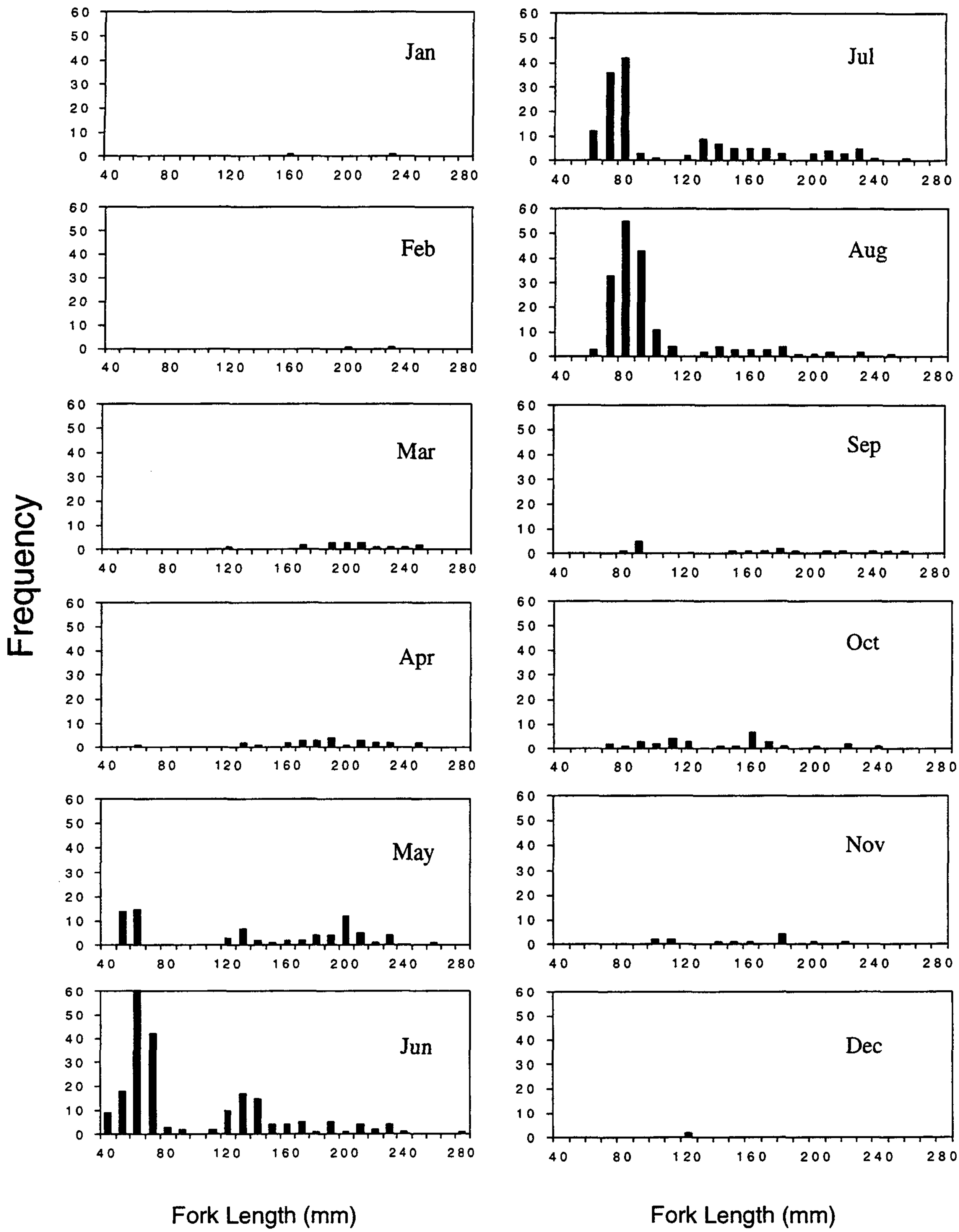

Figure 18 Monthly length frequencies of walleye surfperch collected with the midwater trawl from 1980 to 1995. Values on x-axis are lower class limits.

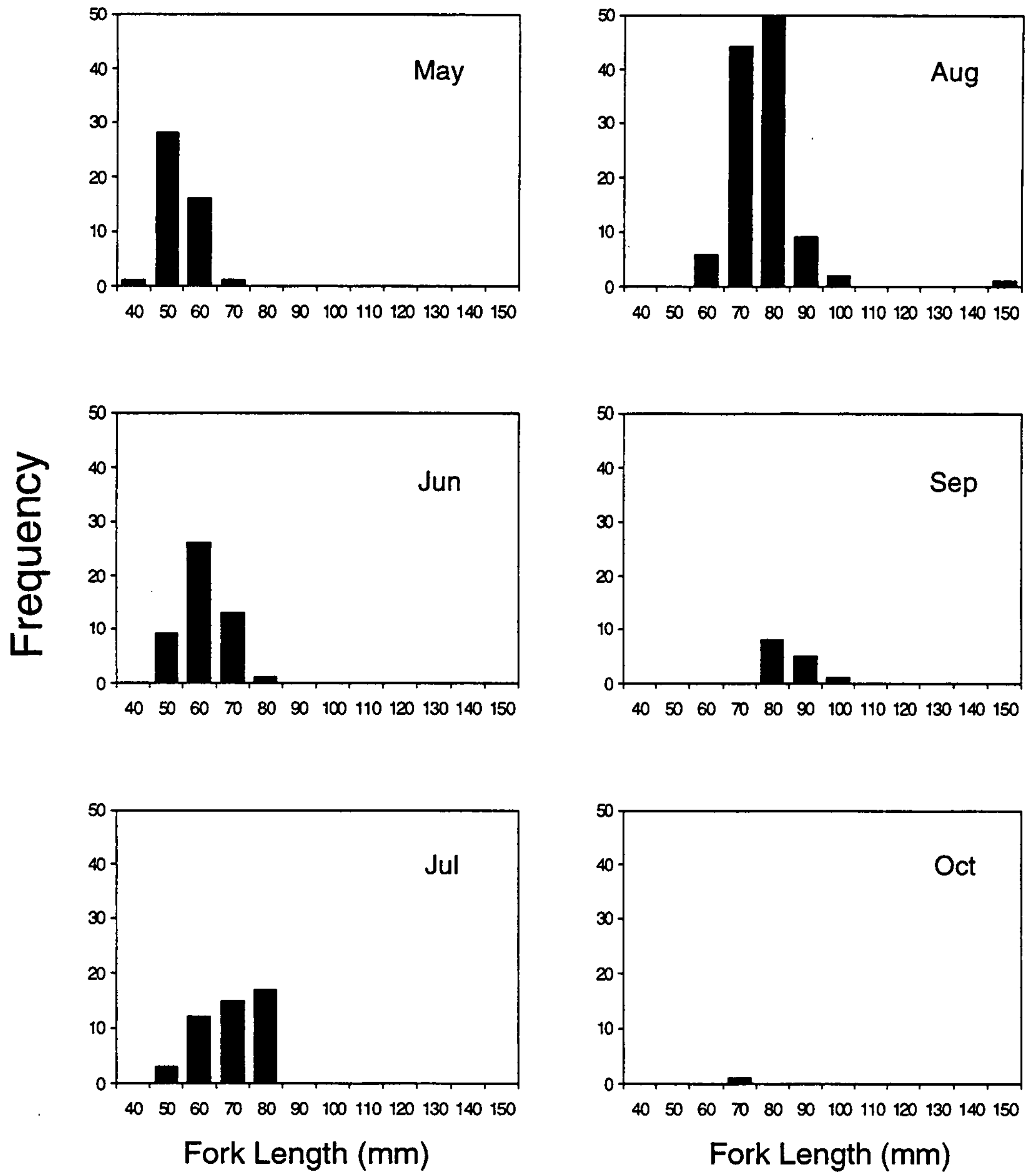

Figure 19 Monthly length frequencies of walleye surfperch collected with the beach seine from 1980 to 1986. Values on x-axis are lower class limits. No walleye surfperch were collected from January to April or in November and December.

Abundance of age–0 walleye surfperch collected with the midwater trawl peaked from June to August, then decreased dramatically in fall, and none were collected from December to March (Figure 21A, see Table 7). Age–0 fish were usually present from May to October with exceptions in 1982, 1993, and 1995 (see Table 7).

Age 1+ walleye surfperch were most abundant in 1981 and 1987 in the midwater trawl catches (Figure 20B, Table 8). The abundance index was very low in 1983, increased to a peak in 1987 and then declined from 1988 to 1995. In 1994, there was no index due to insufficient data. Age 1+ fish were collected in all months except December (Figure 21B, see Table 8). Abundance peaked from May to July and was low in fall and winter.

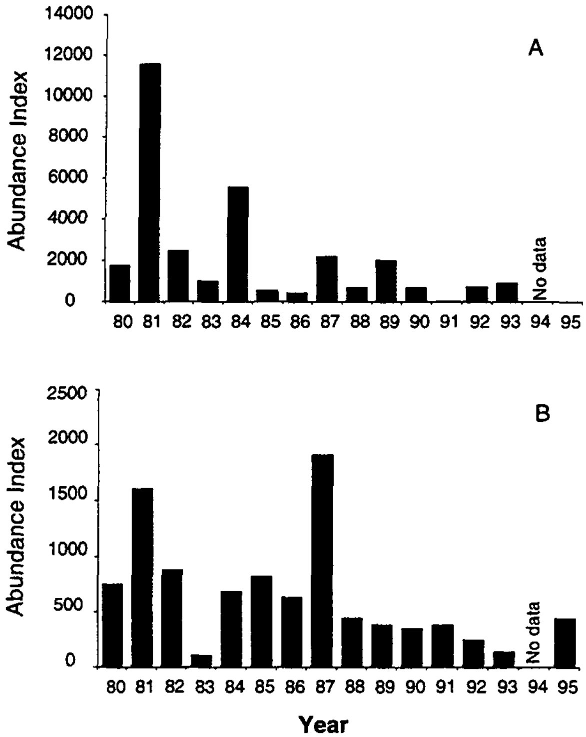

Figure 20 Annual abundance indices of walleye surfperch collected with the midwater trawl from 1980 to 1995: (A) age 0, index period was May to August; (B) age 1+, index period was March to October

Table 7 Monthly abundance indices of age–0 walleye surfperch collected with the midwater trawl. The annual index period was May to August.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual Index*
1980		0	0	0	0	0	215	6923	358	430	0	0	1785
1981	0	0	0	0	6022	19488	10119	10769	188	1505	0	0	11600
1982	0	0	0	0	565	5358	2616	1344	0	0	1745	0	2471
1983	0	0	0	0	0	565	1049	2446	0	0	0	0	1015
1984	0	0	0	0	0	5748	2446	14156	0	716	0	0	5588
1985	0	0	0	0	0	1694	376	188	0	0	0	0	565
1986	0	0	0	0	0	188	904	646	108	0	0	0	435
1987	0	0	0	0	0	2167	6125	466	0	0	0	0	2190
1988	0	0	0	0	188	565	484	1505	108	0	0	0	686
1989	0	0	0	0	0	4979	923	2141					2011
1990		0	0	0	323	1809	716	0	358	0			712
1991		0	0	0	0	0	0	108	0	0			27
1992		0	0	0	0	2275	699	0	0	0			744
1993		0	0	358	0	842	0	2858	0	0			925
1994		0	0	0									
1995				0	0	0	0		0	716	0	0	0
1981–1988	0	0	0	0	847	4472	3015	3940	51	278	218	0	

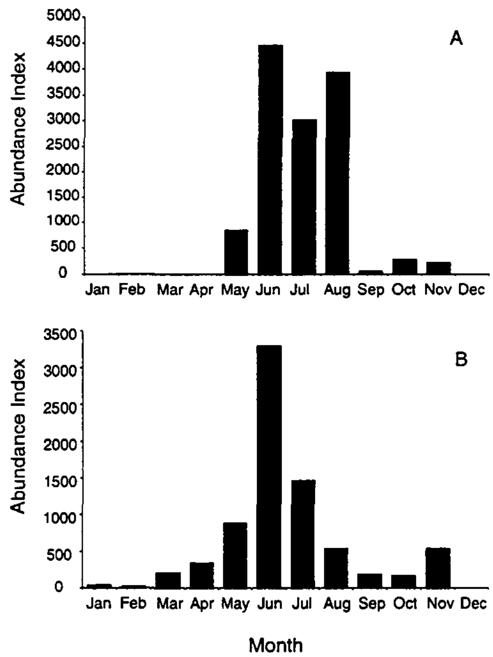

Figure 21 Seasonal abundance of walleye surfperch collected in the midwater trawl from 1981 to 1988: (A) age 0 and (B) age 1+

