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CALIFORNIA FISH AND GAME

Editorial Staff

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SOME RARE AND UNUSUAL OCCURRENCES OF FISHES OFF CALIFORNIA AND BAJA CALIFORNIA

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and
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Nineteen fish species captured off California and Baja California were deemed noteworthy for one or more reasons. Among these, 12 species (*Benthodesmus elongatus pacificus, Carcharhinus obscurus, Coelorinchus scaphopsis, Cryptopsaras couesii, Epinephelus niveatus, Gadus macrocephalus, Lepidocybium flavobrunneum, Myliobatis longirostris, Pleurogrammus monopterygius, Pteraclis aesticola, Ruvettus pretiosus,* and *Taractichthys steindachneri*) rarely have been seen in our waters, but only seven of these 12 represent new locality records. Three are reported here because of their large size (*Acipenser medirostris, Priacanthus cruentatus,* and *Zu cristatus*), but *Zu cristatus* also is a rarely seen species. Two occurrences (*Psettichthys melanostictus* and *Sebastes nebulosus*) extended geographical ranges for commonly taken species; one fish (*Elops affinis*) was new to the outer coast of California; and one (*Paralabrax auroguttatus*) was new to California's marine fauna.

During any given year, perhaps six to ten of the fishes that are brought to Department of Fish and Game (DFG) personnel to identify, or which are caught on Department vessels, are worthy of more than a passing glance. Some of these are new to California's marine fauna; some represent new locality or size records; some afford an opportunity to obtain needed information on the fish's life history, habits, or morphology; and some are just plain rare. Details concerning 19 such species are reported below. These represent an accumulation of noteworthy occurrences over a several-year period.

Many of these fishes were brought to Department personnel at California State Fisheries Laboratory, Long Beach (CSFL), but they have not been retained there. Once a fish has been processed at CSFL and the fisherman has been thanked, it assumes the status of "specimen," and either is sent to an ichthyological collection on the Pacific Coast for permanent curation, or it is discarded. Institutions where such collections are housed are: California Academy of Sciences (CAS), Natural History Museum of Los Angeles County (LACM), Santa Barbara Natural History Museum (SBNHM), Scripps Institution of Oceanography (SIO), Southwest Fishery Center, National Marine Fisheries Service, La Jolla (SWFC), and University of California, Los Angeles (UCLA).

We have arranged our accounts alphabetically by family, as that seemed the least troublesome way to present the information.

ACIPENSERIDAE—STURGEONS

Acipenser medirostris—green sturgeon

On July 11, 1975, Tony Spagnolini, a commercial fisherman, caught what appears to be the largest green sturgeon ever taken in the ocean south of San Francisco (Fitch and Lavenberg 1971:17). Mr. Spagnolini's sturgeon was caught in gill nets which he had set in "10 fathoms of water about one-half mile south of Dana Point west jetty light." The fish was a mature male, 163 cm (5 ft 4¼ inches) total length (TL), and weighed 25.7 kg (56 lb 9½ oz). Its stomach was empty, but the intestinal tract contained the intact shell of a small live snail, *Olivella baetica.* A thin cross-section was made through one of the sturgeon's large pectoral fin rays, and with the aid of a microscope, several staff biologists were able to discern 11 excellent rings, presumed to be annuli.

The largest of 166 green sturgeon caught in gill nets and otter trawls during an ecological survey of the Sacramento-San Joaquin Delta was 56–58 cm fork length (FL), and was presumed to be a juvenile (Radtke 1966:122). Miller (1972) noted that four of five green sturgeon recovered from 54 individuals that were tagged in San Pablo Bay during 1967 and 1968, had migrated into the ocean. Three had moved north, one as far as Gray's Harbor, Washington, and one was recaptured at Santa Cruz, California, south of the tagging site. These fish had been "45 to 50 inches TL" at the time of tagging, and none had been at liberty for more than 3 years when recaptured. The green sturgeon is reported to attain a length of 213 cm (7 ft) and a weight of 136 kg (300 lb), but the largest which can be verified appears to be the largest of 75 fish caught in 1 day in Kyuquot Sound, Vancouver Island, British Columbia. This fish was 203 cm (80 inches) long (Hart 1973). None of the above reports contains age information, however, nor is there any information on age in an excellent, detailed account of the green sturgeon in California by Fry (1973).

BRAMIDAE—POMFRETS

Pteraclis aesticola—Pacific fanfish

Since only three Pacific fanfish have been reported from the eastern north Pacific (Noble and Blodgett 1952, as *P. velifera*; Mead 1972:166), and in view of uncertainty over its specific identification (Mead 1972:118), three recently-captured specimens will help shed light upon its distribution, life history, and meristics.

One of these, at 473 mm standard length (SL), ca. 560 mm TL, and 1015 g, is 58 mm longer (SL) than the previously known record-sized Pacific fanfish from near Cambria, California (Noble and Blodgett 1952). This 473 mm fish was netted during mid-September 1975 at Ranger Bank, Baja California (lat 28°31′N, long 115°30′W), in a nighttime purseseine set for bluefin tuna, *Thunnus thynnus,* by the crew of the vessel *Mauritania.* It was a maturing male with an empty stomach. Its otoliths were examined for evidence of age and appeared to have 9 to 11 hyaline (winter) zones, but there is no certainty that these were annuli.

A previously unreported specimen in the SIO ichthyology collection and another in the SWFC collections have also been examined. The SIO fanfish (SIO 71-184) at 445 mm SL is also larger than the Cambria specimen. This fish was netted on August 2, 1971, some 80 km (50 miles) SW of Point Baja, Baja California, at lat 29°25′N, long 116°30′W. The SWFC fanfish, at 40 mm SL, is the smallest *P. aesticola* known at this time from the eastern north Pacific. It was spit up by an albacore, *Thunnus alalunga,* that was caught on June 8, 1976, at lat 32°25′N, long 137°28′W.

Mead (1972:107) distinguished the three species of *Pteraclis* (*carolinus, velifera,* and *aesticola*) on the basis of branchiostegal rays; dorsal, anal, and pectoral rays; and vertebrae. He reported seven branchiostegal rays for *P. aesticola,* but the four specimens we examined all had eight. Other counts for three of these specimens (LACM 35990-1, SIO 63-491, and SIO 71-184, respectively) are: DR

48 (all three fish); AR 44, 41, 42; PR 19 (all three); principal CR 9 + 8 = 17 (all three); vertebrae 22 + 23 = 45, 21 + 23 = 44, and 22 + 23 = 45. Gill rakers (1 + 7 = 8) and pored lateral line scales (48) were counted only on the LACM fanfish. Based upon these counts, *P. carolinus* and *P. aesticola* can be differentiated only by vertebral counts, and this may be the best character for identifying *P. velifera* also. It is obvious from our meagre observations that additional material from the Pacific Ocean should be examined to determine if these differences will hold, and if, in fact, there are three species of *Pteraclis*.

