

ECOLOGY OF FISHES IN RODEO LAGOON AND RODEO LAKE
OF THE GOLDEN GATE NATIONAL RECREATION AREA,
CALIFORNIA, WITH EMPHASIS ON THE
TIDEWATER GOBY, (EUCYCLOGOBIUS NEWBERRYI (GIRARD)
AND THE YELLOWFIN GOBY, ACANTHOGOBIUS FLAVIMANUS
(TEMMINCK AND SCHLEGEL)

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INTRODUCTION

Rodeo Lagoon is located on the Pacific Coast between Fort Barry and Fort Cronkhite of the Golden Gate National Recreation Area (Figure 1). The lagoon, separated from the ocean by a sandbar, receives seawater over the sandbar during high tides or storms or during periods when the sandbar is broken. There is an input of fresh water from an inland stream (Rodeo Creek) and from underground springs in the surrounding hills which keeps the saline water diluted during the summer dry season. At the east end of the lagoon is a steel weir, on the east side of the road bridge, separating the lagoon from an upper, freshwater lagoon known as Rodeo Lake. This artificial partition, made during World War II, was used by the U.S. Army to save freshwater for emergencies. The freshwater - brackish water environment has also attracted or has entrapped many fish species in the lagoon and lake from different origins.

The objectives of this study are (1) to understand the distribution, relative abundance, and ecological status of fish species, (2) to have a better understanding of the ecological requirements of the tidewater goby, now that it is in a depleted status in the San Francisco Bay Area and has been found only in Rodeo Lagoon (Wang 1982), and (3) to understand the ecological requirements of the yellowfin goby in Rodeo Lagoon and thus control the yellowfin goby population in the lagoon. The yellowfin goby is an introduced fish that is widely distributed in the Sacramento-San Joaquin estuary (Brittan et al. 1963, 1970; Moyle 1976). The yellowfin goby competes for food and habitat with the tidewater goby in the lagoon, and also preys on it.

METHODS

Fish sampling was done once or twice a month from January 1980 to December 1982, except in March 1980, when no sample was collected. Most of the fish collected were examined and counted and released on site, but representative specimens were preserved in 10 percent buffered formalin and then washed with water and transferred into 5 percent buffered formalin for laboratory analysis. The specimens are archived at Golden Gate National Recreation Area, Fort Mason, or at Ecological Analysts, Inc., Concord, California.

Sampling Gear Types

Fish specimens were collected with three types of sampling gear:

1. A 1.2- x 1.0-m beach seine with 1.0-mm mesh was used to collect eggs, larvae, juvenile, and adult in the inshore zones at a depth of 0-1 m. All but 5-6 m of shoreline were seined.
2. A 3.1- x 1.2-m beach seine with 3.0-mm mesh was used to collect adult fish along the shore and in slightly deeper water (less than 1.5 m).
3. A hand-towed ichthyoplankton net with an 0.5-m mouth and 0.5-mm mesh was used to collect fish eggs and early larvae at water depths of 1-1.5 m.

Surface water temperature was measured at each sampling location during sampling. A Yellow Springs Instruments (YSI) Model 56 temperature and dissolved oxygen meter and a Martek Mark 5 water quality analyzer were used to measure water temperature, dissolved oxygen, conductivity, and pH at intervals.

Sampling Stations

Three stations were established along the shoreline of Rodeo Lagoon and one in Rodeo Lake (Figure 1).

Station I

Station I was located on the north side of the lagoon near the park information center, including both sides of the wooden bridge which crosses the lagoon. The bottom substrate of this site is a mixture of sand and some mud. Vegetation (mostly *Salicornia* spp.) grows along the shoreline. The water was brackish most of the year. Sampling depth ranged from 0 to 1.4 m.

Station II

Station II was located on the north side of Rodeo Lagoon, approximately midway between the sandbar and the road bridge. The bottom substrate of this site is soft mud with submerged vegetation (*Zannichellia* spp. and *Najas* spp.) in summer months. Shrubs grow above the shoreline. The water was brackish most of the year. Sampling depth ranged from 0 to 1.2 m.

Station III

Station III was located at the distal end of Rodeo Lagoon, north of the road bridge crossing. The bottom substrate at this site is a mixture of mud and gravel. Submerged vegetation (Zannichellia spp., Najas spp., and Scirpus spp.) occurred in this area mostly in summer. In most of the year the water was fresh. Sampling depth ranged from 0 to 1.0 m.

Station IV

Station IV was located on the south shore of Rodeo Lake near the picnic table. The bottom substrate at this site is a mixture of clay and soft organic debris. Submerged vegetation (Clara spp., Elodea spp., and Typha spp.) are highly dense throughout the year, and shrubs grow above the shoreline. The water was constantly fresh. Sampling depth ranged from 0 to 1.2 m.