Table 8 Monthly abundance indices of age–1+ walleye surfperch collected with the midwater trawl. The annual index period was March to October. NI indicates no index calculated.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual Index*
1980		0	1487	753	0	215	2006	1074	466	0	0	0	750
1981	0	0	0	2366	0	8954	358	431	0	753	3940	0	1608
1982	358	0	753	0	1505	3600	923	0	0	215	0	0	875
1983	0	0	0	0	0	0	376	466	0	0	0	0	105
1984	0	0	0	0	2258	734	0	2149	0	358	0	0	687
1985	0	0	565	0	0	4445	1540	0	0	0	0	0	819
1986	0	188	0	0	296	546	3877	358	0	0	0	0	635
1987	0	0	0	0	2410	7521	4656	358	358	0	358	0	1913
1988	0	0	323	376	619	546	0	546	1112	0	0	0	440
1989	716	0	0	565	546	358	358	466					382
1990		358	753	108	897	0	108	0	358	573			350
1991		0	0	0	0	1433	1587	0	0	0			378
1992		0	0	0	0	1523	0	466	0	0			249
1993		0	296	0	358	0	0	431	0	0			136
1994		0	0	0									NI
1995				0	0	0	0		0	2615	0	546	436
1981–1988	45	24	205	343	886	3293	1466	539	184	166	537	0	

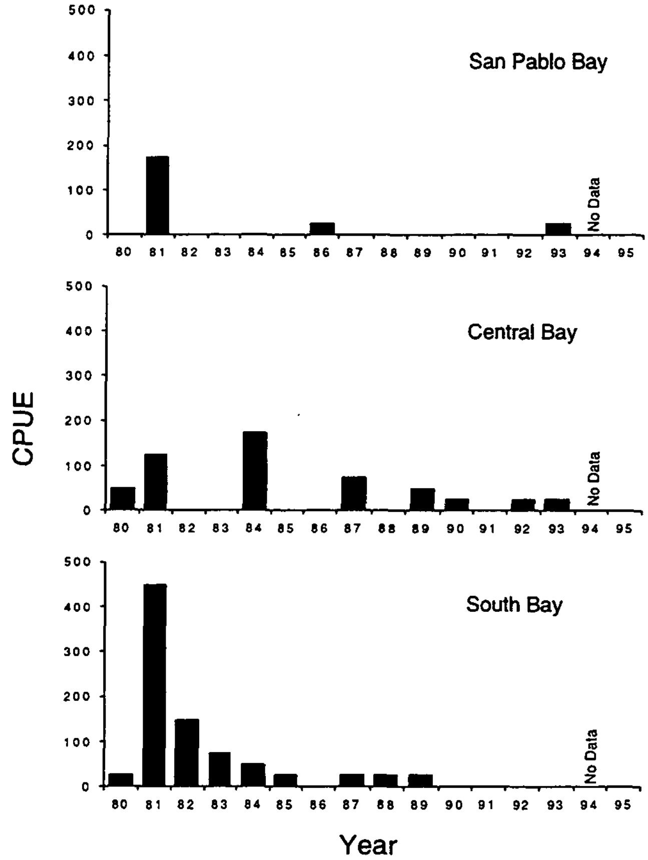

Figure 22 Annual distribution by bay of age–0 walleye surfperch collected with the midwater trawl from 1980 to 1995. Annual CPUE was May to August. Values are CPUE x 100.

Distribution

Age–0 walleye surfperch ranged from South to San Pablo bays in the midwater trawl catches (Figure 22). Annual CPUE was usually highest in either South or Central bays. Only in 1981, 1986, and 1993 did they enter San Pablo Bay in large numbers and then only in August (Figure 23). No walleye surfperch were collected in Suisun Bay or the west delta. Age–0 CPUE was highest in South Bay from May to July. In August, the CPUE was highest in San Pablo Bay due to fish collected in 1981, 1986, and 1993. In October they were collected only in South Bay and in November only in Central Bay.

Age–0 walleye surfperch also ranged from South to San Pablo bays in the beach seine (Figure 24). The CPUE was highest in Central Bay in all months. In the beach seine, the seasonal distribution was restricted to May to September compared to May to November in the midwater trawl.

Age–1+ walleye surfperch had the same range as age–0 fish in the midwater trawl from South to San Pablo bays (Figure 25). From 1980 to 1987, the CPUE was highest in either South or Central bays but, during the drought years 1988 to 1992, the CPUE was usually highest in San Pablo Bay. In 1995 they were found only in Central Bay. The CPUE was highest in South Bay in spring, in Central Bay in summer, and in San Pablo Bay in late summer and early fall (Figure 26).

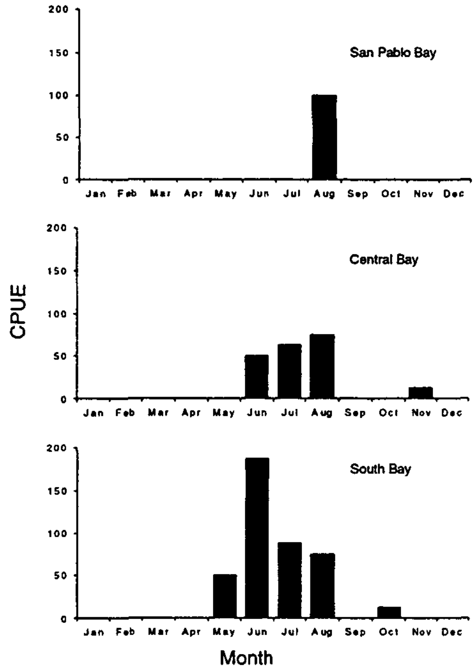

Figure 23 Seasonal distribution by bay of age–0 walleye surfperch collected with the midwater trawl from 1981 to 1988. No walleye surfperch were collected in Suisun Bay and the west delta. Values are CPUE x 100.

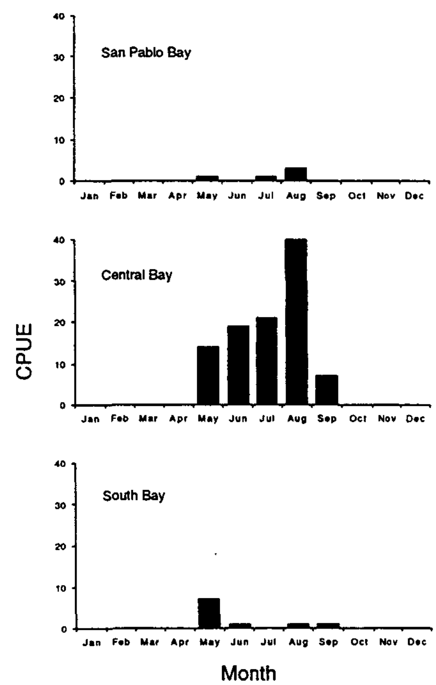

Figure 24 Seasonal distribution by bay of age–0 walleye surfperch collected with the beach seine from 1981 to 1986. No walleye surfperch were collected in Suisun Bay and the west delta. Values are CPUE x 100.

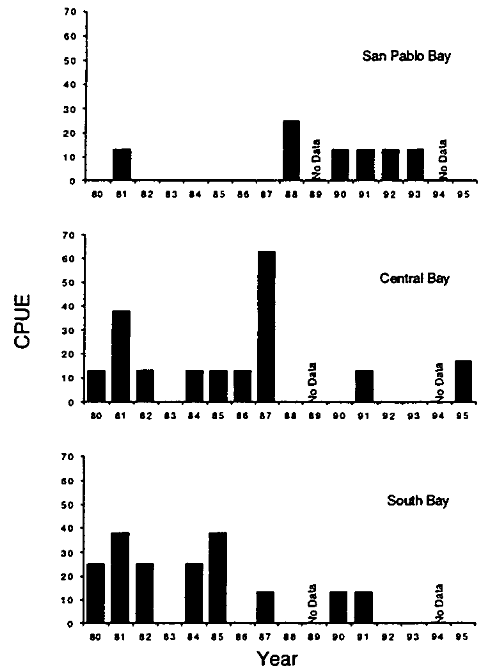

Figure 25 Annual distribution by bay of age–1+ walleye surfperch collected with the midwater trawl. Annual CPUE was March to October. No walleye surfperch were collected in Suisun Bay or the west delta. Values are CPUE × 100.

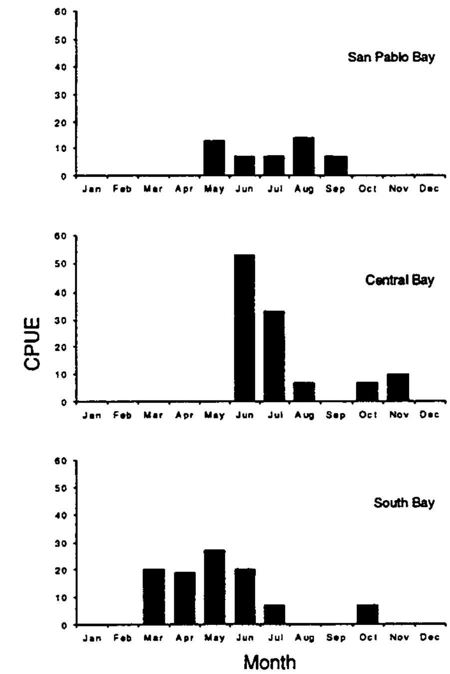

Figure 26 Seasonal distribution by bay of age–1+ walleye surfperch collected with the midwater trawl from 1981 to 1988. No walleye surfperch were collected in Suisun Bay and the west delta. Values are CPUE × 100.

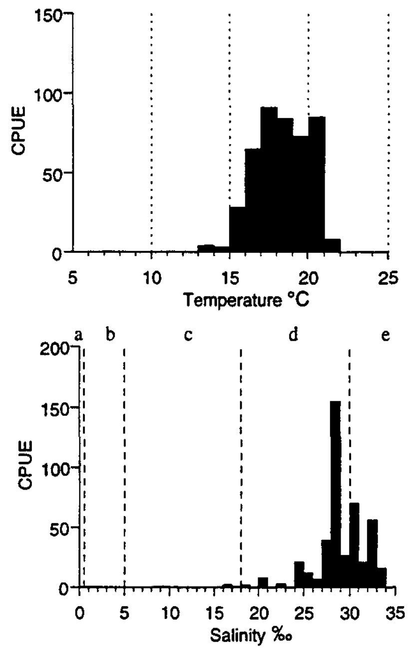

Figure 27 Temperature and salinity distributions for age–0 walleye surfperch collected with the midwater trawl. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Temperature and Salinity

Age–0 fish were collected with the midwater trawl at slightly lower average temperatures and over a narrower temperature range than age–1+ fish (Figures 27 and 28). The range for age–0 fish was 13.3 to 21.7 °C, $\overline{\chi}$ = 14.0 °C. The range for age–1+ fish was 8.6 to 21.7 °C, $\overline{\chi}$ = 17.0 °C.

Both age groups were collected in polyhaline and euhaline salinities (see Figures 27 and 28). Age–0 fish were collected at slightly higher salinities than age 1+: from 9.3 to 33.6‰, $\overline{\chi}$ = 27.9‰ for age–0 fish compared to 7.2 to 32.8‰, $\overline{\chi}$ = 27.7‰ for age–1+ fish.

Age–0 fish were collected with the beach seine at higher temperatures but lower salinities than in the midwater trawl (see Figure 27, Figure 29). The temperature range was 14.3 °C to 22.0°C, $\overline{\chi}$ = 16.7 °C, and the salinity range was 0.8‰ to 32.6‰, $\overline{\chi}$ = 26.0‰.

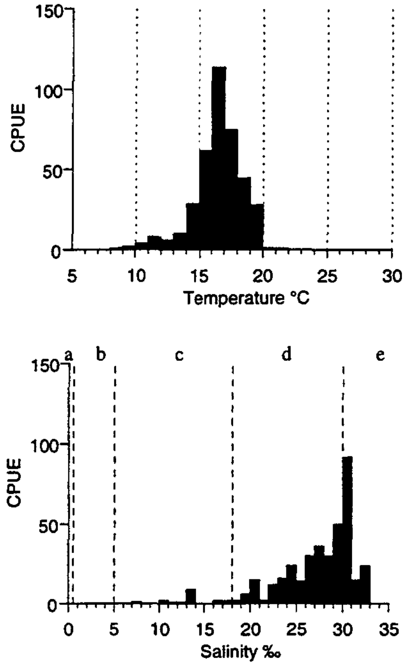

Figure 28 Temperature and salinity distributions for age–1+ walleye surfperch collected with the midwater trawl. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

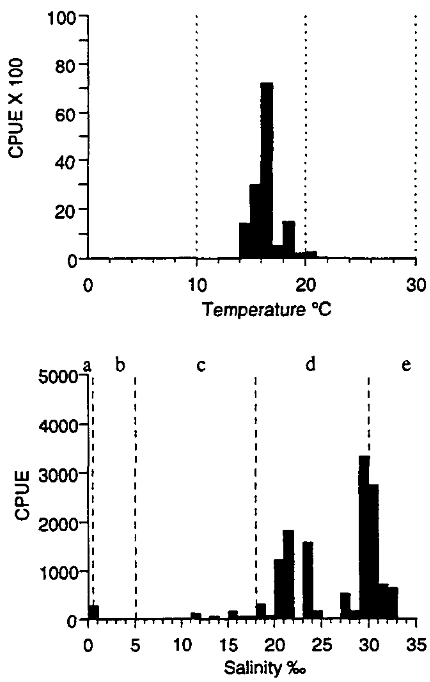

Figure 29 Temperature and salinity distributions for age–0 walleye surfperch collected with the beach seine. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Discussion

Walleye surfperch used the estuary primarily as a birthing area and secondarily as a nursery area. Age–1+ fish entered the estuary in spring and summer to give birth. Their abundance decreased in September and most emigrated from the estuary in fall and winter. The length frequency data show that the fish still present in January and February were older fish, either migrating into the estuary early or overwintering in the estuary.