Taractichthys steindachneri—Pacific bigscale pomfret

Fitch and Lavenberg (1968:97) reported that "specimens of *Taractes longipinnis* [= *Taractichthys steindachneri*] apparently have been noted only four times in the eastern Pacific—all since April, 1953, all in the 80-mile stretch between Doheny State Park Beach and Redondo Beach, and all floundering or swimming feebly in the shallow surf." Subsequently, three additional specimens have been taken, two within this "80-mile stretch" of southern California coastline, and one at Goleta, about 145 km (90 miles) upcoast from Redondo Beach. Details regarding these as well as the four earlier captures are reported here for the first time.

The first three individuals, taken at Corona del Mar, Redondo Beach, and Doheny Beach respectively, were reported upon by Fitch (1953), Radovich (1961), and Anonymous (1961). The Redondo Beach specimen, a "24-pound" fish (650 mm SL) was retained by the fisherman who had picked it up in the surf, but the Corona del Mar fish (590 mm SL) and the Doheny Beach pomfret (328 mm SL) were deposited in the UCLA ichthyology collection. The fourth individual mentioned by Fitch and Lavenberg (1968) was caught barehanded on March 17, 1964, in the surf near the Belmont Shore pier by a Long Beach fisherman, Kevin Desmond. This fish was 497 mm SL, 678 mm TL, and weighed about 5.5 kg (12 lbs).

Since 1968, three additional Pacific bigscale pomfrets have been taken on our coast. The first of these was seen on September 11, 1969, floundering in the surf off the Anaheim Bay jetty and was caught by an unknown fisherman. The fisherman allowed a biologist to measure and weigh the fish (measurements noted as "27 inches SL, 31½ inches TL," and weight as "20 pounds"), and remove its head (for otoliths and other data), but he would not give up the specimen. The otoliths of this fish had six excellent hyaline (winter) zones.

During the last week of October 1975, an unknown fisherman gaffed a specimen (409 mm SL, 541 mm TL, 3050 g) as it swam feebly past his skiff while he was fishing at the outer edge of a kelp bed off Salt Creek, South Laguna, Orange County, California. The pomfret was left with Tony Spagnolini at Dana Point Harbor who turned it over to Department biologists. Judged by some excellent growth zones on its otoliths, this fish was just entering its third winter. This Salt Creek pomfret, and the one taken at Belmont Shore in 1964, have been deposited in the LACM ichthyology collection.

Finally, on January 27, 1977, Ann Duffey and Marie Angel, Santa Barbara, while taking a noontime stroll on the beach at Goleta found a bigscale pomfret that apparently had just stranded itself. They turned the fish over to Gary Robinson, Marine Science Institute, University of California, Santa Barbara (UCSB) who called it to our attention. When examined at CSFL a few days later, it was 526 mm SL, 675 mm TL, and weighed 5.6 kg (12.3 lb). It has been retained at UCSB, but eventually will be deposited in the LACM fish collection.

The use of "Pacific" in the vernacular for this fish is to distinguish it from *T. longipinnis,* a bigscaled pomfret found in the Atlantic Ocean, and the only other member of the genus (Mead 1972).

CARCHARHINIDAE—REQUIEM SHARKS

Carcharhinus obscurus—dusky shark

In recent publications, the northern range limit for the dusky shark is not very definitive, being listed "to southern California" by Miller and Lea (1976:40) and "southern California . . ." by Kato, Springer, and Wagner (1967). In earlier publications, however, the northern range has been noted as "San Diego, California," (Rosenblatt and Baldwin 1958, for *C. lamiella* = *C. obscurus*) and "San Pedro southward . . .; rare north of San Diego; common in San Diego Bay" (Walford 1935:33; for *C. lamiella*). Californian records based upon actual specimens are extremely rare, and Walford's report that the species was "common in San Diego Bay" apparently had been perpetuated for more than 50 years, having first appeared in print in 1883.

The capture on September 21, 1976, of a 105 cm TL *C. obscurus* at Redondo Beach, is of interest because it is a few miles upcoast from San Pedro and gives an exact geographic locality for a verified specimen. This small shark, an immature male weighing 6 kg (13¼ lb), was caught in the surf at night by Fred Oakley of Hawthorne, California. Mr. Oakley presented the fish to Jerry Goldsmith, Marineland of the Pacific, who turned it over to Fitch. The stomach of this shark contained the remains of a walleye surfperch, *Hyperprosopon argenteum,* and a jumbo squid, *Dosidicus gigas.*

The SIO ichthyology collection contains two dusky sharks from off southern California (SIO 63-677, La Jolla, 13 Aug. 1963, 930 mm TL; and SIO 63-678, 5 km (3 miles) off Ocean Beach jetty, 14 Aug. 1963, 3000 mm TL) and Richard Rosenblatt informed us (pers. commun.) that he has seen many others from off southern California. *C. obscurus* attains an estimated maximum length of 3.7 m (12 ft.) according to Kato, Springer, and Wagner (1967). They are known from tropical and subtropical waters throughout the world.

CERATIIDAE—SEADEVILS

Cryptopsaras couesii—triplewart seadevil

On July 19, 1976, Augustino Tarantino, a Fort Bragg commercial fisherman brought to Schultz a triplewart seadevil that he had trawled that day near Noyo Canyon in 192 m (105 fm). Examination in the laboratory revealed that Mr. Tarantino's catch was an adult female 245 mm SL (ca. 342 mm TL) with two parasitic males attached: one, 94 mm SL and the other 30 mm. *C. couesii* is found in all the world's oceans (Fitch and Lavenberg 1968), but females with parasitic males are not common anywhere, only nine having been captured prior to the Noyo Canyon specimen (Pietsch 1975). In addition to being only the tenth known *C. couesii* with attached parasitic males, Tarantino's fish was only the second adult female from California, and was taken approximately 317 km (197 miles) upcoast from the previous northern range limit for the species. In addition, the largest male was 21 mm longer than the largest previously known specimen, a 73 mm male attached to a 356 mm female captured off South Africa (Pietsch 1975, 1976).