RESULTS AND DISCUSSION

Physical-Chemical Aspects

Figure 2 shows the mean surface water temperature in Rodeo Lagoon from 1980 to 1982. The lowest temperature was recorded as 8.5 C in January 1981, and the highest was 21.7 C in June 1981. Summer 1980 was a warm season. In 1981, the lagoon temperature rose rapidly in June but turned cold for the rest of the summer. The temperature profile for 1982 was somewhat in between those of 1980 and 1981. Dissolved oxygen values, all recorded at Station III, ranged from 6.2 to 13.8 ppm. In general, dissolved oxygen was low in summer and higher in winter. The highest salinity recorded in the lagoon was 14.0 ppt, at Station I in February 1980, and the lowest was freshwater, recorded at Station III in most months of the rainy season. Salinities of 5-14 ppt were recorded in 1980; they were 5 ppt or less in 1981 and 1982. Rodeo Lake is a freshwater lake. The range of pH was from 6.8 to 9.5 in Rodeo Lagoon and from 6.2 to 7.5 in Rodeo Lake.

The climate in the study area is strongly regulated by the ocean. The water temperature is rather on the chilly side, even in summer. The lagoon is well oxygenated by the constant coastal breeze. Salinities are generally higher near the sandbar and lower near the road bridge, but the lagoon can be well-mixed if the coastal wind shifts direction in a short time. The pH is higher (more acidic) in Rodeo Lake, because of the heavy vegetation in and around the lake, and on the alkaline side in the Rodeo Lagoon because the water is brackish.

Biological Accounts

Ten species of fish, represented by various life stages, were collected in Rodeo Lagoon with the sampling gear used in this study. Six of those species are native to California waters, and four are introduced (Table 1). The species observed only in Rodeo Lagoon were topsmelt, jacksmelt, yellowfin goby, tidewater goby, and Pacific staghorn sculpin. The species collected only in Rodeo Lake was the green sunfish. Threespine stickleback, prickly sculpin, goldfish, and golden shiner were taken in both the lagoon and the lake (Table 1). Thus, the freshwater fishes found in Rodeo Lagoon were goldfish and golden shiner, and the marine fishes found there were topsmelt, jacksmelt, yellowfin goby, and Pacific staghorn sculpin.

In the following description of fish ecology, the results are derived mainly from sampling with a 1.2 x 1.0-m beach seine, supplemented by the catch with the 0.5-m ichthyoplankton net and the 3.1- x 1.2-m beach seine.

1. Threespine Stickleback, Gasterosteus aculeatus Linnaeus

Threespine stickleback was at the top rank of beach seining collection from 1980 through 1982. Various life stages were found (Table 2). The catch increased substantially in 1982.

Spawning takes place in both Rodeo Lagoon and Rodeo Lake at various salinities, from April through October as temperature approaches 12-15 C. The male builds a nest in the shallow weedy

area. After the courtship ritual, the gravid female deposits her eggs in the nest and the male fertilizes them immediately. Eggs, in small clusters, are embedded in the nest. The male guards and aerates the eggs. When the hatching time approaches he tears down the nest (Bigelow and Schroeder 1953), and the egg clusters are broken into individual eggs. This may be an important spawning strategy to enhance hatching success. Eggs hatch in 7 days at 19 C (Breder and Rosen 1966). The threespine stickleback is a multiple spawner during the breeding season.

Newly hatched larvae are guarded by the male parent for several days. The larvae then disperse into the dense vegetation in the littoral zone of the lagoon and lake.

Juveniles covered with bony plates on the side of the body and also equipped with sharp spines on the dorsal and pectoral fins, emerge from vegetation into deeper water and form dense schools.

Food items of the threespine stickleback are mostly small zooplankton and small crustaceans. In California, most of the threespine stickleback reach sexual maturity within one year, and some may live up to 2-3 years (Moyle 1976), but most of the adults die in late fall or early winter.

Threespine stickleback constitute a forage fish for other fish and birds.

2. Tidewater Goby, Eucyclogobius newberryi (Girard)

The beach seining catch of the tidewater goby ranked fourth in 1980, but went up to second rank in 1981 and 1982 (Table 2). Various life stages were collected in Rodeo Lagoon but none were observed in Rodeo Lake (Table 1).

The early life history of the tidewater goby in Rodeo Lagoon has been described by Wang (1982) in a report submitted to the National Park Service. The following is a summary of the ecological status of the tidewater goby in Rodeo Lagoon.

Goldberg (1977) reported that in southern California coast streams the tidewater goby has asynchronous ovarian cycles: individuals are in different development stages throughout the year. In this study, spawning took place in spring and fall in 1980, in all seasons except summer in 1981, and in all seasons except early winter in 1982 (Figure 3). Spawning was concentrated at Stations I and II. The Station II area also serves as a nursery ground. The spawning period was short but intense in 1980; light but prolonged spawning occurred in 1981 and 1982. Higher salinities (e.g., mesohaline in 1980) may enhance spawning activities, but higher water temperatures (as in summer 1980) are apparently unfavorable for spawning.