Age–0 walleye surfperch were collected in the shallows from May to August. They moved to the deeper areas of the estuary from June to August and then migrated out of the estuary in fall and winter as shown by the decrease in the midwater trawl catch in September. Walleye surfperch are reported to use bays and estuaries less than other surfperch species and our data suggests that they did not remain in the estuary as long as the more frequently collected surfperch species, which include shiner perch, pile perch, and dwarf perch.

Both age groups were collected in polyhaline and euhaline salinities. The differences in age–0 and age–1+ regional and seasonal distributions accounted for the slightly higher salinity and temperature ranges of age–0 fish. For example, age–0 fish primarily used South and Central bays, whereas age–1+ fish used South, Central, and San Pablo bays. Also, during dry years when outflow was low and salinity high, age–1+ fish moved to the lower salinity of San Pablo Bay. Age–0 fish were collected in South Bay in summer, whereas age–1+ fish were found in South Bay in spring and in Central and San Pablo bays in summer. South Bay was usually warmer than Central and San Pablo bays in summer.

Similar to other surfperch species, walleye surfperch abundance has declined: age–0 abundance since 1984 and age–1+ abundance since 1987. There has also been a long-term decline of walleye surfperch along the coast. Between 1980 and 1986, the annual number of walleye surfperch sampled from the marine recreational fishery decreased by 72% (Karpov and others 1995). Although the walleye surfperch is considered a coastal species, its occurrence in bays and estuaries may contribute to its decline as it migrates to shallow areas where it may be vulnerable to overfishing. There are no size or take regulations for the species.

Pile Perch

Introduction

The pile perch, *Rhacochilus vacca*, ranges from Guadalupe Island, Baja California to Port Wrangell, Alaska (Tarp 1952, Miller and Lea 1972). It is common in bays and estuaries along sandy and rocky shores and around pilings (Roedel 1953) but has also been observed in open water (Baltz 1984), and in close association with dense kelp (Alevizon 1975). Pile perch may school in midwater when not foraging (Baltz 1984). It is eurythermal (Tarp 1952) and found in polyhaline to euhaline salinities (Wang 1986). It is common from the surface to 46 m and temperature may control its depth distribution. In southern California, subadults were observed at 8.5 to 10.4 m in fall and <7.5 m in winter and spring (Terry and Stephens 1976).

The pile perch is viviparous, as are all surfperch. Mating takes place in fall, sperm is stored for at least 2.5 months, and fertilization occurs from December to April. The gestation period lasts 6 months and parturition occurs from June to October (Wares 1968). In the San Francisco Estuary, parturition occurs from late spring to early summer (Wang 1986). In the southern regions of the pile perch range, reproduction occurs earlier in the year. For example, in La Jolla, pile perch give birth in April (Wares 1968).

Most males mature at ages 3 and 4 but a small proportion matures as early as age 2 (Wares 1968). Females are usually mature at ages 3 or 4, the year they mate or give birth, and may delay reproduction for 1 to 4 years. The mean fecundity is 12 young for the 1st reproduction and 60 young for older fish (Baltz 1984, Fritzsche and others 1992). Fecundity is positively correlated with maternal size, but there is no evidence that size at birth depends on maternal size or age. Size at birth has been reported as 76.0 to 85.7 mm TL (Wares 1968) or 70 to 80 mm TL (Wang 1986). Pile perch can live to 9 or 10 years and females live longer than males (Wares 1971). They reach a maximum size of 441 mm TL (Miller and Lea 1972).

Because of its highly developed pharyngeal teeth, the pile perch can crush hard-shelled invertebrates. Food preferences differ by season, location, and age of fish (Wares 1971). Juveniles feed on mussels, clams, and snails (Wares 1971). Adults feed on barnacles, shrimp, mussels, clams, crabs, and amphipods (Haldorson and Moser 1979, Ebeling and Laur 1986).

The pile perch is an important sport fish along the California coast and in estuaries and supports a small commercial fishery in southern California and Baja California (Hart 1973, Fritzsche and others 1992). It is taken by anglers from shore, piers, jetties, and skiffs. (Feder and others 1974). In northern California it is caught mostly from piers, and from Santa Cruz to San Luis Obispo, it is taken primarily by spear fishermen (Karpov and others 1995).

Methods

Otter trawl data from 1980 to 1995 were used for seasonal and annual abundance, seasonal distribution, and temperature and salinity analyses. The otter trawl data is incomplete for 1989 and the trawl was not used from November to January 1990 to 1994. Because only 210 pile perch were collected in the otter trawl no annual distribution data is presented.

Based on length frequencies, fish were classified into 2 age groups: age 0 and age 1+. The cutoff lengths for this separation were as follows: 105 mm FL from January through June, 110 mm FL for July, 130 mm FL for August, 135 mm FL for September, 140 mm FL for October, 155 mm FL for November and 160 mm FL for December. A January 1 birth date was assumed. This corresponds to the date of fertilization, not the date of parturition. The index period for age–0 pile perch was June to October, and February to October for age–1+ pile perch.

Results

Length Analyses

Pile perch collected with the otter trawl ranged from 42 to 322 mm FL, although fish >220 were uncommon (Figure 30). Using Wares (1971) size criteria, at least 3 age classes were collected in most months. Ages 1 and 2 (<200 mm) were the most common in all months. From December to March, and in June and July, modes were present for ages 1 and 2 and ages 3 and 4 (200 to 260 mm). In March, 1 age–5 fish (322 mm) was collected.

Abundance

Age–0 pile perch were most abundant in 1981 and next most abundant in 1980 (Figure 31A). Abundance declined after 1983 and no age–0 fish were collected in 1987, 1988, and 1990 to 1995. They were most abundant from July to October (Figure 32A). In 1981, they were also collected in November and December, and in 1982 and 1983, in May and December (Table 9).

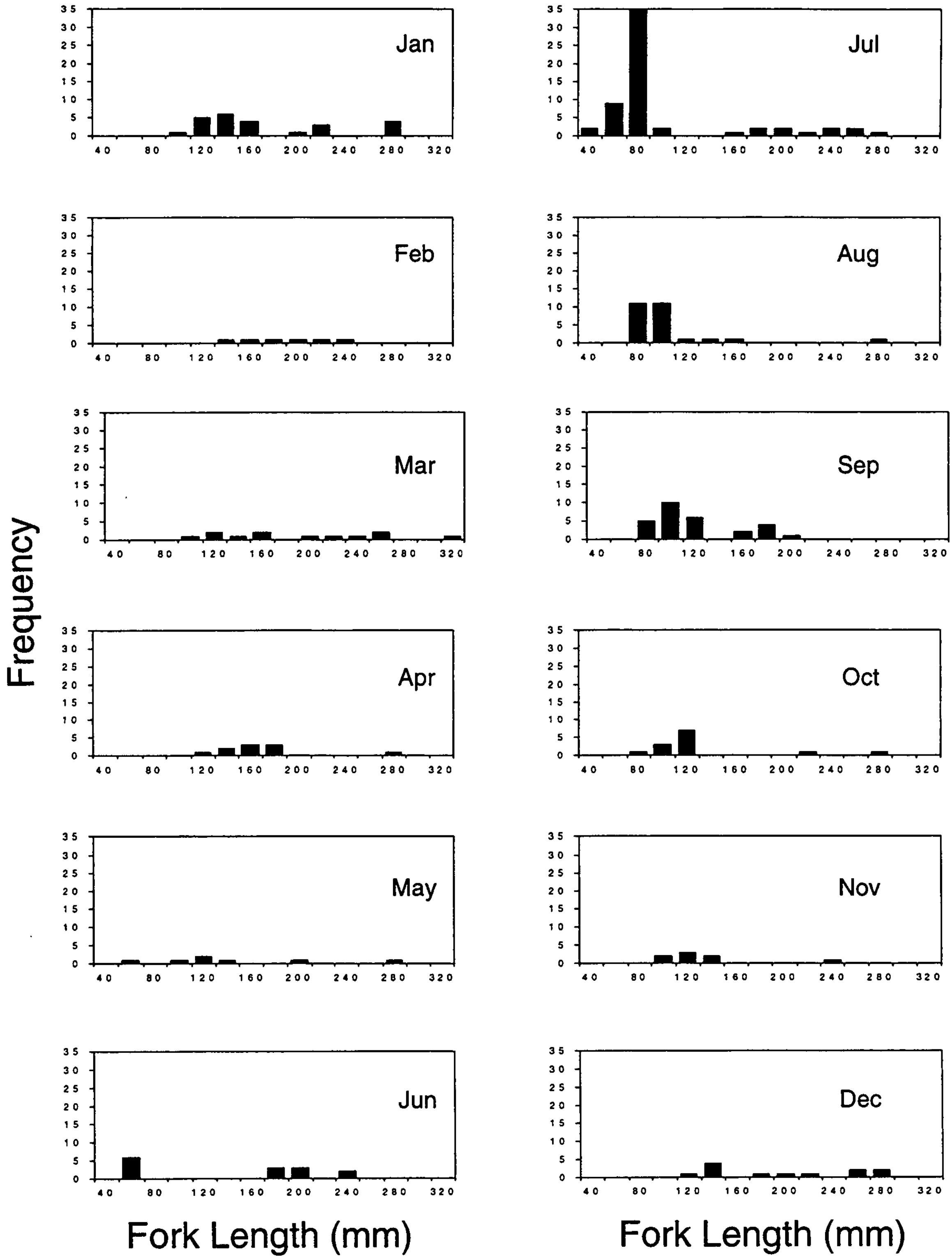

Figure 30 Monthly length frequencies of pile perch collected with the otter trawl from 1980 to 1995. Values on x-axis are lower class limits.

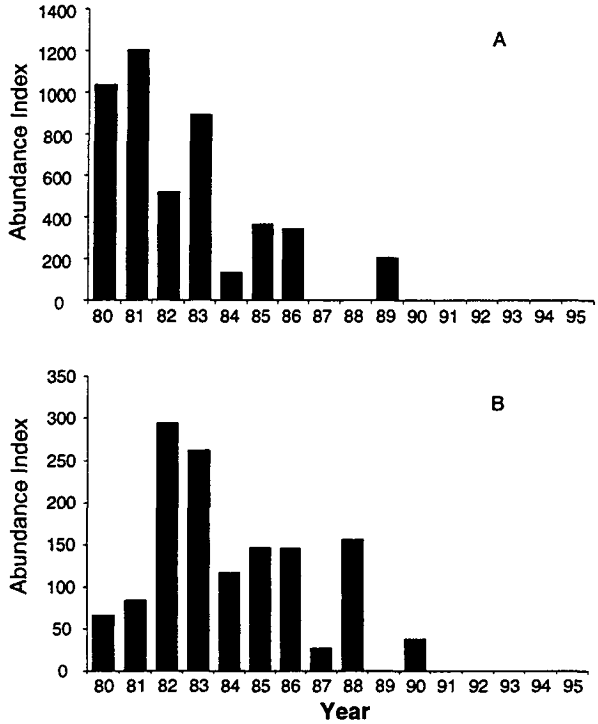

Figure 31 Annual abundance indices of pile perch collected with the otter trawl from 1980 to 1995: (A) age 0, index period was June to October; (B) age 1+, index period is February to October. Values are index x 100.