The stomach of the Noyo Canyon seadevil contained the remains of seven lanternfish: five *Diaphus theta,* one *Lampanyctus* sp., and one too digested to identify but recognizable as a myctophid from its badly eroded otoliths.

Sagittae were removed from the female seadevil and both parasitic males and examined for evidence of age. Those from the female had 11 excellent winter (hyaline) zones, and she was judged to have first spawned when 5 years old. The sagittae of the 94 mm male had seven winter zones, whereas those of the 30 mm male had three. Obviously, when more than one male is present, they do not necessarily all attach at the same time, nor do all attach after the female reaches maturity. Pietsch (1975) reported upon a female *C. couesii* 15.8 mm long which was parasitized with a firmly attached male 9.8 mm SL.

The Noyo Canyon specimen has been deposited in the LACM ichthyology collection.

ELOPIDAE—TARPONS

Elops affinis—machete

On August 7, 1975, James A. Allen, Ventura, California, caught a machete while surffishing near the Southern California Edison steam generating plant at Mandalay Beach. He was using mussel, *Mytilus californianus,* for bait, and his fish (sex unknown) was 485 mm SL, 610 mm TL, and weighed 1095 g eviscerated. Its otoliths were removed and when examined for evidence of age, there appeared to be seven fairly distinct annuli. Based upon this capture, Miller and Lea (1976:239) reported the northern range limit for *Elops affinis* as Ventura. Previously, *E. affinis* had been taken only in Salton Sea in California.

The history of *E. affinis* in Salton Sea is short but interesting. In August 1941, E. H. Glidden obtained two specimens from the Colorado River below Laguna Dam, "one 11 inches long and the other 14" (Glidden 1941), and reported upon several others that had been caught and seen there earlier that year. Because it was "a very desirable game fish," he hoped it would find its way into Salton Sea.

Glidden's wish seemed to have been answered, when in May 1942, commercial mullet fishermen and Department biologists caught 41, "ten-pounders" over a 10-day period at several Salton Sea localities. These fish "ranged in length (to fork of caudal fin) from 17.1 inches to 19.7 inches, and from 1.75 pounds to 2.5 pounds in weight" (Dill and Woodhull 1942).

In their glowing account of the ten-pounder's potential as a game fish in Salton Sea, Dill and Woodhull (1942) planned to recommend that *Elops affinis* be "classed as a game fish by law in our inland waters." As a result of this recommendation and in anticipation of heavy sportfishing pressure, the California Fish and Game Commission subsequently passed a law setting daily and possession bag limits on "ten-pounders" in California's waters. Although this law remained in effect for nearly two decades, to our knowledge no other ten-pounder (= machete) was taken in our waters, including Salton Sea and tributaries, until Mr. Allen caught his in 1975 near Ventura. The "in the Salton Sea" notation by Miller and Lea (1976:52) is a 35-year perpetuation of wishful thinking.

The Ventura machete has been deposited in the LACM ichthyology collection.

GADIDAE—CODS

Gadus macrocephalus—Pacific cod

Pinkas (1967) extended the southern range for the Pacific cod from Point Piedras Blancas to Santa Monica Bay, and discussed other captures from central California. On January 4, 1975, a second Pacific cod was caught in southern California waters. This fish, almost identical in size to the Santa Monica Bay specimen, was caught on hook and line in 183 m (600 ft) of water off Summerland, Santa Barbara County, California, by Ernest Henderson of Oxnard.

The Summerland cod, a ripening female, was 545 mm SL, 595 mm TL, and weighed 2725 g. Its stomach contained the soupy remains and earstones from two slender sole, *Lyopsetta exilis,* and a small Pacific sanddab, *Citharichthys sordidus.* The otoliths from the cod were removed and examined for age, but not until they were sliced into thin sections could one discern what appeared to be three rather indistinct winter annuli. Although Ketchen (1970) reported that ". . . the best (most readable) specimen of Pacific cod otoliths is worse than the worst specimen which the writer has examined from the Atlantic," he did give ages for a considerable number of individuals. Our age-length data for the Summerland specimen agree with Ketchen's. This fish has been deposited in the LACM ichthyology collection.

GEMPYLIDAE—SNAKE MACKERELS

Ruvettus pretiosus—oilfish (Figure 1)

The oilfish was first reported from the eastern Pacific in 1944 (Barnhart and Hubbs), based upon a specimen 475 mm SL that was taken at Encinitas, San Diego County, California, on August 13, 1942. Five years later, on January 28, 1947, a specimen that was "49 inches in length and weighed 34 pounds" (Fitch 1947) was caught in a purseseine set for bluefin tuna at Guadalupe Island, Baja California.

Since 1947, five additional oilfish have been caught in the eastern north Pacific, two off southern California, and three off Baja California; these have remained unreported until now. The first of these five, and the third from the eastern north Pacific, was caught in a gill net set in 110 m (60 fm) of water off

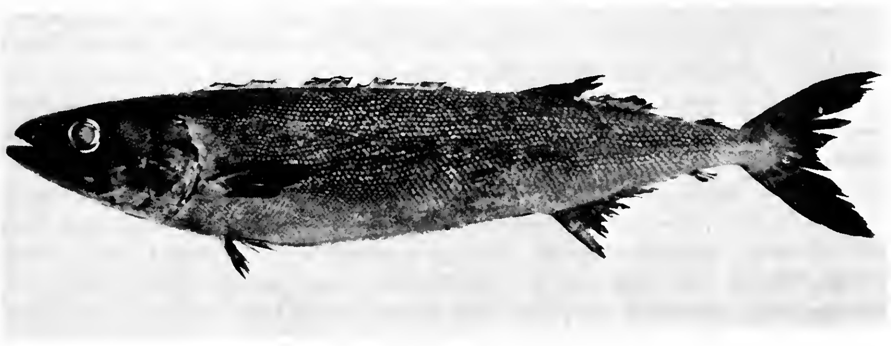

FIGURE 1. Oilfish, *Ruvettus pretiosus,* 810 mm SL taken with gill nets off Marineland of the Pacific during the night of September 10–11 1967.
Photo by Jack W. Schott.

Marineland of the Pacific during the night of September 10–11, 1967. It was 810 mm SL, 960 mm TL, and weighed 5.4 kg (11 lb 14 oz). Phillip L. Guglielmo, skipper of the gill netter *San Aniello* presented the fish to CSFL.