During the breeding season, adult fish moved into the shallow inshore water with sand, clay, or gravel bottoms. Swift (1980)

describes the male tidewater goby as digging a vertical burrow approximately 100-200 mm into the substrate. The proximal end of each egg bears a bundle of adhesive filaments which attach to the wall of the burrow. The male guards the eggs during incubation. Goldberg (1977) reported that an individual female is able to spawn more than once, but the exact spawning frequency in a single season or life could not be determined.

Prolarvae have little pigmentation and are pelagic; the postlarvae are covered with dense pigmentation on the dorsal and ventral surfaces of the body and gradually assume benthic habits.

Juveniles are abundant in the inshore weedy areas, particularly near Station II. It would appear that some fish moved there from Stations I and III as planktonic larvae.

In this study, stomach analysis of the tidewater goby revealed copepods and small amphipods as the primary diet for juvenile tidewater goby, amphipods and mysid shrimp for the adults.

Adult fish were seldom seen in winter months, when water temperature declined to less than 10 C. They may return to the deeper portion of the lagoon, and some probably die.

Both Moyle (1976) and Swift (1980) believe that the population of the tidewater goby is declining both at this locale and in its entire range. The tidewater goby has a short life span (ca. 1-3 years), and it needs a specific freshwater - brackish water habitat to survive. Rodeo Lagoon provides the exact environment required. However, Rodeo Lagoon is a limited area (ca. 1 km x 0.25 km). When short-term environmental changes occur, the tidewater goby may suffer only some loss of the population, since it is able to spawn at different times of the year, but over the long term, as the lagoon becomes polluted, the survival of the entire population will become uncertain. Some managerial recommendations for the protection of this rare natural resource have been proposed by this author to the National Park Service (Wang 1982).

3. Yellowfin Goby, Acanthogobius flavimanus (Temminck and Schlegel)

The beach seining catch of yellowfin goby was ranked second in 1980 and ranked fifth in 1981 and 1982 (Table 2). Juveniles and adults were observed in 1980; larvae, juveniles, and adults were captured in 1981, but only juveniles were collected in 1982. The catch of yellowfin goby declined rapidly after March 1981. The date of introduction of the yellowfin goby to the lagoon is unknown.

Judging from the prolarvae and postlarvae taken in the ichthyoplankton net, spawning was estimated to have occurred in February and March 1981 (Figure 3). In the Sacramento - San Joaquin Estuary, spawning lasts from December through June or early July. Eggs are deposited on the wall or roof of a Y-shaped burrow, 15-

35 cm deep, constructed in intertidal mudflats (Dotsu and Mito 1955). In Rodeo Lagoon the burrows are probably built in sandy or clay bottoms near sandbars. The female may leave the burrow after spawning or join the male in the burrow. At a temperature of 13 C, incubation requires about 28 days. Newly hatched larvae remain in the burrow for a short period, and then emerge and become planktonic. Larvae were collected mostly near the sandbar in Rodeo Lagoon. In the Sacramento-San Joaquin estuary, yellowfin goby larvae were found in the more-saline central and south portions of San Francisco Bay and San Pablo Bay, and some of the postlarvae and early juveniles begin to ascend Carquinez Strait and Suisun Bay in February and March.

Juveniles settle on the bottom at about 13 cm TL (Miyazaki 1940). Juvenile yellowfin goby collected in 1980 in Rodeo Lagoon probably originated in the Pacific Ocean. The juveniles collected in the lagoon in 1981 were either hatched out from the lagoon or came in from the ocean. Specimens taken in 1982 were apparently from the ocean.

Major food items for the small juvenile yellowfin goby are copepods (Dotsu and Mito 1955); large juveniles and adults feed on mysid shrimp, amphipods, and small fish such as tidewater goby and threespine stickleback (this study).

The yellowfin goby, an estuarine fish native to Japan, Korea, and northern China (Tomiyama 1936; Miyazaki 1940; Fowler 1961) was probably introduced into the Sacramento-San Joaquin estuary by accident in the 1950s, through the ballast systems of shipping vessels (Brittan et al. 1963). Currently, this species is not only abundant within the estuary, but also has been observed along the coast from Elkhorn Slough to Tomales Bay (Miller and Lea 1972; Kukowski 1972). A second yellowfin goby population is reported in Los Angeles and Long Beach Harbor and Newport Bay (Haaker 1979), and was conceivably established in the same manner as in San Francisco Bay. In this study, the yellowfin goby has been observed throughout the estuary, including the lower portions of tributaries that drain into the estuary. No specimens were collected in O'Neill Forebay or San Luis Reservoir in 1979-1981, although the species was reported there several years ago (Brittan et al. 1970; Moyle 1976).