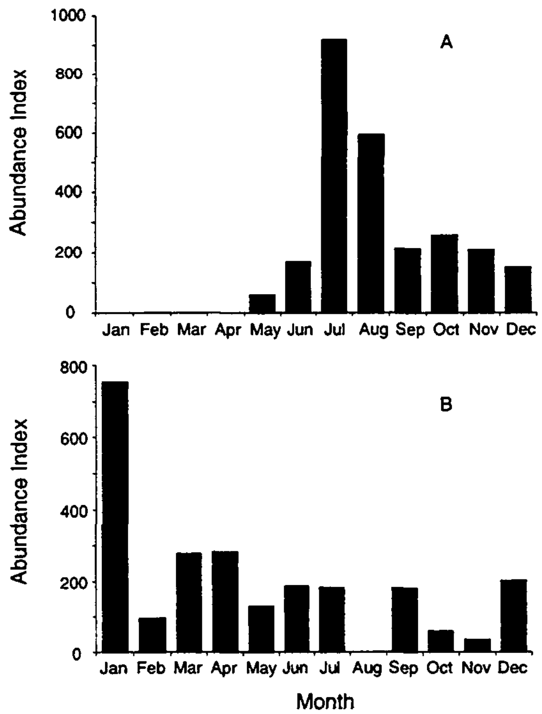

Figure 32 Seasonal abundance of pile perch collected with the otter trawl from 1981 to 1988: (A) age 0 and (B) age 1+

Table 9 Monthly abundance indices (in hundreds) of age–0 pile perch collected with the otter trawl, 1980 to 1995. The annual index period was June to October.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980		0	0	0	0	0	1819	787	2380	189	0	0	1035
1981	0	0	0	0	0	250	1126	3777	532	322	1697	250	1201
1982	0	0	0	0	250	0	970	974	464	188	0	469	519
1983	0	0	0	0	219	688	2032	0	162	1563	0	500	889
1984	0	0	0	0	0	216	460	0	0	0	0	0	135
1985	0	0	0	0	0	0	1601	0	219	0	0	0	364
1986	0	0	0	0	0	188	1170	0	352	0	0	0	342
1987	0	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	365	250					205
1990		0	0	0	0	0	0	0	0	0			0
1991		0	0	0	0	0	0	0	0	0			0
1992		0	0	0	0	0	0	0	0	0			0
1993		0	0	0	0	0	0	0	0	0			0
1994		0	0	0	0	0	0	0	0	0			0
1995	0	0	0	0	0	0	0		0	0	0	0	0
1981-1988	0	0	0	0	59	168	920	594	216	259	212	152	

Table 10 Monthly abundance indices (in hundreds) of age–1+ pile perch collected with the otter trawl from 1980 to 1995. The annual index period was February to October.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980		0	189	189	0	0	0	219	0	0	0	0	66
1981	0	281	250	0	0	0	230	0	0	0	281	216	85
1982	1921	0	219	250	346	435	710	0	688	0	0	673	294
1983	497	0	250	946	412	0	0	0	750	0	0	466	262
1984	216	0	0	0	0	1055	0	0	0	0	0	0	117
1985	0	0	594	0	0	0	513	0	0	216	0	0	147
1986	909	243	619	454	0	0	0	0	0	0	0	0	146
1987	0	243	0	0	0	0	0	0	0	0	0	0	27
1988	2470	0	281	594	281	0	0	0	0	250	0	250	156
1989	0	0	0	0	0	0	0	0					0
1990		0	344	0	0	0	0	0	0	0			38
1991		0	0	0	0	0	0	0	0	0			0
1992		0	0	0	0	0	0	0	0	0			0
1993		0	0	0	0	0	0	0	0	0			0
1994		0	0	0	0	0	0	0	0	0			0
1995	0	0	0	0	0	0	0		0	0	0	0	0
1981–1988	752	96	277	281	130	186	182	0	180	58	35	201	

Abundance indices of 1+ pile perch were highest in 1982 and 1983, lagging behind the highest age–0 abundance indices by 1 year (Figure 31B). No fish were collected in 1989 and from 1991 to 1995. Age–1+ fish were collected in every month except August and were most abundant in January (Figure 32B). In most years no age–1+ pile perch were collected from June to November (Table 10).

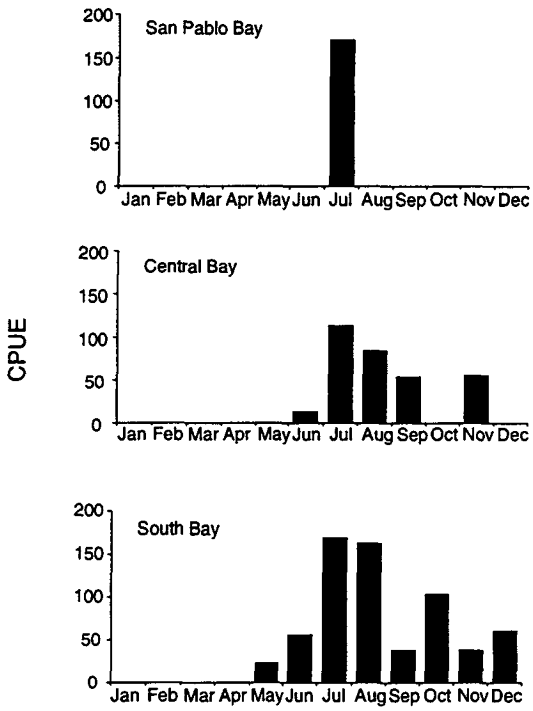

Figure 33 Seasonal distribution by bay of age–0 pile perch collected with the otter trawl from 1981 to 1988. No pile perch were collected in Suisun Bay or the west delta. Values are CPUE x 100.

Seasonal Distribution

Age–0 pile perch ranged from South to San Pablo bays but the highest CPUEs occurred in South and Central bays (Figure 33). They were first collected in May in South Bay and extended their distribution to Central Bay in June and to San Pablo Bay in July. The increase in CPUE in San Pablo Bay in July may not be an actual distribution expansion because it is based on only 14 age–0 fish caught in southern San Pablo Bay in 1980, 1982, and 1985. Likewise, the CPUE variations in South Bay and Central Bay in August, September, and November may be an artifact of low catches.

Age–1+ pile perch also ranged from South to San Pablo bays but had no strong seasonal distribution pattern (Figure 34). The CPUE was highest in South Bay in all months except February, June, and July. In February and June the CPUE was highest in Central Bay and in July in San Pablo Bay. However, the CPUE increase in San Pablo Bay in July was based on collections of only 4 fish in 1982 and 1 fish in 1985.

Temperature and Salinity

Age–0 pile perch were collected at higher temperatures than age–1+ fish. Age–0 fish were collected at 10.9 to 20.6 °C , $\bar{\chi}$ = 17.7 °C (Figure 35). Age–1+ fish were collected between 7.9 and 21.2 °C, $\bar{\chi}$ = 13.9 °C (Figure 36).

Both age groups were primarily collected in euhaline and polyhaline salinities, but age–0 fish were collected at higher salinities than age–1+ fish. The salinity for age–0 fish ranged from 14.2 to 33.6‰, $\bar{\chi}$ = 28.0‰ (Figure 35). Age–1+ fish were collected at 5.1 to 32.4‰, $\bar{\chi}$ = 24.5‰ (Figure 36).

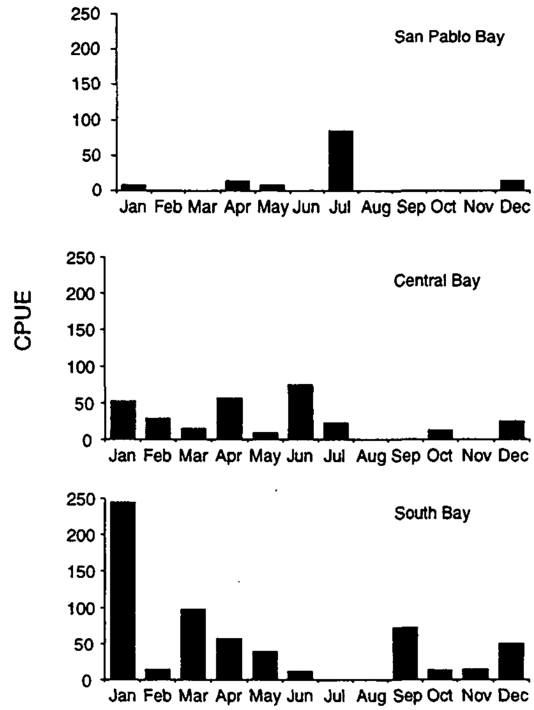

Figure 34 Seasonal distribution by bay of age–1+ pile perch collected with the otter trawl from 1981 to 1988. No pile perch were collected in Suisun Bay or the west delta. Values are CPUE x 100.

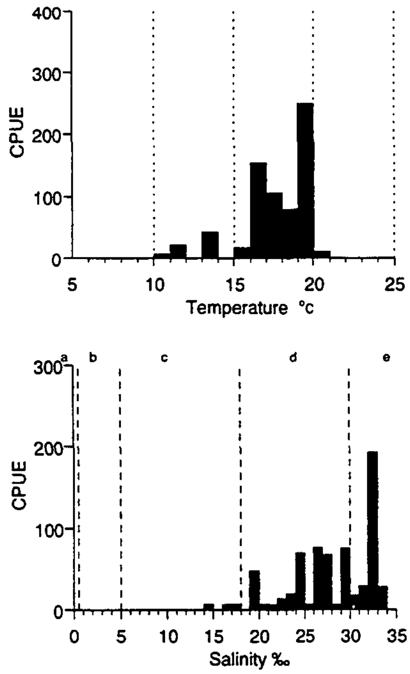

Figure 35 Temperature and salinity distributions of age–0 pile perch collected with the otter trawl. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

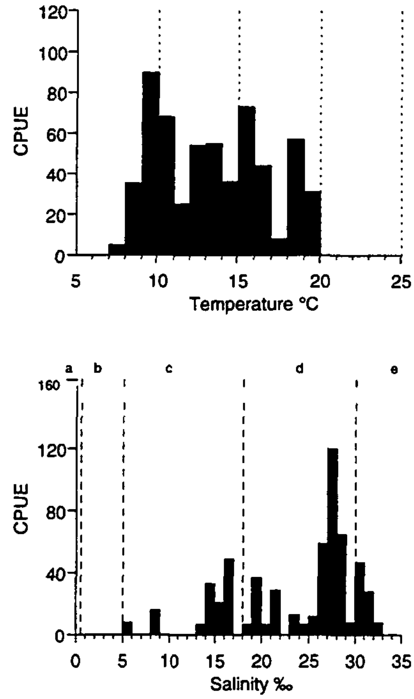

Figure 36 Temperature and salinity distributions for age–1+ pile perch collected with the otter trawl from 1980 to 1995. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Discussion

The pile perch is found all year in the San Francisco Estuary. It uses the estuary as a birthing and nursery area and is found mostly in Central and South bays. Age–0 fish are present in late spring and early summer, when parturition occurs. In winter the low catch of age–0 fish may represent emigration out of the estuary or to areas where the otter trawl does not sample effectively. Young fish leave Yaquina Bay, Oregon, during their first winter (Wares 1971), but in the San Francisco Estuary, the catch of age 1+ fish increased in January. The length frequency data show that most of these fish are overwintering juveniles (age 2) rather than adults entering the estuary. Age 1+ abundance peaked in March and April, just before parturition, then decreased from summer through November. This decrease has also been reported in other studies (Wares 1968). In southern California, the fall decrease reportedly represents emigration in response to warmer temperatures (Terry and Stephens 1976).

The migratory patterns of both age groups of pile perch in the estuary are hard to define. Otter trawl catches were low in all years—only 210 were collected from 1980 to 1995. Even fewer (30) were collected with the beach seine, too few to determine residence time of age–0 fish, movement from the shallows to deep areas within the estuary, and response to temperature and salinity. Our gear is probably ineffective in catching pile perch due to their preferred habitats around pilings, wharfs and rocky outcroppings. Other studies using sport fishing gear and spears have been more effective in sampling pile perch (Karpov and others 1995).

Age–0 pile perch were captured at higher salinities and temperatures than age–1+ fish. In southern California, adults were rarely present at >16 °C but subadults were collected at these temperatures (Terry and

Stephens 1976). Our data show that age–1+ fish were found in temperatures >16 °C but most were collected between 9 and 14 °C. Very few age–0 fish were collected in <16 °C.

Both age groups were collected primarily in polyhaline and euhaline salinities as Wang (1986) also found. The collection of age–0 pile perch at higher salinities than age–1+ may be an artifact of the large number of age–1+ fish collected in January when salinities were lower. Most age–0 fish were collected in summer.

Similar to other surfperch species in the San Francisco Estuary, pile perch abundance has declined. Age–0 abundance decreased after 1987 and age–1+ abundance after 1988. No age–0 fish were collected from 1990 to 1995, and age–1+ fish were absent from 1991 to 1995. This agrees with a long-term decline in pile perch populations along the coast (Karpov and others 1995). Factors which may have contributed to the pile perch decline may include a reduction in estuarine habitat, low fecundity, and overharvest. The dredging of channels and filling in of shallows have caused significant alterations to estuarine habitats in the San Francisco Estuary (SFEP 1991). Pile perch may be affected by this as they use the shallows for nursery and rearing areas. Pile perch use shallow habitats during critical times in their life cycles, which also makes them vulnerable to overfishing. There are no bag, possession, or size limits, and no closed season for this species.