The next *Ruvettus pretiosus* was caught by Terry Cross, Oceanside, California, in his gill nets which had been set overnight (September 20–21, 1972) in 146 m (80 fm) some "four or five miles due west of Oceanside." This fish, a female showing no sign of maturity, was 920 mm SL, 1060 mm TL, and weighed 6.8 kg (15 lb).

The three most-recently captured oilfish were taken December 14, 1976, on longline gear which was being fished by Mike Ward, Oxnard, California, some 64 km (40 miles) west of Cedros Island, Baja California (lat 27°54'N, long 116°02'W). Fishing depth, according to Mr. Ward, skipper of the vessel *La Vida,* was 11 m (6 fm). He released one of these three oilfish, but returned to port with the other two. The largest of these, 135 cm SL, 145 cm FL, 156 cm TL, and weighing 27.7 kg (61 lb), he left with Chuck Saccio, San Diego Fish Company, who subsequently presented it to CSFL. The other oilfish, 122 cm SL, 132 cm FL, 145 cm TL, and weighing 21.9 kg (48.5 lb) was sent to SIO for identification, and later was given to CSFL. Upon examination at CSFL, both fish were found to be females with empty stomachs. Otoliths of the 156-cm specimen had eight excellent hyaline zones on them, whereas those from the 145-cm fish had seven.

Wheeler (1969:384) reported that *R. pretiosus* grows to "80 inches (203 cm) and a weight of 100 lb (45 kg)," and Munro (1958:116) noted the species as "obtaining 200 lb." Munro probably was repeating a weight that Nordhoff (1928) estimated for the species after being given a giant sized head. An editorial note at the end of Nordhoff's account attributes a length of "6 ft 10 inches" to *R. pretiosus.*

For centuries, the purgative properties of *R. pretiosus* flesh have been exploited by people in many parts of the world, and native fishermen have developed special gear and techniques for catching oilfish (Gudger 1925; Nordhoff 1928). One reason given for the popularity of *Ruvettus* flesh (and oil) as a laxative is that it works rapidly without cramping. On the other hand, chemists who have analyzed the oil from *R. pretiosus* (Cox and Reid 1932; Nevenzel, Rodegker, and Mead 1965) have concluded that its purgative properties have probably been over-emphasized. Bone (1972) postulated that the oil in the flesh and bones of *Ruvettus* affects its buoyancy and hydrodynamics in such a manner that to maintain position in the water column the fish must orient obliquely when at rest.

The two oilfish brought ashore by Mike Ward have been deposited in the CAS and LACM ichthyology collections.

HEXAGRAMMIDAE—GREENLINGS

Pleurogrammus monopterygius—Atka mackerel

Although Miller and Lea (1976:243) have reported the Atka mackerel as ranging south to Morro Bay, California, they omitted pertinent details regarding the Morro Bay specimen, and the occurrence of *P. monopterygius* in California. Perusal of the literature and examination of museum and other collections, revealed that until 1974, only two Atka mackerel had been taken in our waters, one reported upon by Bolin (1952) and the other, an unreported specimen in the CAS collection (CAS 25733). Both had been caught near Santa Cruz, Monterey Bay, one in 1951 and the other in 1952. Interestingly, we were unable to find any record of Atka mackerel having been taken in waters off British Columbia, Washington, or Oregon, although they are abundant in the eastern north Pacific from southeast Alaska to and into the Bering Sea. They range south to Japan in the western Pacific (Quast and Hall 1972).

The Morro Bay specimen (323 mm SL, 375 mm TL, 478 g) was caught on hook and line by a Bakersfield, California sportfisherman, Jim Smith, on July 23, 1974. He kept it alive in the baitwell of the partyboat *Pathfinder,* until the vessel returned to port, and then turned it over to Dean Tyler of the Morro Bay Aquarium who notified our Morro Bay office of the catch. This fish, a male, was hooked near the bottom in 46 m (25 fm) about midway between San Simeon Point and Point Piedras Blancas, San Luis Obispo County, and is the basis for the southern range limit reported for the species by Miller and Lea (1976:243). Its otoliths had two excellent hyaline (winter) growth zones and an opaque margin.

Eleven months later another Atka mackerel was caught in an otter trawl being fished from the vessel *Anna W* off Trinidad Head, California (lat 41°09′N, long 124°10′W). Although the net was fishing on the bottom in "62 to 100 fm," the Atka mackerel probably was caught at or near the surface while the net was being let out or retrieved. This fish was 325 mm SL, 385 mm TL, and weighed 600 g. Its sex was not determined. Its otoliths had three excellent hyaline zones and an opaque margin. Medveditsyna (1962) reported taking *P. monopterygius* in Russian waters which ranged in length from 30 to 50 cm, and noted that these fish were predominantly 2 to 10 years old.

The Morro Bay and Trinidad Head Atka mackerel have been deposited in the LACM ichthyology collection.

MACROURIDAE—GRENADIERS

Coelorinchus scaphopsis—gulf rattail

A gulf rattail caught with an otter trawl by the vessel *Sea Romeo* while fishing in 274 m (150 fm) off Point Piedras Blancas, San Luis Obispo County, California, on September 11, 1974, extended the known range for the species northward approximately 225 km (140 miles). The fish, a mature female was 305 mm TL. In a recent review of the rattail fishes found off Oregon and in adjacent waters, Iwamoto and Stein (1974:50) called attention to the correct generic spelling for *Coelorinchus,* and told how it could be distinguished from other eastern north Pacific genera and species of macrourids. They examined three specimens from the CAS and SIO collections that had been taken in the vicinity of Santa Cruz Island and Point Conception, but apparently overlooked at least one other Californian specimen in the SBNHM collection (280 mm TL) that had been trawled in July 1967 "off Santa Barbara." Iwamoto and Stein (1974) also apparently missed notes by Lavenberg and Fitch (1966:105) and by Fitch (1966:10) mentioning its capture in the vicinity of Santa Barbara. *C. scaphopsis* otoliths have been found in at least two Pleistocene deposits in southern California (Fitch 1966:10; 1970:20). The Piedra Blancas specimen has been deposited in the LACM ichthyology collection.