Yellowfin goby adapt well to different salinities and sudden changes in salinities (Brittan et al. 1970). During the spawning season, yellowfin goby larvae were not found in Carquinez Strait or Suisun Bay. The hypothesis is that adult yellowfin goby have to return to the more saline bays to spawn. In a landlocked freshwater environment, they may die off eventually because of progressively diminished spawning success. This hypothesis seems to be supported by the evidence from Rodeo Lagoon. In 1980, salinities in the lagoon were mesohaline for most of the year and the mean water temperatures were relatively high in the summer months. This may have promoted the growth and maturation of the yellowfin goby. Many adults (≥ 85 mm TL) were observed in the

fall. Nevertheless, spawning success in winter 1980-1981 turned out to be marginal, probably because of a decline in salinity during the spawning period: salinity was 5 ppt in February 1981 and 4.8 ppt in March 1981, when a few yellowfin goby larvae were collected near the sandbar. After March 1981, the yellowfin goby disappeared from all sampling stations suddenly. A massive die-off of the yellowfin goby in the lagoon was suggested. There were no larval yellowfin goby observed in 1982; the salinities in the lagoon were 5 ppt or less, and only 4 juveniles were collected by beach seine. The reproduction of yellowfin goby had practically ceased in Rodeo Lagoon when the salinity was below 5 ppt.

Wang (1982) proposed the National Park Service to regulate the lagoon salinities to as low as 0-5 ppt to minimize natural spawning of the yellowfin goby in the lagoon. If the sandbar has to be dredged to drain the lagoon during flood season in order to save the wooden bridge and sewage pipe which cross the lagoon the near sandbar, this author would recommend that the National Park Service allow only a limited amount of seawater to be flushed in each time.

4. Prickly Sculpin, *Cottus asper* Richardson

Prickly sculpin was at ranked third in beach seining from 1980 through 1982. Various life stages were observed (Tables 1 and 2). Prickly sculpin is a native to coastal lagoons, lakes, and streams.

Spawning occurs from January through April in Rodeo Lagoon, Rodeo Lake, and Rodeo Creek.

Eggs, in clusters, are found on the undersurfaces or in crevices of rocks, gravel, or submerged objects. The male guards the nesting site until hatching occurs (Krejsa 1967). Eggs adhere strongly to each other, but less strongly to the substrate. The incubation period is about 15-16 days at 12 C (Krejsa 1967). The egg hatching rate is higher at a salinity of 12 ppt than in fresh water (Millikan 1968), indicating that the prickly sculpin has a marine origin.

The newly hatched larvae are pelagic (Krejsa 1967), and they were found at the water's surface in Rodeo Lagoon. It is suggested that larval sculpin may use surface tension to maintain their position, since they have no air bladders (Mason and Machdori 1976). Prickly sculpin larvae are abundant in the Delta (Turner 1966) and upper Sacramento-San Joaquin estuary (Wang 1981).

Juveniles become demersal at about 15 mm TL (Broadway and Moyle 1978). They were common in the beach seining catch at all sampling stations.

Juveniles feed on planktonic crustaceans. Large juveniles and adults feed on aquatic insects, mysid shrimp, and amphipods.

Prickly sculpin have some value as a forage species for salmon, trout, bass, and birds (Moyle 1976).

5. Pacific Staghorn Sculpin, Leptocottus armatus Girard

The beach seining catch of the Pacific staghorn sculpin ranked fifth in 1980 and sixth in 1981, and this species was not observed in 1982 (Table 2). Various life stages were found in Rodeo Lagoon (Table 1).

Spawning occurred in the lagoon from November 1980 through March 1981, when the salinities in the lagoon ranged between 5 and 10 ppt. Egg clusters were collected with the ichthyoplankton net near a boulder at Station II; larvae were collected near the sandbar at Station I. In the Sacramento-San Joaquin estuary, the spawning of this species occurs from October through April in polyhaline-to-mesohaline environments (Wang 1981). Eggs hatch in 9-14 days at 15 C (Jones 1962).

Newly hatched larvae immediately swim to the surface of the water (Jones 1962). In Rodeo Lagoon, the larvae of the Pacific staghorn sculpin were found at surface inshore at Stations I and II.

Juveniles inhabit the bottom, and very few were collected in rodeo Lagoon. The major food items include mysid shrimp and amphipods, and tidewater goby were occasionally found in the stomachs of large Pacific staghorn sculpin. Thus, the Pacific staghorn sculpin and the yellowfin goby are the major competitors and predators of the tidewater goby in Rodeo Lagoon.

Pacific staghorn sculpin are able to live in fresh water but unable to complete their life cycle there. Control of the salinity at 0-5 ppt in Rodeo Lagoon will minimize the spawning success of the Pacific staghorn sculpin.

6. Golden Shiner, Notemigonus crysoleucas, (Mitchell)

Golden shiner was ranked sixth in the beach seining catch in 1980 and fourth in 1981 and 1982 (Table 2). This species was generally found only in Rodeo Lake in 1980 and 1981, but specimens were observed in Rodeo Lagoon as far as Station I in January 1980 after a severe winter storm. Golden shiner larvae and juveniles were observed in this study.