Dwarf Perch

Introduction

The dwarf perch, *Micrometrus minimus,* ranges from Cedros Island, Baja California to Bodega Bay (Miller and Lea 1972). It is restricted to shallow inshore, marine and estuarine habitats (Terry and Stevens 1976) primarily in shallow eelgrass beds, on rock reefs, and around jetties (Feder and others 1974). It is common from the surface to 9 m but is concentrated from 0.9 to 6 m (Feder and others 1974, Tarp 1952). In southern California the dwarf perch is found at mean depths of 1.5 m throughout the year (Shrode and others 1982). The dwarf perch prefers temperatures of 11 to 21 °C, and at 23 °C was found to move to deeper waters (Shrode and others 1982). It is found throughout the year in bays and estuaries and is resident in the San Francisco Estuary (Hubbs 1921).

The dwarf perch mates in summer and parturition occurs from June to August (Hubbs 1921) or April to May in southern California (Feder and others 1974). Males are mature at birth and females mature at 1 year. Males inseminate the females a few weeks after birth and the females store sperm for 6 to 9 months (Schultz 1993). Gestation lasts 6 months. The brood size of 2 to 50 young is moderately large for the surfperch family (Baltz 1984). Fecundity is positively correlated with maternal age (Hubbs 1921). Males live 1 year and females 2 or 3 years. Length at birth is 25 to 35 mm TL and the maximum size is 159 mm TL (Wang 1986, Miller and Lea 1972). Because of its small size, the dwarf perch has no commercial or economic value and is rarely taken by anglers.

Juveniles feed on small crustaceans, amphipods, polychaetes, and molluscs (Feder and others 1974). As it grows it becomes a partial herbivore (Hubbs 1921) and then remains omnivorous (Shrode and others 1983).

Methods

The beach seine data from 1980 to 1986 were used for annual and seasonal abundance and distribution, and temperature and salinity analyses. Abundance and distribution data are incomplete for 1980 due to lack of sampling from January to July. The otter trawl data from 1980 to 1995 were used for supporting evidence of abundance trends.

By visual inspection of length frequencies of dwarf perch collected in the beach seine, fish were classified into 2 age groups: age 0 and age 1+. All dwarf perch over 70 mm FL were age–1+ fish and those under 70 mm FL were age–0 fish. The annual index period was May to December for age–0 fish and February to October for age–1+ fish. Dwarf perch collected with the otter trawl were not separated into 2 age groups.

Results

Length Analyses

In the beach seine, dwarf perch ranged from 25 to 163 mm FL but fish >115 mm were uncommon (Figure 37). The modal length of 55 to 85 mm in winter represented juvenile fish overwintering in the estuary. Before parturition from March to May, the modal length was 85 to 145 mm. During parturition, the modal length declined to 35 to 75 mm and the catch of larger fish decreased.

In the otter trawl, dwarf perch ranged from 32 to 130 mm (Figure 38). Many age–1+ fish >70 mm overwintered in the deeper areas of the estuary. Most size groups disappeared in the summer otter trawl catches and reappeared in fall and winter.

Abundance

Typically, abundance of dwarf perch in the otter trawl was low and they were most abundant in the early 1980s. Abundance decreased after 1982 and none were collected after 1991 (Figure 39, Table 11).

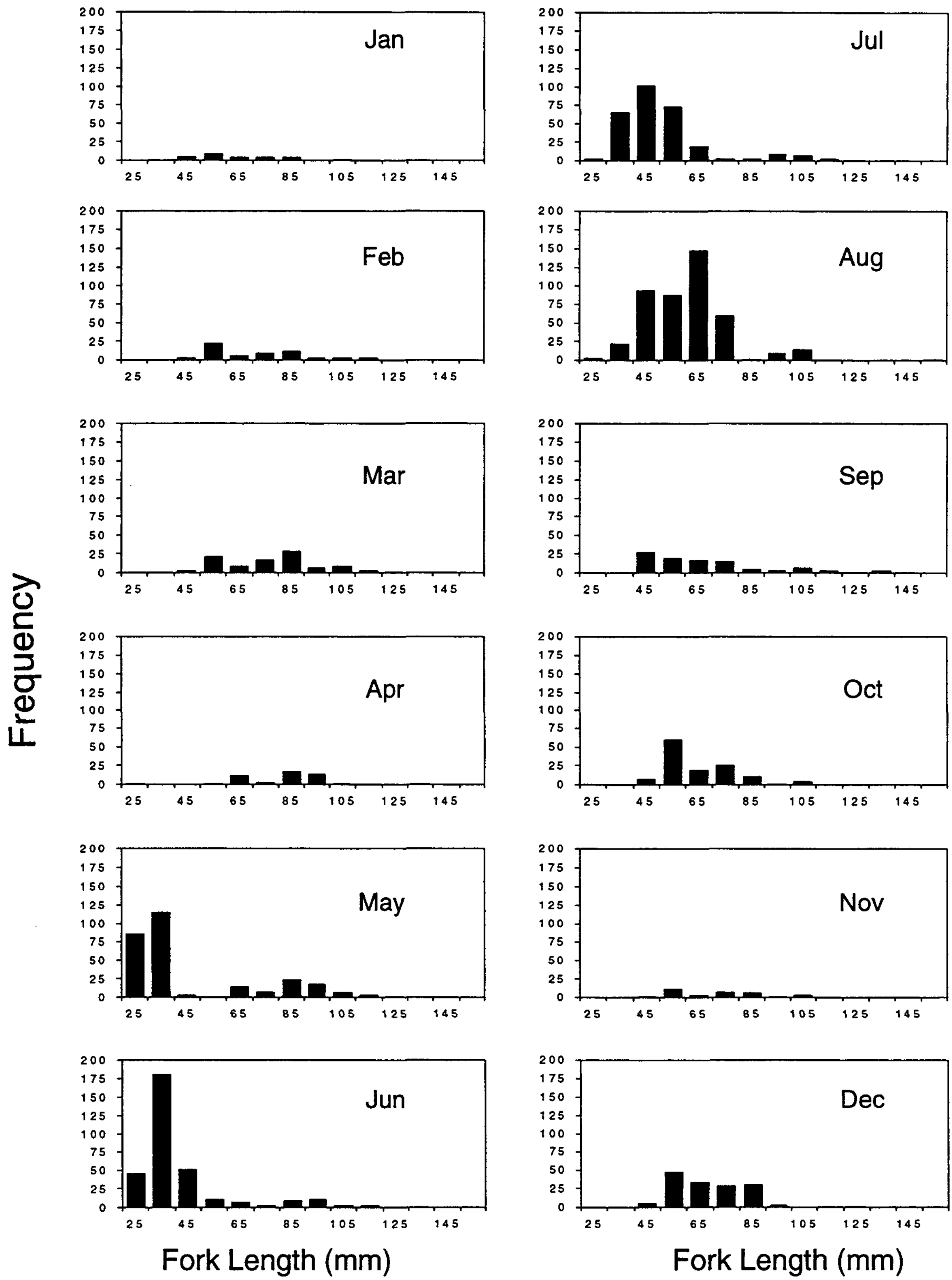

Figure 37 Monthly length frequencies of dwarf perch collected with the beach seine from 1980 to 1986. Values on the x-axis are lower class limits.

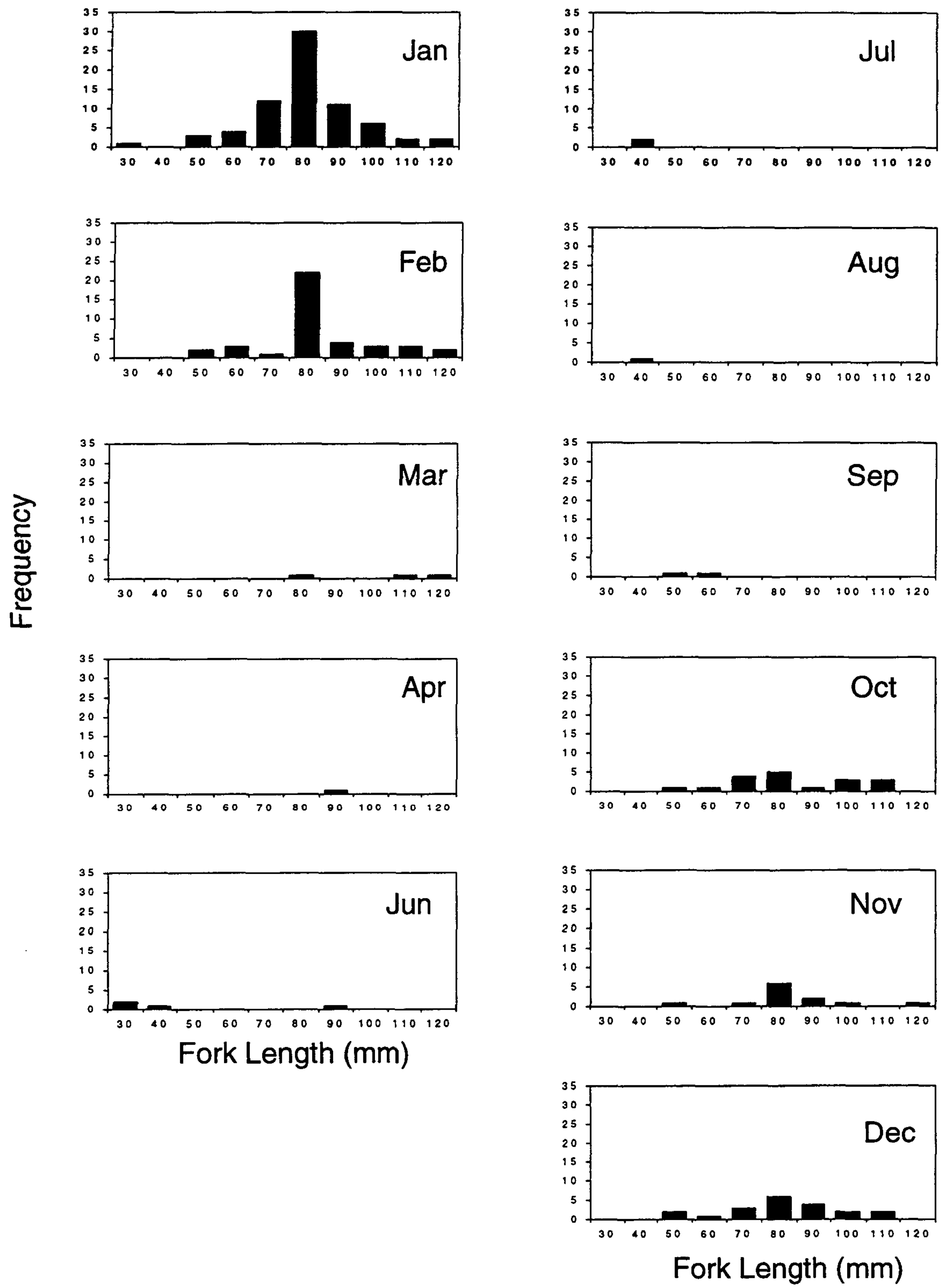

Figure 38 Monthly length frequencies of dwarf perch collected with the otter trawl from 1980 to 1995. Values on the x-axis are lower class limits. No dwarf perch were collected in May.

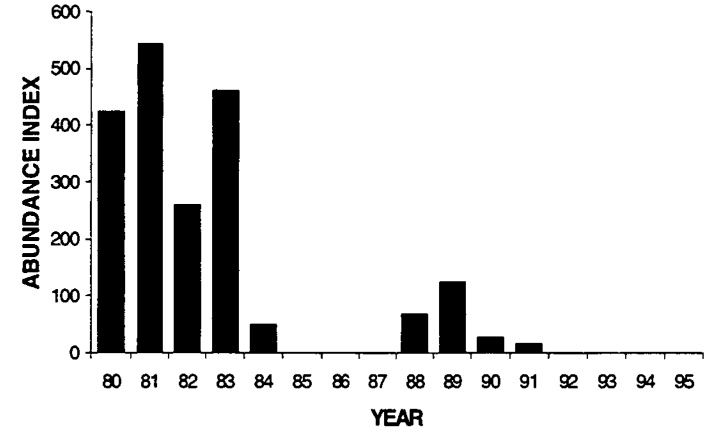

Figure 39 Abundance index of all sizes of dwarf perch collected with the otter trawl from 1980 to 1995

Table 11 Monthly abundance indices of all age groups of dwarf perch collected with the otter trawl from 1980 to 1995. The annual index period was February to October.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Annual Index*
1980		0	0	0	0	0	0	0	450	3359	188	250	423
1981	2036	2849	0	0	0	0	719	0	0	1322	0	935	543
1982	6686	750	532	219	0	0	0	188	0	657	2752	1001	261
1983	6316	3533	94	0	0	313	0	0	219	0	188	1060	462
1984	0	438	0	0	0	0	0	0	0	0	0	625	49
1985	0	0	0	0	0	0	0	0	0	0	0	0	0
1986	438	0	0	0	0	0	0	0	0	0	0	188	0
1987	0	0	0	0	0	0	0	0	0	0	0	250	0
1988	1219	406	0	0	0	211	0	0	0	0	0	0	69
1989	532	876	0	0	0	0	0	0					125
1990		250	0	0	0	0	0	0	0	0			28
1991		0	0	0	0	134	0	0	0	0			15
1992		0	0	0	0	0	0	0	0	0			0
1993		0	0	0	0	0	0	0	0	0			0
1994		0	0	0	0	0	0	0	0	0			0
1995	0	0	0	0	0	0	0		0	0	0	0	0
1981–1988	2087	997	78	27	0	66	90	24	27	247	368	507	

Both age groups of dwarf perch collected with the beach seine were most abundant in 1981 and much less abundant after that year (Figures 40A and 40B). Age–0 fish were collected throughout the year (Table 12). Abundance was highest from May to August and peaked in June, then decreased from September to December (Figure 41A).