MYLIOBATIDAE—EAGLE RAYS

Myliobatis longirostris—longnose eagle ray

In 1964, Applegate and Fitch described *Myliobatis longirostris* from a single adult male caught with a midwater trawl in Magdalena Bay, Baja California. During the ensuing 13 years, nine additional specimens, unreported until now, were brought to CSFL by Warren Beadle, Ivan Goyette, and Homer Moore, commercial fishermen who caught them in their white seabass nets while fishing off southern Baja California. Eight of these rays (3 females 330 to 820 mm disc width, 4 males 615 to 665 mm, and 1 not measured nor sexed) were taken during 1970 and 1971 in 46 to 64 m (25 to 35 fm) between Santo Domingo Point and Cape San Lazaro. Seven of these and the holotype have been deposited in the LACM fish collection, and one has been sent to the United States National Museum of Natural History. The ninth previously unreported specimen, an adult male 665 mm wide, was caught in 64 m (35 fm) off Abreojos Point, Baja California, during January 1977. The three fishermen who brought these in reported catching numerous other longnose eagle rays in their gill nets, but only these nine were saved.

Within the Gulf of California, considerable numbers of *M. longirostris* are taken each year by shrimp trawlers. Most of these are discarded at sea, but many end up in the trash-fish piles at shoreside shrimp processing plants. Unfortunately, we do not have depth or locality records for any of these Gulf specimens, but they show up in catches made near Guaymas in the north and Mazatlan in the south. Thus, the species' geographic range obviously extends from Mazatlan (at least) to San Cristobal Bay (Applegate and Fitch 1964) on the outer coast of Baja California. It has been taken throughout the water column, from the surface to 64 m (35 fm).

PLEURONECTIDAE—RIGHTEYE FLOUNDERS

Psettichthys melanostictus—sand sole

Miller and Lea (1976:243) extended the southern range limit for the sand sole to El Segundo, Santa Monica Bay, based upon a specimen collected January 15, 1975, by Fitch at the Los Angeles Department of Water and Power steam generating plant. Subsequently, on April 16, 1976, a sand sole 266 mm SL (321 mm TL, 306.5 g) was removed from the Unit 7 and 8 screenwell of Southern California Edison's steam generating plant at Redondo Beach by Mark Helvey and Llew Johnson. This fish, representing the second sand sole from Santa Monica Bay and a new southern range limit for the species, has been preserved at Southern California Edison's Research and Development Marine Laboratory, Redondo Beach. The 1975 sand sole from El Segundo is preserved in the LACM ichthyology collection.

PRIACANTHIDAE—BIGEYES

Priacanthus cruentatus—glasseye catalufa

On June 30, 1974, Don Baker, an Encinitas, California sportfisherman caught at Alijos Rocks, Baja California (lat 24°57′03″N, long 115°44′55″W) a 507-mm (20-inch) TL bright-red, perch-shaped fish with a very large eye. He did not recognize the fish, so he had it frozen and brought it to CSFL after he returned to port. It turned out to be a record-sized *Priacanthus cruentatus,* which at 397 mm SL and 2725 g (6.0 lb) was so much larger than the previous known record size, i.e., "about a foot" (Gosline and Brock 1960:160), that it should be recorded for posterity. Mr. Baker's fish, a spent female, had a number of pelagic red crabs, *Pleuroncodes planipes,* in its stomach. Mr. Baker was fishing from the boat *Cape Polaris* in 33 m (18 fm) of water; he was using a piece of cut mackerel for bait.

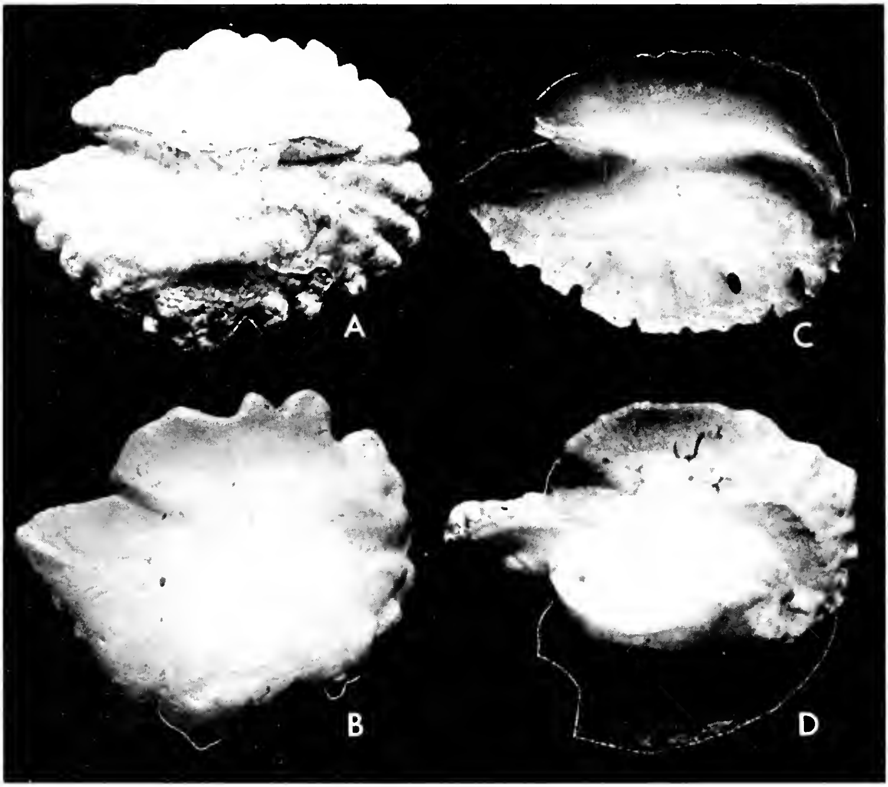

FIGURE 2. Right sagittae of *Cookeolus boops* (A, 5.4 mm long), *Pseudopriacanthus serrula* (B, 6.5 mm long), *Priacanthus cruentatus* (C, 5.3 mm long) and *Priacanthus alalaua* (D, 3.2 mm long).
Photos by Jack W. Schott.

There apparently is a substantial population of giant-sized *P. cruentatus* at Alijos Rocks as several others ranging in total length to 18 inches (455 mm) and in weight to just under 4 lb (1850 g) have been brought to CSFL and SIO by fishermen who caught them there. The 455 mm individual, a spawned out female (360 mm SL) was taken there in October 1970, and had the remains of one each *Vinciguerria lucetia* and *Gonichthys tenuiculum* in its stomach. Judged by growth zones on their otoliths, these Alijos Rocks "giants" are rapidly-growing fish: there were either eight or nine hyaline (winter) zones on the sagittae of the 507 mm specimen, and five on the 455 mm one.