Spawning occurs in May and June in Rodeo Lake. Eggs are probably deposited over and adhere to aquatic vegetation, as described by Webster (1942). Newly hatched larvae remain near the bottom for a short period and then swim to near the surface of the lake.

Juveniles form small schools and were often observed in an open area surrounded by aquatic vegetation at Station IV.

Stomach contents of the golden shiner included small insects, cladocerans, and other zooplankton (Moyle 1976).

The golden shiner is a freshwater fish native to the Atlantic coast and inland to the Mississippi River drainage (Scott and Crossman 1973). This species was introduced to southern California as a bait fish in 1981 (Moyle 1976). They are very common in the Delta. The appearance of this species in Rodeo Lake (and also in Rodeo Lagoon) could be a result of the release of bait fish by sport fishermen in Rodeo Lake.

Adult golden shiner can tolerate salinities as high as 14 ppt (Hildebrand and Schroeder 1928). It remains to be seen whether a reproductive population will establish itself in Rodeo Lagoon in the next few years.

7. Jacksmelt, Atherinopsis californiensis Girard

No specimens of this species were observed in 1980. Three larvae (Rank 7) and a cluster of about 50 eggs were collected by beach seine in 1981. One larva (Rank 7) was taken in 1982 (Tables 1 and 2).

Spawning takes place along the coast and in bays in seawater-to-polyhaline environments. Eggs collected in Rodeo Lagoon were apparently carried over the sandbar by a high tide or introduced during the period when the sandbar was breached. Some eggs hatched out at salinities as low as 5 ppt, but no juvenile jacksmelt were found in the lagoon, indicating that the larvae perished from lower salinities in the lagoon.

8. Topsmelt, Atherinops affinis (Ayres)

Three juvenile topsmelt (Rank 7) were collected in Rodeo Lagoon in 1980. None were observed in 1981 or 1982 (Tables 1 and 2).

Spawning occurs mostly in bays and estuaries from seawater to mesohaline conditions. The specimens collected in Rodeo Lagoon were apparently from the Pacific Ocean. Salinity in the lagoon is too low to maintain a reproductive population there. Those topsmelt that are entrapped in the lagoon will die.

9. Goldfish, Carassius auratus (Linnaeus)

Two juveniles (Rank 6) were collected in 1982, one from Rodeo Lake and another from Rodeo Lagoon (Tables 1 and 2).

Goldfish were introduced into North America in the late 19th Century (Scott and Crossman 1973). The species is widespread in the warm waters of California (Moyle 1976). Judging from small juveniles (35 mm TL) taken, there is a reproducing population in Rodeo Lake.

10. Green Sunfish, Lepomis cyanellus Rafinesque

One adult male (Rank 7) was captured at Station IV, Rodeo Lake, in July 1982 (Tables 1 and 2).

It is uncertain whether this species will spawn in Rodeo Lake or not, since neither larvae nor juveniles have yet been seen.

The green sunfish is of great adaptability to various environments (McCarracher 1972), because of their aggressive territorial behavior and fierce feeding competition (Moyle 1976). This may pose a potential threat to the tidewater goby, particularly if a green sunfish population establishes itself in the vicinity of Station III in the future.

11. Other fish species may be expected to be found in Rodeo Lagoon, Rodeo Lake, and Rodeo Creek: most of the streams along the northern California coast have been used as spawning grounds by steelhead, Salmo gairdneri and coho (silver) salmon, Oncorhynchus kisutch. Those anadromous fish may cross the sandbar at high tide or swim through the channel when the sandbar is broken during winter storms. Juvenile steelhead were found in Redwood Creek and the lagoon at Muir Beach during a fish survey carried out there in July 1982 with Judd Howell and his associates. The lagoon at Muir Beach has a physical structure similar to that of Rodeo Lagoon. Either one or both species of these anadromous fish are anticipated in Rodeo Lagoon, Rodeo Lake, or Rodeo Creek.

SUMMARY

1. A total of 10 species of fish were observed in Rodeo Lagoon and Rodeo Lake during 1980-1982. The ecological status of those species have been investigated and interpreted.
2. Rodeo Lagoon provides all the survival requirements for the tidewater goby, a native goby that is becoming increasingly uncommon in its entire distribution as well as in this locale. For this reason, the tidewater goby in Rodeo Lagoon deserves special protection in the Golden Gate Recreation Area.
3. Yellowfin goby, an introduced species and a competitor of the tidewater goby, was abundant in the lagoon in 1980, although the population declined drastically in 1981 and 1982.
4. The life cycle of the tidewater goby can be completed at salinities of 5 ppt or less, but not in fresh water; for yellowfin goby, reproduction is marginal at 5 ppt and unsuccessful below 5 ppt. Control of salinity in the Rodeo Lagoon at and just below 5 ppt will minimize the populations of yellowfin goby and other coastal marine fish in the lagoon.