Age–1+ dwarf perch were also collected all year (Figure 41B, Table 13). Abundance was bimodal, with a major peak in spring and a secondary peak in October. When all years were combined they were most abundant in May.

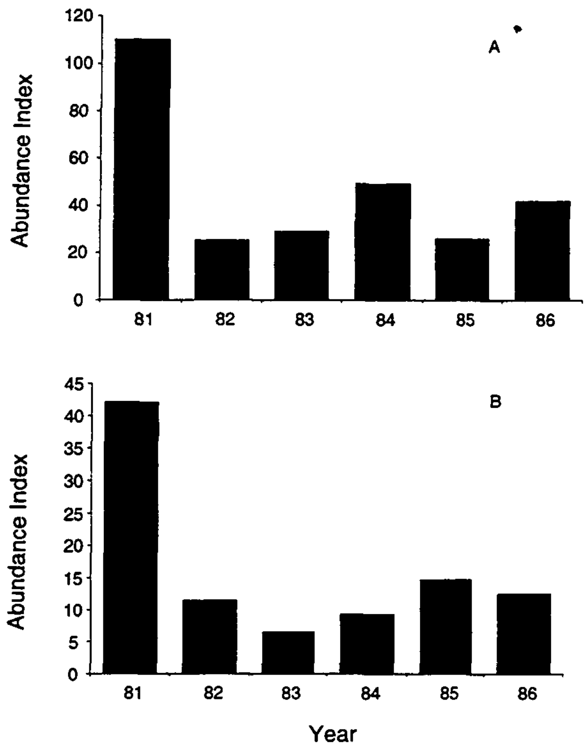

Figure 40 Annual abundance indices of dwarf perch collected with the beach seine from 1981 to 1986: (A) age 0, index period was May to December; (B) age 1+, index period was February to October

Table 12 Monthly abundance indices of age–0 dwarf perch collected with the beach seine from 1980 to 1986. The annual index period was May to December. No sampling occurred from January to July 1980.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980								242	19	40	4	216	
1981	0	11	14	7	296	221	165	108	33	20	15	23	110
1982	15	27	27	0	11	31	66	62	21	10	0	0	25
1983	0	0	2	0	70	32	15	19	24	54	19	0	29
1984	0	4	3	1	24	248	87	28	3	3	1	0	49
1985	2	3	2	0	22	31	35	104	2	11	3	0	26
1986	4	3	1	4	67	69	111	66	15	8	0	1	42
1981–1986	4	8	8	2	82	105	80	65	16	18	6	4	

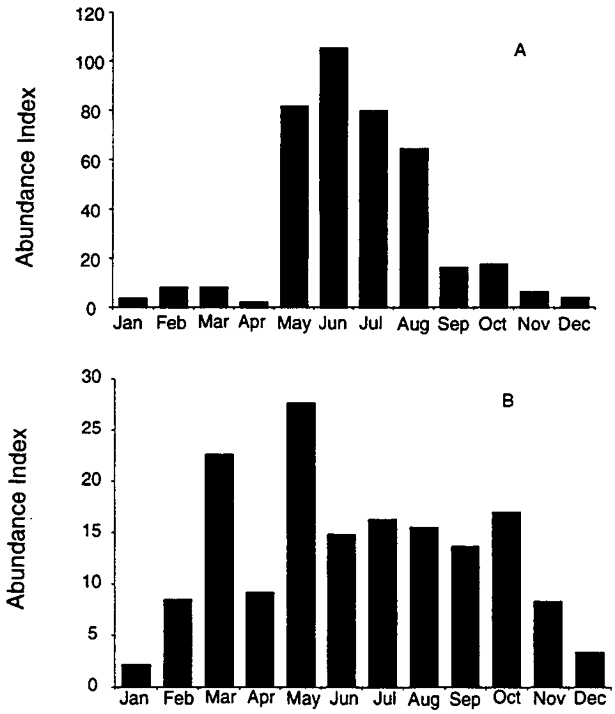

Figure 41 Seasonal abundance of dwarf perch collected with the beach seine from 1981 to 1986: (A) age 0 and (B) age 1+

Table 13 Monthly abundance indices of age–1+ dwarf perch collected with the beach seine from 1980 to 1986. No sampling occurred from January to July 1980. The annual index period was February to October. NI indicates no index calculated.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*Jun*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980								153	32	18	9	207	NI
1981	2	30	47	7	114	47	42	16	33	43	16	20	42
1982	2	13	40	6	11	8	2	20	2	2	0	0	12
1983	0	0	2	8	11	0	5	2	20	11	34	0	7
1984	3	5	7	10	2	14	26	10	8	2	0	0	9
1985	2	2	20	3	14	9	12	20	14	39	0	0	15
1986	4	1	20	21	14	11	11	25	5	5	0	0	13
1981–1986	2	9	23	9	28	15	16	16	14	17	8	3	

Distribution

Age–0 dwarf perch were collected from South to San Pablo bays (Figure 42). The highest annual CPUE was in Central Bay in every year except 1983, when CPUE was highest in South Bay. Age–1+ fish were also collected from South to San Pablo bays. The highest annual CPUE was in Central Bay in all years (Figure 43).

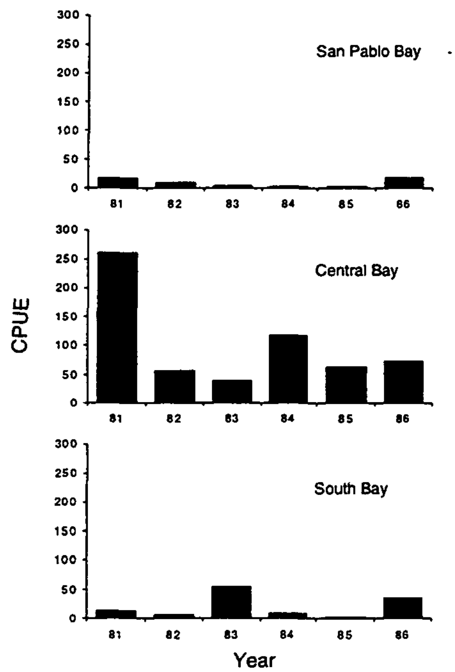

Figure 42 Annual distribution by bay of age–0 dwarf perch collected with the beach seine from 1981 to 1986. Values are annual CPUE from May to December. No dwarf perch were collected in Suisun Bay or the west delta.

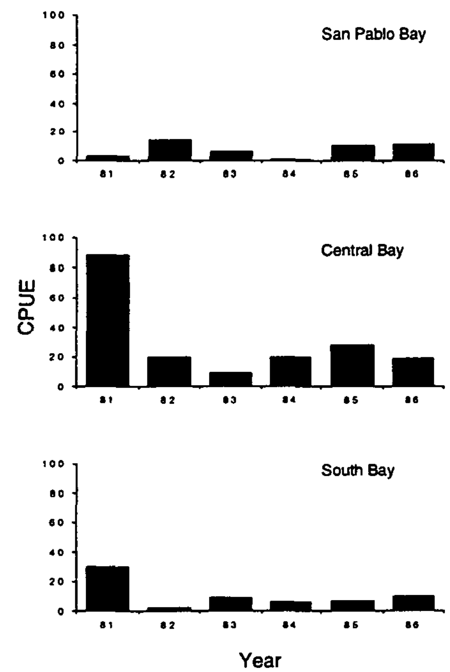

Figure 43 Annual distribution by bay of age–1+ dwarf perch collected with the beach seine from 1981 to 1986. Values are annual CPUE from February to October. No dwarf perch were collected in Suisun Bay or the west delta.

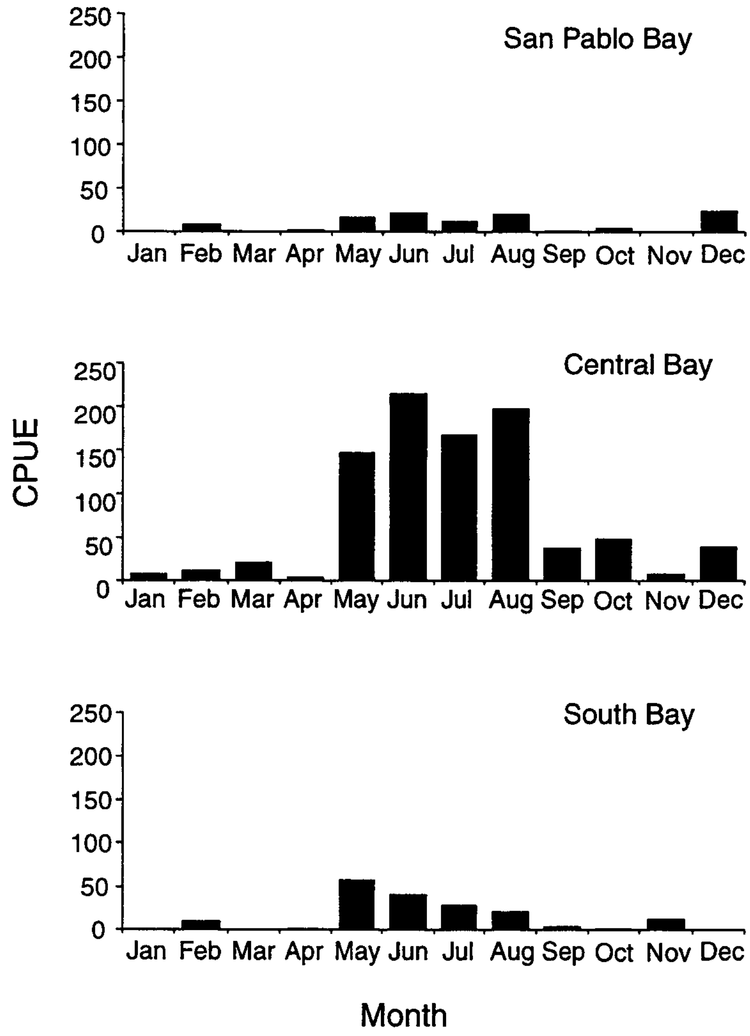

Figure 44 Seasonal distribution by bay of age-0 dwarf perch collected with the beach seine from 1981 to 1986. No dwarf perch were collected in Suisun Bay or the west delta.

Seasonally, the highest CPUE of age–0 dwarf perch was in Central Bay in all months except November when it was highest in South Bay (Figure 44). Coincident with parturition, CPUE increased in South, Central and San Pablo bays in summer.

With several exceptions, age–1+ fish were concentrated in Central Bay (Figure 45). The CPUE was highest in South Bay in February and November, equal in Central and San Pablo bays in April, and highest in San Pablo Bay in December. This erratic pattern may be due to low catches (<500) of age–1+ fish in the beach seine.

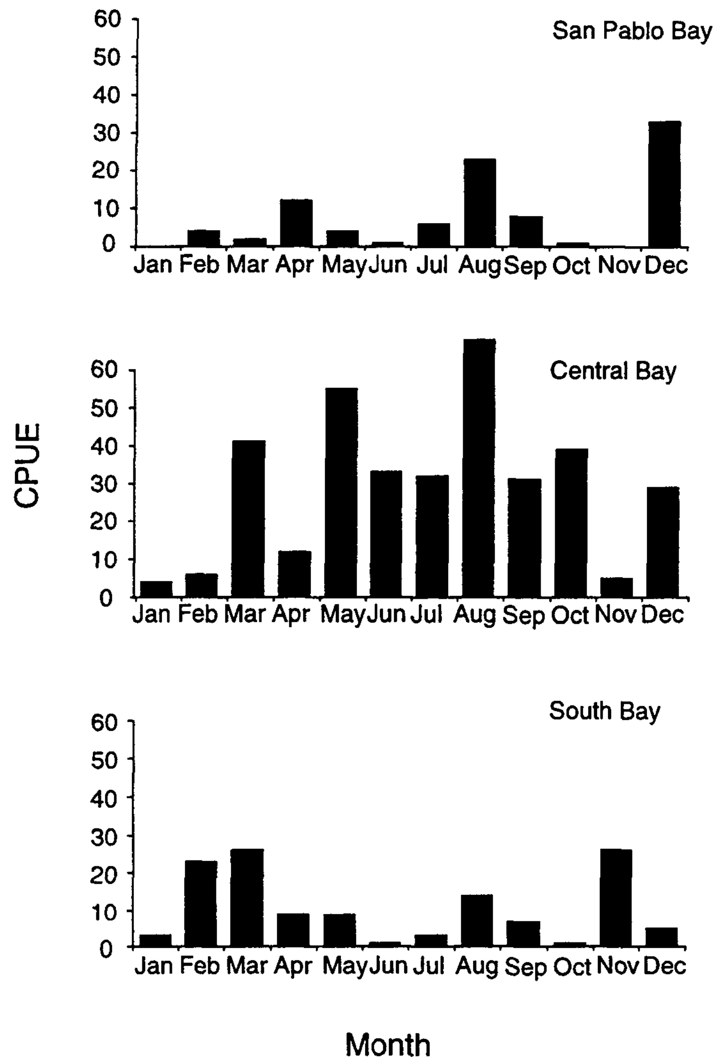

Figure 45 Seasonal distribution by bay of age–1+ dwarf perch collected with the beach seine from 1981 to 1986. No dwarf perch were collected in Suisun Bay or the west delta.