P. cruentatus is found on both sides of the Atlantic Ocean and in the eastern, central, and western Pacific (Caldwell 1962; Gosline and Brock 1960). In the eastern Pacific, they appear to be even more abundant at the Revillagigedos islands than at Alijos Rocks, but do not attain such a large size. Ten or more than 50 individuals caught in gill nets set overnight just upcoast from Braithwaite Bay, Socorro Island (Revillagigedos), during April 1955 had the following counts: D X, 13; A III, 13–14; GR 5–6 + 17–21 = 22–26; vert. 10 + 13 = 23.

In overall morphology, the sagittae of *P. cruentatus* are more similar to those of *Cookeolus* and *Pseudopriacanthus* (the remaining genera of family Priacanthidae), than they are to those from other species of *Priacanthus* (Figure 2). Observable differences between otoliths of *cruentatus* and those from six other species of *Priacanthus* (*alalaua, arenatus, hamrur, macaracanthus, meeki,* and *tayenus*) seem to be of generic magnitude, but we do not advocate changing their generic status without investigating and evaluating a multitude of other features, especially internal anatomy. We have no plans for making such a study; we merely wished to draw attention to this anomalous situation.

The 507-mm catalufa from Alijos Rocks has been deposited in the LACM ichthyology collection; whereas the 455-mm specimen was placed in the UCLA collection.

SCOMBRIDAE—MACKERELS AND TUNAS

Lepidocybium flavobrunneum—escolar (Figure 3)

Although 32 years elapsed between the taking of the first and second escolars in southern California, and 16 years between the second and third, the fourth

FIGURE 3. Escolar, *Lepidocybium flavobrunneum,* 768 mm SL taken with gill nets off Point Dume, November 11, 1976.
Photo by Jack W. Schott.

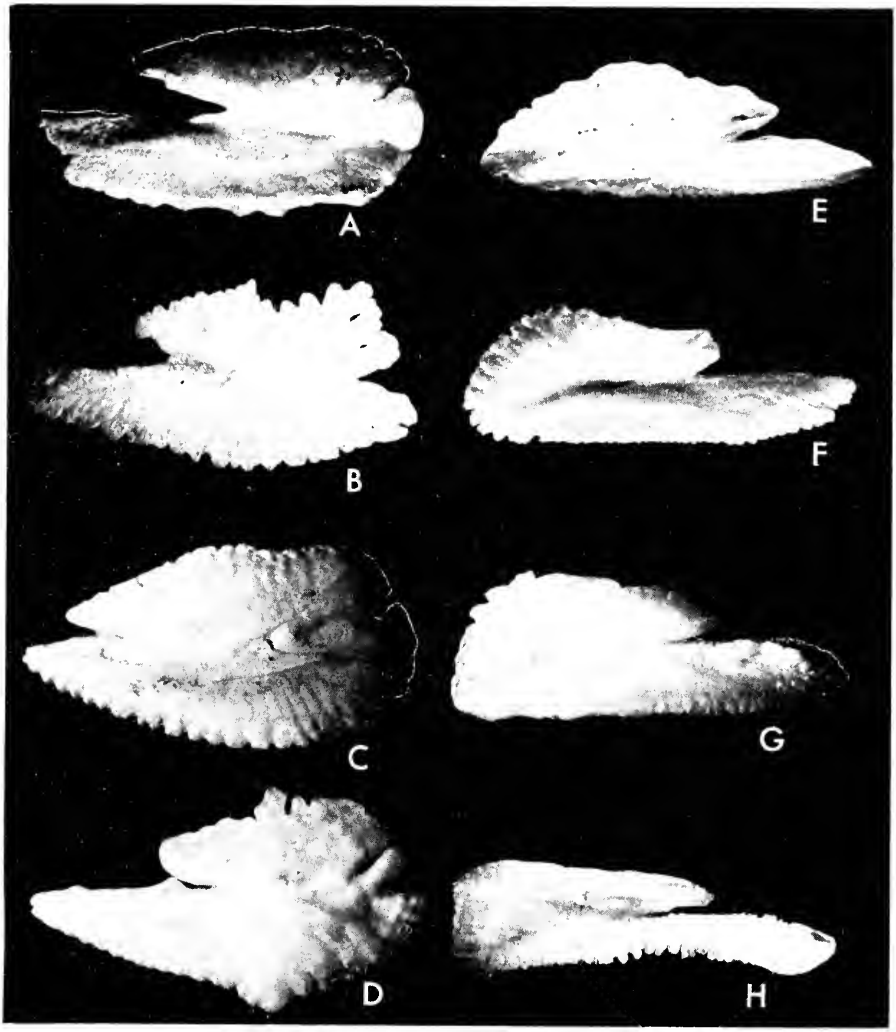

FIGURE 4. Typical gempylid (left series) and scombrid (right series) sagittae. A. *Gempylus serpens* 5.8 mm, B. *Ruvettus pretiosus* 9.7 mm, C. *Rexea solanderi* 9.4 mm, D. *Thyrsites atun* 10.1 mm, E. *Scomber scombrus* 4.2 mm, F. *Lepidocybium flavobrunneum* 7.5 mm, G. *Scomberomorus concolor* 9.1 mm, H. *Acanthocybium solanderi* 12.3 mm. *Photos by Jack W. Schott.*

was caught just 2 months after its predecessor. These four escolars came from a very restricted area of southern California's coastline, yet they represent the only known occurrences for the species in the eastern north Pacific.

The first escolar from California was picked up on shore at Long Beach in the spring of 1928. This fish, 734 mm TL, was reported upon by Myers (1932: as *Xenogramma carinatum*), and apparently represented the fifth or sixth known specimen from anywhere in the world. Subsequently, *L. flavobrunneum* has been reported from numerous tropical and subtropical areas of the world's oceans, but never abundantly.

The second specimen from California, previously unreported, was 610 mm TL and weighed 1835 g. It was picked up in the surf near Marineland of the Pacific's pier (Los Angeles County, Calif.) on August 1, 1960. The fisherman who caught it sought help from John Prescott, then Curator for Marineland, in identifying his prize, but would not donate it to science. Regardless, Fitch was able to make a number of observations from the specimen before returning it to its captor.