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FIGURE 1. RODEO LAGOON AND RODEO LAKE

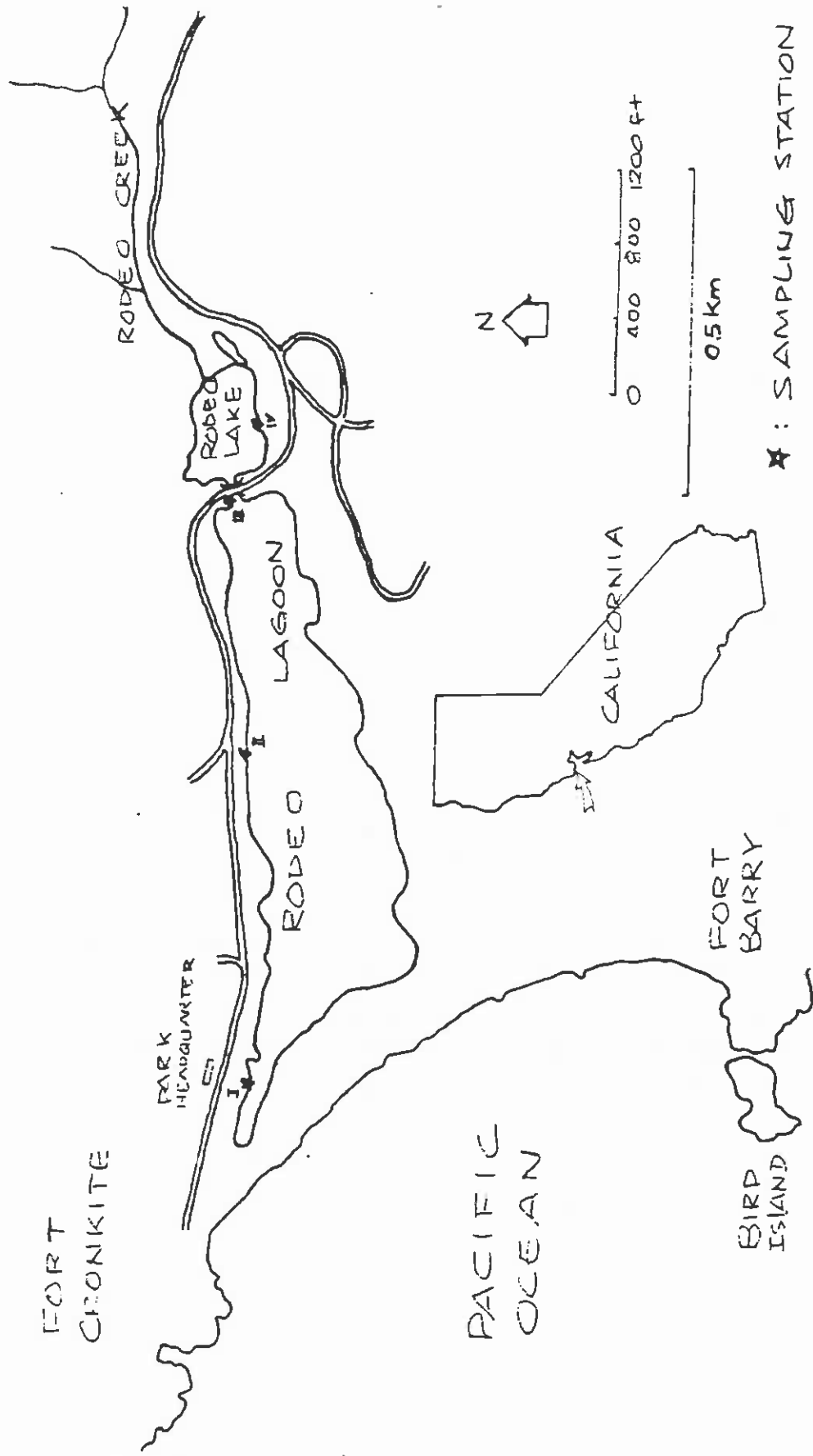


FIGURE 2. MEAN SURFACE WATER TEMPERATURE IN RODEO LAGOON AND RODEO LAKE