Temperature and Salinity

Age–0 and age–1+ dwarf perch were collected in similar temperature ranges, but age–0 fish were collected at slightly higher temperatures (Figures 46A and 47A). Age–0 fish were collected from 9.1 to 25.5 °C, $\bar{\chi}$ = 17.7 °C. The temperature range for age–1+ fish was 9.1 to 25.0 °C, $\bar{\chi}$ = 16.3 °C.

Both age groups were most abundant in polyhaline and euhaline water but were collected from 0.2‰ to 33.9‰. The age–0 mean salinity of 27.3‰ was somewhat higher than the age–1+ mean salinity of 25.5‰ (Figures 46B and 47B).

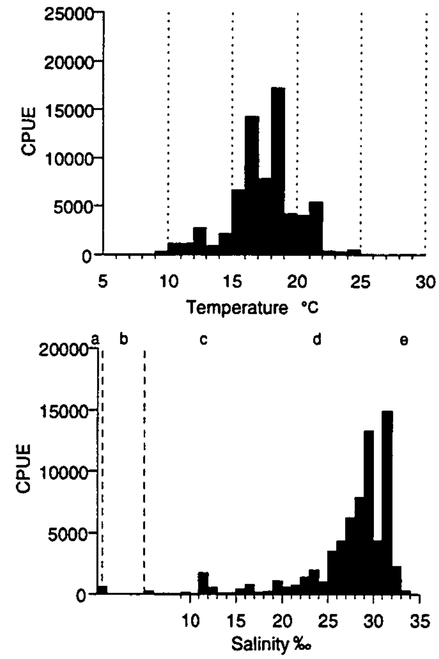

Figure 46 Temperature and salinity distributions for age–0 dwarf perch collected with the beach seine from 1980 to 1986. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

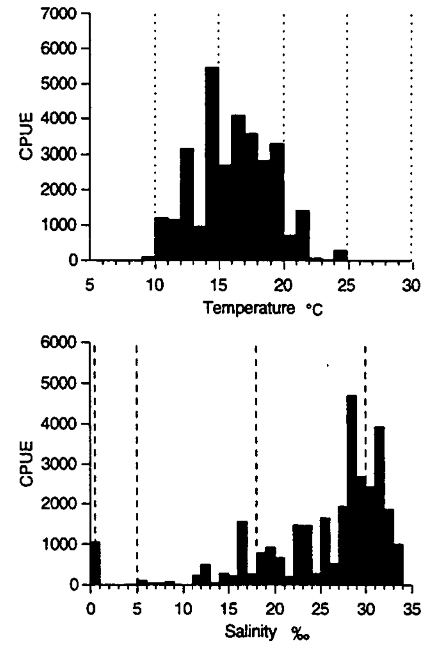

Figure 47 Temperature and salinity distributions for age–1+ dwarf perch collected with the beach seine from 1980 to 1986. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Discussion

Dwarf perch used the shallow areas of the estuary as demonstrated by the high beach seine catch and the small collections in the otter and midwater trawls. Age–0 and age–1+ fish were collected all year indicating the presence of a resident population in the estuary, as Hubbs (1921) and Wang (1986) also found.

Abundance of age–0 dwarf perch peaked from May to August when parturition occurred. There was an early peak of age–1+ fish in March comprised mostly of juveniles overwintering in the estuary and some adults migrating early into the shallows after wintering in deeper water. The abundance decrease in fall for both age groups may be due to movement out of the shallows to deeper areas. This is supported by the catch increase of all sizes in the otter trawl in fall and winter.

Age–0 fish ranged from South to San Pablo bays, but the highest CPUE was in Central Bay in most months. From May to August, when they became abundant, age–0 dwarf perch expanded their distribution from Central Bay to South and San Pablo bays. Age–1+ fish were also concentrated in Central Bay but did not expand or shift their distribution to the other embayments except in winter. Shrode and others (1983) found that depth or a factor correlated with depth, but not temperature, seemed important in the distribution of adults. Juveniles prefer warmer temperatures (Shrode and others 1983) and may have moved to the higher temperatures in South and San Pablo bays in the summer months to reach warmer water. Adults and juveniles overlapped in their summer distribution in southern California as they did in this estuary in Central Bay (Shrode and others 1983).

Abundance of both age groups was low. Although the beach seine data end in 1986, abundance of dwarf perch in the otter trawl remained low through 1995, as has abundance of the other common surfperch species collected in the estuary. One reason for this decline is that dwarf perch are restricted to shallow inshore marine and estuarine habitats which are subject to major environmental fluctuations due to urbanization, dredging, and water development projects (SFEP 1991).

Historically, the dwarf perch has not been an important sport fish. But dwarf perch, like the small shiner perch, are common in the nearshore areas where they can be caught easily by shore anglers, and hence may be declining due to increased fishing effort and lack of size and take limits.

White Seaperch

Introduction

The white seaperch, *Phanerodon furcatus,* ranges from Vancouver Island to Point Cabras, Baja California (Miller and Lea 1972). It is common around piers, jetties and in deeper waters in estuaries and bays (Bane and Bane 1971). It is found from the surface to 43 m but is concentrated from 2.5 to 34 m (Feder and others 1974). When not foraging, the white seaperch forms loose schools in midwater between the bottom and the kelp canopy (Baltz 1984). Seasonal migrations have been observed in northern California. In Elkhorn Slough, abundance increased in late summer and fall and decreased in spring (Antrim 1981). In Tomales Bay, males disappear when females are in their spawning stage (Banerjee 1971). The white seaperch is found in temperatures ranging between 7 and 21 °C (Tarp 1952).

The white seaperch is viviparous. Parturition occurs in late April through mid-July in Elkhorn Slough (Antrim 1981) and from May to July in southern California (Goldberg 1978). Maternal length and fecundity are positively correlated (Banerjee 1971, Goldberg 1978). For example, females <215 mm SL have an average brood size of 12.1 young, and females >252 mm have an average of 24.6 young. In Tomales Bay, the young school together after birth near the shore (Banerjee 1966).

Maximum size is 315 mm TL (Miller and Lea 1972). Males and females grow equally until their 4th year, after which females become larger (Banerjee 1966). Males and females may have equal longevity (Anderson and Bryan 1970) or females live longer than males (Eckmayer 1979). Maximum age is 8 years (Banerjee 1966).

The white seaperch preys on crustaceans including amphipods, isopods, and small crabs and polychaete worms. In spring, white seaperch preys on polychaetes and crustaceans; in winter they feed upon polychaetes; and in summer their diet shifts to copepods and amphipods (Antrim 1981). At one time, the white seaperch was the most important surfperch taken commercially by trawl fishermen and purse seiners (Feder and others 1974), but is no longer a significant component of the commercial catch (Karpov and others 1995).

Methods

Otter trawl data from 1980 to 1995 were used to analyze annual abundance, seasonal abundance and distribution, and temperature and salinity distributions. All age groups are combined because only 127 white seaperch were collected with the otter trawl. The annual abundance index period was May to October.

Results and Discussion

White seaperch were most abundant in 1981 and 1984 (Figure 48, Table 14). Abundance declined after 1987 and none were collected after 1990.

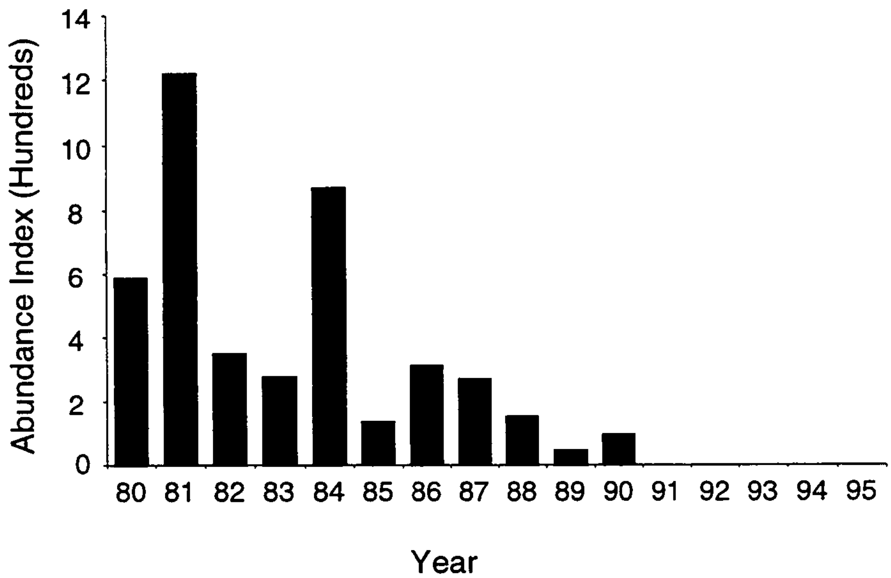

Figure 48 Annual abundance of white seaperch collected with the otter trawl from 1980 to 1995. The index period was May to October.

Table 14 Monthly abundance indices of all age groups of white seaperch collected with the otter trawl from 1980 to 1995. The annual index period was May to October.

Year	*Jan*	*Feb*	*Mar*	*Apr*	*May*	*June*	*Jul*	*Aug*	*Sep*	*Oct*	*Nov*	*Dec*	*Index*
1980		0	0	0	0	0	1394	1745	189	189	0	0	586
1981	250	818	0	0	0	250	2064	3361	406	1241	281	0	1220
1982	281	0	0	0	938	435	216	500	0	0	216	134	348
1983	0	0	219	469	532	938	0	0	0	189	0	0	277
1984	0	0	0	0	192	0	0	3067	1025	949	0	0	872
1985	0	0	0	0	0	469	0	0	352	0	216	0	137
1986	0	0	0	0	0	0	0	837	379	649	0	0	311
1987	0	0	0	0	115	0	304	892	313	0	0	0	271
1988	0	0	0	0	250	313	0	216	135	0	0	0	152
1989	0	0	0	0	0	0	189	0					47
1990		0	281	0	0	0	329	243	0	0			95
1991		0	0	0	0	0	0	0	0	0			0
1992		0	0	0	0	0	0	0	0	0			0
1993		0	0	0	0	0	0	0	0	0			0
1994		0	0	0	0	0	0	0	0	0			0
1995	0	0	0	0	0	0	0		0	0	0	0	0
1981–1988	66	102	27	59	253	301	323	1109	326	379	89	17	

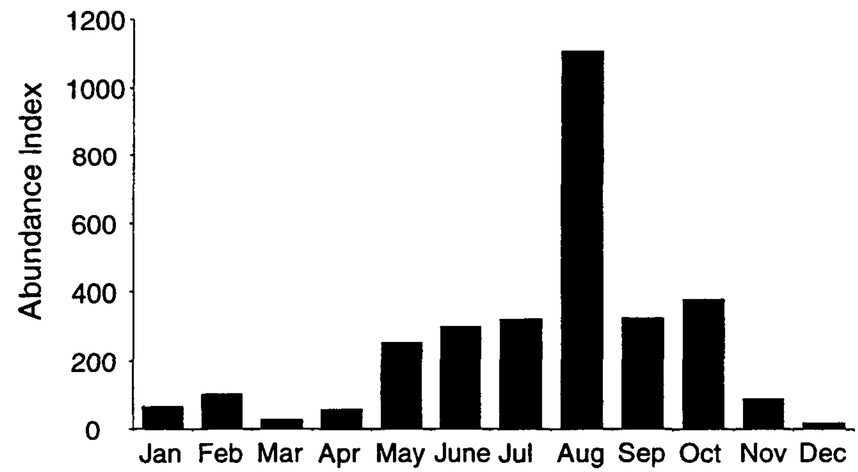

Figure 49 Seasonal abundance of white seaperch collected with the otter trawl from 1981 to 1988

They were collected all year from South to San Pablo bays. Abundance was highest from May to October and peaked in August (Figure 49). The highest CPUE was in South Bay from March to July and in Central Bay from August to November (Figure 50). In December they were collected only in San Pablo Bay.