Sixteen years later, on November 11, 1976, Jim Gramatico, a commercial fisherman, delivered a 6.5-kg (14½ lb) escolar to a San Pedro fresh fish market. This fish, taken in trammel nets off Point Dume, was recognized as a rarity by Joe DiMeglio, Pioneer Fisheries, so he saved it intact and presented it to William L. Craig, National Marine Fisheries Service, who turned it over to Fitch. Just two months later, on January 11, 1977, Chris Larson, of Balboa, California, while riding a wave just upcoast from the Newport pier, struck and stunned an escolar with the skeg of his surfboard. He grabbed the escolar before it could escape, and took it ashore where, in seeking help to identity it, Robert Decker, a Department Fish and Game warden, was contacted. The Point Dume escolar was a mature male, 768 mm SL, 814 mm FL, and 895 mm TL, whereas the Newport Beach fish (also a mature male) was 910 mm SL, 965 mm FL, and 1055 mm TL. It weighed 13 kg (28.5 lb). The stomachs of both of these individuals were empty. The otoliths of the Newport Beach escolar appeared to have either five or seven hyaline zones on them, but these were quite vague and there is no certainty that they were annuli. The Point Dume and Newport Beach escolars each had 31 vertebrae; 18 precaudal and 13 caudal. Matsubara and Iwai (1958) reported that a Japanese specimen had 16 precaudal and 15 caudal vertebrae.

Miller and Lea (1976:191) reported the range for *L. flavobrunneum* in the eastern Pacific as "from Peru to Washington," but there is no basis for the Washington record, and the northern limit at that time should have read "Point Vicente, Calif." The "62.25 inch" maximum size noted by Miller and Lea is a typographical error and should read "61.4 inch" as it is based upon a specimen 156 cm TL noted by Maksimov (1970).

Although *L. flavobrunneum* has been reported from, or is known to occur off California, Ecuador, Peru, Hawaii, Japan, New South Wales, Lord Howe Island, New Caledonia, Bahamas, Gulf of Mexico, east coast of Canada, West Africa (including Gulf of Guinea), and South Africa, it is considered rare in all localities. Only in two accounts (Fourmanoir 1970; Maksimov 1970) were more than two individuals reported upon. Fourmanoir (1970) noted 13 adults captured on long line gear in the vicinity of New Caledonia and New Hebrides during the period May 1959 through October 1969. These fish were taken at fishing depths of 110 to 195 m, and the seven which were measured were 743 to 918 mm SL. He also reported upon eight young *L. flavobrunneum* (29 to 90 mm SL) which were found in stomachs of yellowfin tuna (*Thunnus albacares*) and albacore, and a 33-mm SL specimen that was caught with midwater trawl. Maksimov (1970) presented length frequency, food habit, and other data upon 142 adults captured with longlines in two areas off the west coast of Africa during 1965 and 1966. Catches of *L. flavobrunneum* in these areas were only 0.204 and 0.175 individuals per 1000 hooks. From length frequencies, it was determined that females grew faster than males, but no ages were assigned. Escolars were found in stomachs of other fish on seven occasions: five times in swordfish, *Xiphias gladius* (581 stomachs examined); once in yellowfin tuna

(3308 stomachs); and once in another escolar (142 stomachs).

Matsubara and Iwai (1958), after conducting an extensive study of the anatomy and relationships of Japanese gempylid fishes, placed *L. flavobrunneum* in family Gempylidae, but erected a subfamily, Lepidocybiinae, for it because of features which distinguish it from other gempylids, yet show relationship with some of the scombrids. The saccular otoliths (sagittae), not examined by Matsubara and Iwai, are definitely scombroid (Figure 4) and resemble very closely those from *Scomberomorus* (Fitch and Craig 1964). Sagittae of the six gempylid genera available to us (i.e., *Gempylus, Neolotus, Promethichthys, Rexea, Ruvettus,* and *Thyrsites*) have a sulcus (groove on inner face of otolith) that is quite different from that found in *Lepidocybium* and among scombroids. As pointed out by Frizzell (1965), fish otoliths are structures of the nervous system buried in the cranium, and by this fact, their evolution to a great extent is independent of the forces of natural selection. Thus, logic dictates that they should be of greater value in interpreting evolution and lineages than are structures which are helpful to the fish in adapting to a particular environment or situation—structures which historically have been used by taxonomists in determining relationships among teleosts. Of all otolith characters, the features of the sulcus are most diagnostic for distinguishing families and genera. Because of their otoliths, as well as the characters found by Matsubara and Iwai (1958) which suggest a close affinity with scombroids, we believe that *L. flavobrunneum* should be assigned to family Scombridae rather than Gempylidae and have done so here.

The Point Dume and Newport Beach escolars have been deposited in the LACM ichthyology collection.

SCORPAENIDAE—ROCKFISHES

Sebastes nebulosus—China rockfish

The southern range for the China rockfish has been revised twice since 1973, once for the mainland coast (Burge and Schultz 1973:182) and once for our offshore islands (Love and Vucci 1974). Now, with capture of a specimen 200 mm SL, 243 mm TL, and 295 g off Redondo Beach on September 13, 1975, its mainland distribution must be revised once more. The Redondo *S. nebulosus* was caught from one of the partyboats operating out of that port, and turned over to Kathy Kuletz, a Department employee. Although the exact locality and depth of capture were not obtained, fishing that day was conducted along the southern shore of Santa Monica Bay. The otoliths of this fish had seven hyaline (winter) zones and an opaque margin. The specimen has been deposited in the LACM ichthyology collection.

SERRANIDAE—SEA BASSES

Epinephelus niveatus—snowy grouper

Miller and Lea (1976:240) have reported the snowy grouper from Point Piedras Blancas, but purposely omitted pertinent details regarding the capture of that and other specimens from California. Until 1965, this species had not been taken north of about Cedros Island, Baja California, but on January 21 of that year a sportfisherman caught a 5-kg (11-lb) fish while fishing in "60 fm . . . 5 to 5½ miles north or northwest of North Coronado Island" (Carl L. Hubbs, letter dated 28 January 1965). This then was the basis for *E. niveatus* being listed as a member of the Californian fish fauna (Bailey et al. 1970) prior to 1974.

On June 10, 1974, a sportfisherman on the partyboat *Sea Venture* caught one while fishing in "about 50 fm" some 4.8 to 6.4 km (3 to 4 miles) west of Point Estero, San Luis Obispo County. Unfortunately, the fish was filleted, but the intact carcass with skin attached was readily identified. This specimen was 600 mm SL and 735 mm TL; its otoliths had either 20 or 21 hyaline (winter) zones on them. Sex was not determined.