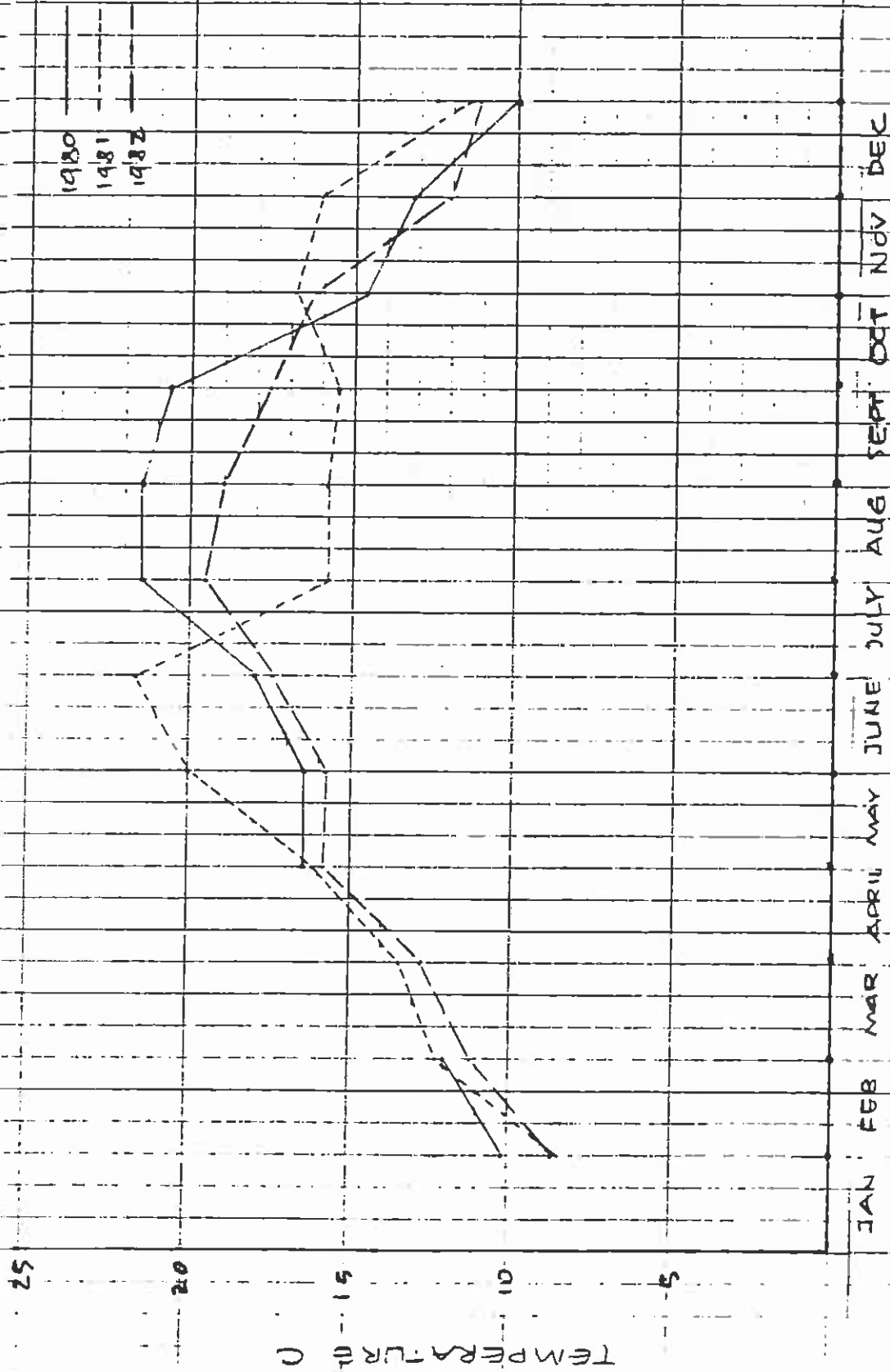


FIGURE 3. OCCURENCE OF THE LARVAE OF TIDEWATER GOBY AND YELLOWFIN GOBY IN RODED LAGOON (COLLECTED BY EARTHROP LANKTON INC.