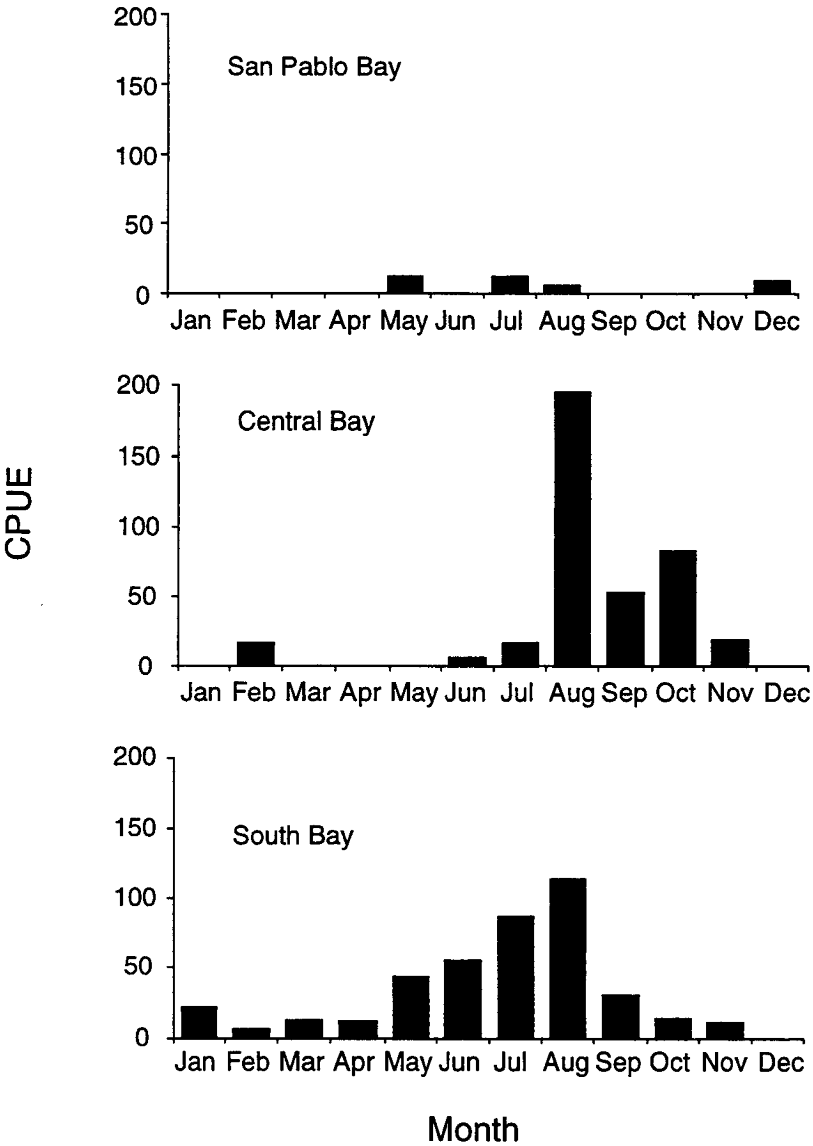

Figure 50 Seasonal distribution of white seaperch by bay collected with the otter trawl from 1981 to 1988. No white seaperch were collected in Suisun Bay or the west delta. Values are CPUE x 100.

White seaperch ranged from 47 to 291 mm FL (Figure 51). At least 2 age classes were collected from May to September when parturition occurred. The length frequency data show that some young fish stay in the estuary in winter but most leave in fall.

White seaperch were collected in temperatures ranging from 8.4 to 20.5 °C, $\overline{\chi}$ = 16.9 °C (Figure 52). They occurred in polyhaline and euhaline salinities, 13.3‰ to 33.6‰, $\overline{\chi}$ = 28.1‰.

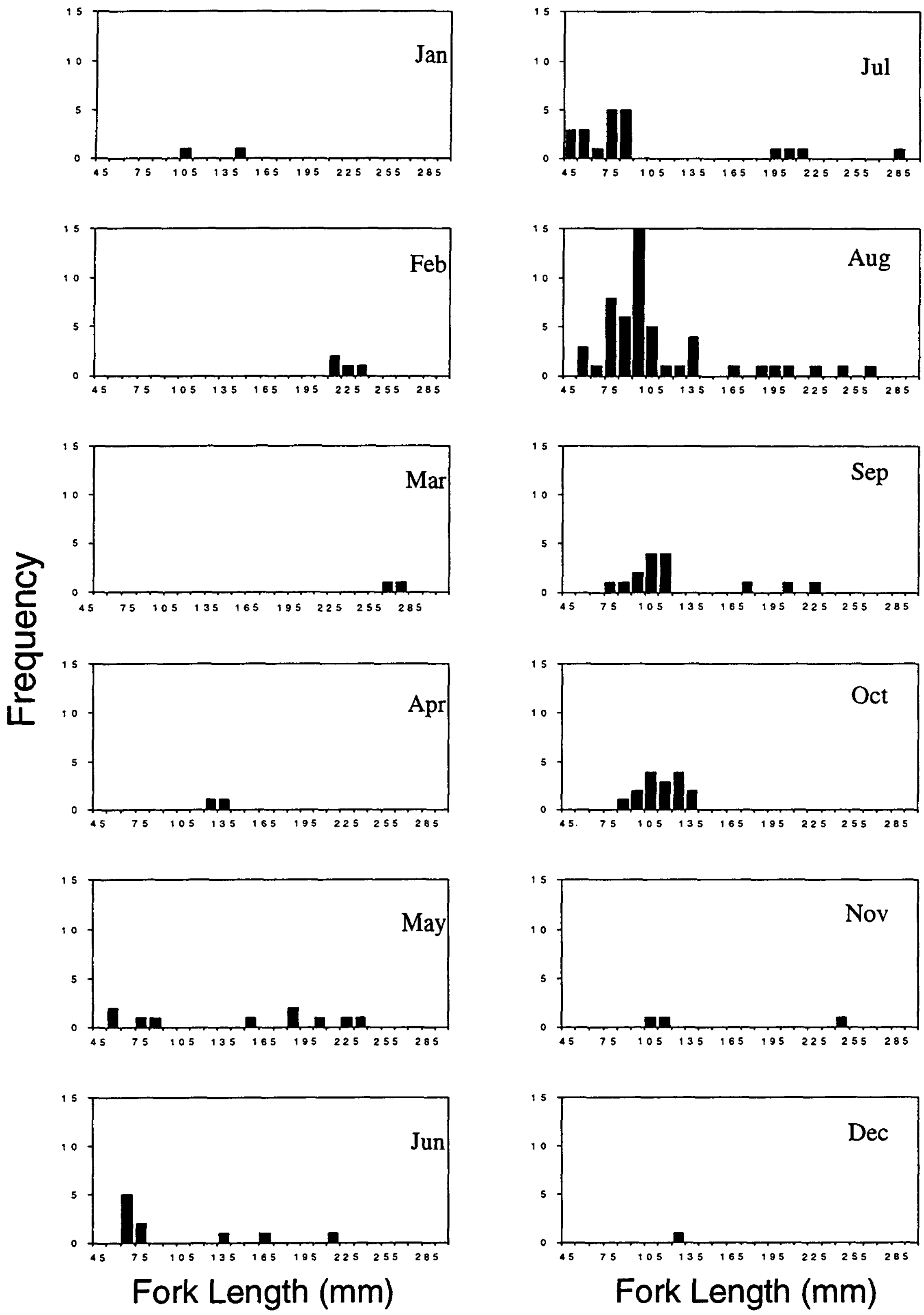

Figure 51 Monthly length frequencies of white seaperch collected with the otter trawl from 1980 to 1995. Values on x-axis are lower class limits.

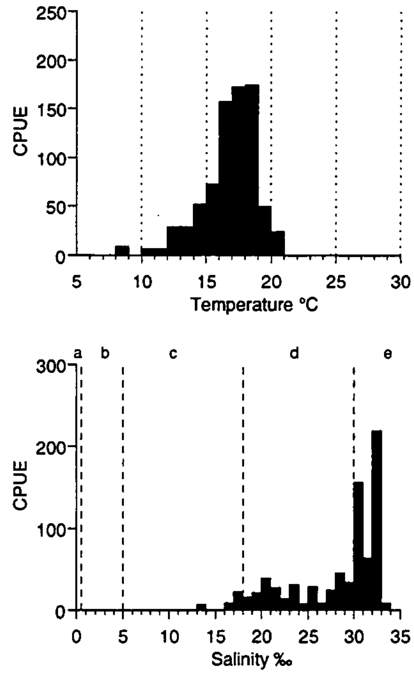

Figure 52 Temperature and salinity distributions for white seaperch collected with the otter trawl from 1980 to 1995. The vertical lines on the salinity graph mark the boundaries of the Venice system ranges: (a) limnetic, (b) oligohaline, (c) mesohaline, (d) polyhaline, and (e) euhaline.

Uncommon Species of Surfperches in the San Francisco Estuary

Barred Surfperch

The barred surfperch, *Amphistichus argenteus,* ranges from Playa Maria Bay, Baja California to Bodega Bay, California (Miller and Lea 1972). It is found along the coast, from the surface to 73 m and is common at sandy beaches in the surf zone. This species and the walleye surfperch form large schools all year, unlike other surfperch which school only during the birthing and mating seasons (Feder and others 1974). The barred surfperch is eurythermal and is commonly found from 7 to 21 °C. It feeds on crabs and small mussels. In La Jolla, California, it mates from November to December and the young are born in spring and summer. This species does not store sperm. It is reported to reach 9 years of age and 432 mm TL (Baxter 1980, Miller and Lea 1972). It is commonly caught from piers and along the surf line by sport anglers (Karpov and others 1995).

In the San Francisco Estuary, 165 barred surfperch were collected in the otter trawl, 73 in the beach seine, but only 4 in the midwater trawl (see Tables 1, 2, and 3 in the Introduction section of this chapter). In the otter trawl, they were collected in all years except 1986. Catches have declined since 1984 (see Table 2). The barred surfperch catch may have been low because it is more common in the ocean than in bays and estuaries (Karpov and others 1994). Barred surfperch were collected primarily in South Bay. From 1980 to 1984, they were collected all year long, but from 1985 to 1995 they were only collected from May to October. The minimum fork length was 45 mm, the maximum 328 mm.

Surfperch catch declined in Karpov's (1995) comparison of the marine recreational fishery between 1958 to 1961 and 1981 to 1986; this decline was due mainly to weight reductions for barred surfperch and redtail surfperch landed. Barred surfperch landed also declined in size during this period.

Black Perch

The black perch, *Embiotoca jacksoni*, ranges from Point Abreojos, Baja California to Fort Bragg, including Guadalupe Island, Baja California (Miller and Lea 1972). It is found to 55 m, but is most common from 6 to 24 m (Feder and others 1974). It is common in bays and estuaries on reefs, pilings, and kelp beds at temperatures from 11 to 21 °C. Prey items include, algae, amphipods, polychaetes, crustaceans and molluscs (Feder and others 1974, Baxter 1980).

Black perch mate from April through June and store sperm for less than 3 months. Gestation is about 6 months and parturition occurs from September to November. The average brood size is 14 (Baltz 1984). It reaches a maximum length of 389 mm (Miller and Lea 1972).

This study collected a total of 77 black perch: 1 in the midwater trawl, 59 in the otter trawl, and 17 in the beach seine (see Tables 1, 2, and 3 in the Introduction section of this chapter). Size ranged from 56 to 286 mm FL. Black perch ranged from South to Suisun bays but were most abundant in Central Bay. They were collected all year.

Rubberlip Seaperch

The rubberlip seaperch, *Rhacochilus toxotes*, ranges from Thurloe Head, Baja California to Mendocino County, including Guadalupe Island, Baja California (Miller and Lea 1972). It can be found in giant kelp forests from the surface to 46 m but is most abundant at 3 to 31 m (Feder and others 1974). Adults feed on crabs, shrimp, and octopi and juveniles feed on polychaetes, bryozoans, amphipods and mussels (Feder and others 1974). The rubberlip seaperch is found from 11 to 21 °C (Baxter 1980). Maximum size is 470 mm TL (Miller and Lea 1972). The reproductive life cycle of the rubberlip seaperch has not been well documented.

Only 28 rubberlip seaperch were collected: 4 in the midwater trawl, 12 in the otter trawl, and 12 in the beach seine (see Tables 1, 2, and 3 in the Introduction section of this chapter). In the otter trawl none were collected from 1990 to 1994 and only 1 was collected in 1995. Rubberlip surfperch were collected from Central and San Pablo bays and were most abundant in Central Bay. Lengths ranged from 72 to 401 mm FL.

Other Surfperches

Other species and numbers of surfperches collected during this study are the calico surfperch (3), redtail surfperch (1), spotfin surfperch (1), silver surfperch (8), and rainbow seaperch (1). All of these species were collected from 1980 to 1987, except 1 calico, which was captured in the midwater trawl in 1993, and 1 redtail surfperch in 1995 (see Tables 1, 2, and 3 in the Introduction section of this chapter).

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