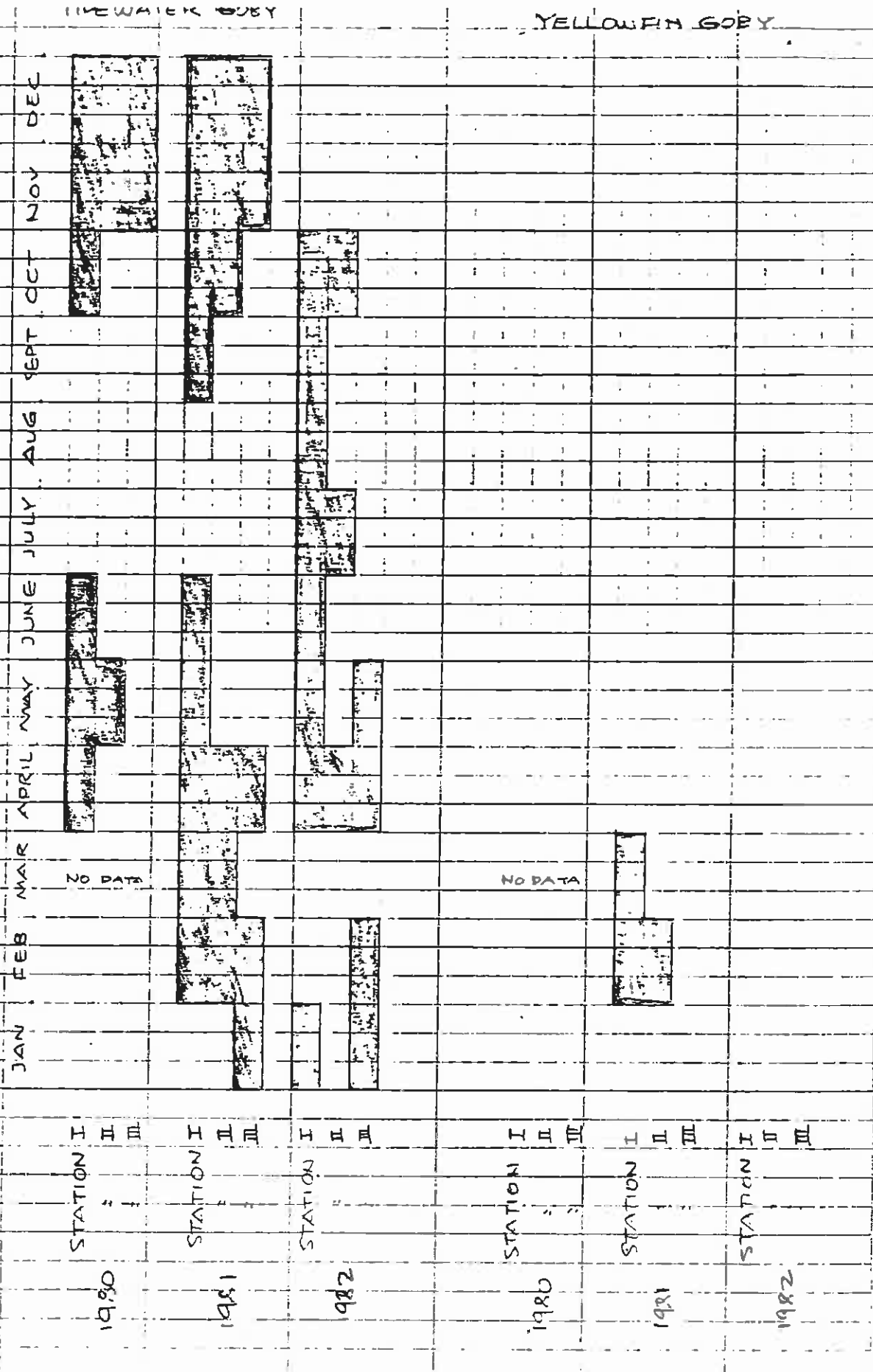


TABLE 1 A LIST OF SPECIES OF FISHES COLLECTED IN RODEO LAGOON AND RODEO LAKE, 1980-1982

Family and Species	Origin	Life Stages			Locations	
		Eggs	Larvae	Juveniles	Adults	Rodeo Lake Rodeo Lagoon
Cyprinidae						
<u>Carassius auratus</u> Goldfish	Introduced Freshwater			X		
<u>Notemigonus crysoleucas</u> Golden shiner	Introduced Freshwater	X		X		X
Atherinidae						
<u>Atherinops affinis</u> Topsmelt	Native Coastal marine			X		X
<u>Atherinopsis californiensis</u> Jacksmelt	Native Coastal marine	X	X			X
Gasterosteidae						
<u>Gasterosteus aculeatus</u> Threespine stickleback	Native Euryhaline	X		X	X	X
Centrarchidae						
<u>Lepomis cyanellus</u> Green sunfish	Introduced Freshwater				X	
Gobiidae						
<u>Acanthogobius flavimanus</u> Yellowfin goby	Introduced Euryhaline	X		X	X	X

TABLE 1 (CONT.)

Family and Species	Origin	Life Stages			Locations	
		Eggs	Larvae	Juveniles	Adults	Rodeo Lake Rodeo Lagoon
Gobiidae (continued)						
<u>Eucyclogobius newberryi</u> Tidewater goby	Native Euryhaline		X	X	X	X
Cottidae						
<u>Cottus asper</u> Prickly sculpin	Native Freshwater		X	X	X	X
<u>Leptocottus armatus</u> Pacific staghorn sculpin	Native Euryhaline	X	X	X	X	X

TABLE 2 TOTAL CATCH OF FISHES AND FISH EGGS BY A BEACH SEINE (1.2 x 1.0-m,
WITH 1.0-mm MESH) IN RODEO LAGOON AND RODEO LAKE, 1980-1982

	1980		1981		1982	
	Total	Rank	Total	Rank	Total	Rank
Threespine stickleback	365+	1	611+	1	1,838+	1
Tidewater goby	177	4	442	2	386	2
Yellowfin goby	207	2	27	5	4	5
Prickly sculpin	194	3	150	3	170	3
Pacific staghorn sculpin	13	5	18	6	-	
Golden shiner	10	6	32	4	8	4
Jacksmelt	-		3 (A cluster of eggs, Ca. 50)	7	1	7
Topsmelt	3	7	-		-	
Goldfish	-		-		2	6
Green sunfish	-		-		1	7
Total	969+		1,283+ (A cluster of eggs, Ca. 50)		2,140+	
Total Sampling Effort (Seine haul)	44		60		68	