During the next 18 months, three additional snowy groupers were taken in our waters: between Point Buchon and Avila, off Point Piedras Blancas, and off Redondo Beach. The Point Buchon fish, a female weighing 3.5 kg (7.8 lb), was caught on August 31, 1974, in an otter trawl being fished on the bottom in 130 m (71 fm). George Graft, skipper of the trawler *St. Rita,* turned it over to Department personnel at Morro Bay. It was 490 mm SL, 600 mm TL, and its otoliths had 14 or 15 hyaline zones on them.

The Piedras Blancas grouper was delivered to Gold Nugget Seafood, Morro Bay, on September 25, 1975. It had been trawled that day in 110 to 128 m (60 to 70 fm), and was 420 mm SL, 515 mm TL, and weighed 2325 g (5.12 lb). It too was a female. Its otoliths had either seven or eight hyaline zones.

Finally, on December 3, 1975, a snowy grouper was caught in 76 m (250 ft) of water some 13 to 15 km (8 or 9 miles) SW of King Harbor, Redondo Beach. This fish, 442 mm SL 538 mm TL, and weighing 2225 g (4.9 lb), was saved for us by Dan Armstrong, Redondo Sportfishing. The otoliths of this fish had eight excellent winter annuli. It too was a female and the stomach was empty.

In working with these four specimens, as well as with others captured from time to time along the central and southern Baja California coast, numerous discrepancies have been found in various characters ascribed to the species. Smith (1971) in this key to American species of the subgenus *Epinephelus* (p. 105) has used several characters (i.e., color pattern spotted, saddle shaped blotch on caudal peduncle, pelvic fins longer than pectorals) which are consistent only for juveniles. None of the Californian specimens, and few adults we have seen from the eastern Pacific, have the white spots on the sides from whence the species derives its common name. The black saddle on the caudal peduncle, and the elongate pelvic fins are both juvenile characters.

The largest individual we have seen from the eastern Pacific was a nearly ripe female 670 mm SL, 805 mm TL, which weighed 10 kg (22 lb). This fish was caught on Thetis Bank, Baja California (lat 24°56.5'N,long 112°36'W) on August 23, 1963, by James Cowie, a crewmember aboard the Department's research vessel *Alaska.* Greatest depth of capture in the eastern Pacific appears to be the 130 m (71 fm) at which the Point Buchon fish was trawled.

Selected counts for several eastern Pacific specimens are: D XI, 13–15; A III, 9; GR 8–9 + 1 + 13–15 = 22–25.

The Piedras Blancas and Redondo Beach specimens have been deposited in the LACM ichthyology collection.

Paralabrax auroguttatus—gold spotted bass

Although Miller and Lea (1976:247) reported *Paralabrax auroguttatus* from California for the first time, several important details are missing from their account. This fish was caught from the half-day boat *Redondo Special* on August 18, 1975. Dan Armstrong, an employee of Redondo Sportfishing, who called

Fitch about the bass, said that it had been caught "on the bottom in 200 ft of water," and that it "looked like a sand bass but was covered with large yellow spots. Some of the fins were yellowish green at the tips, and the pectoral fin was so thin you could see the body spots beneath it." Armstrong was shown photos of several species of *Paralabrax,* and unhesitatingly picked *P. auroguttatus.* Both his verbal description, and the depth of capture fit only *P. auroguttatus* from among the eastern Pacific members of genus *Paralabrax* (Walford 1974). Previously, gold spotted bass had been taken as far north as Cedros Island, Baja California. They range south to Cape San Lucas (Outer Gorda Bank) and are abundant throughout much of the Gulf of California. They rarely are caught at depths shallower than 37 m (20 fm) and have been hooked on the bottom in 155 m (85 fm). The largest we have seen was a 710-mm TL fish which was caught in 64 m (35 fm) at the north end of Cedros Island.

TRACHIPTERIDAE—RIBBONFISHES

Zu cristatus—scalloped ribbonfish (Figure 5)

On July 12, 1968, a scalloped ribbonfish, 980 mm SL and weighing 2500 g, was caught in a nighttime purse seine set for bluefin tuna at the "175-fathom spot

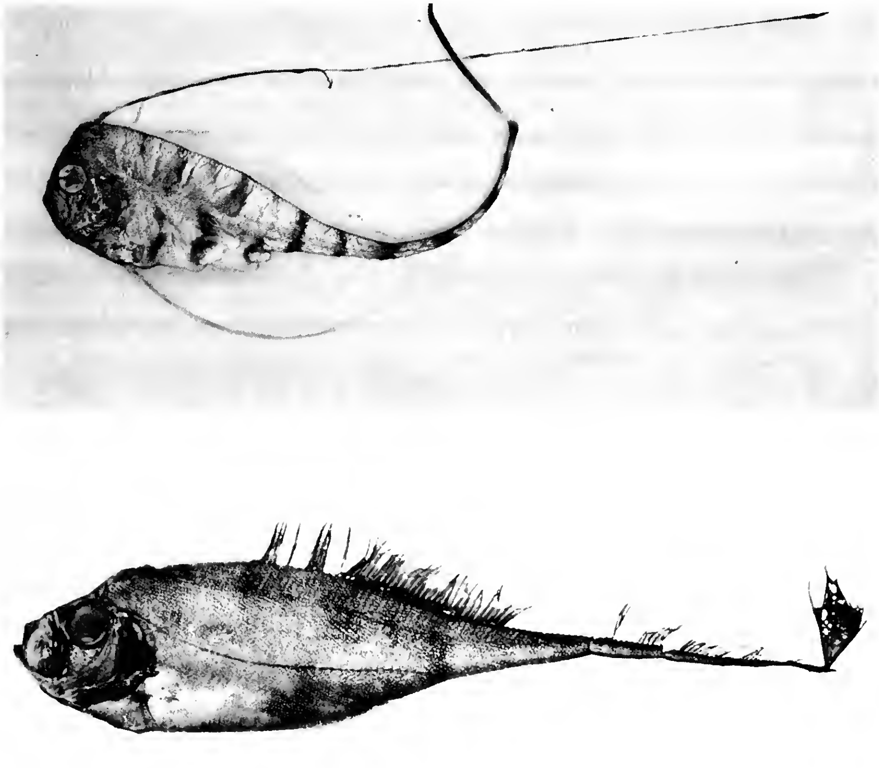

FIGURE 5. Scalloped ribbonfish, *Zu cristatus.* Upper: Juvenile 213 mm SL, lower: adult 980 mm SL.
Photos by Jack W. Schott.

above Ranger Bank" (lat 28°52.5'N,long 115°59.2'W). It was brought to CSFL by Gino Guidi, San Diego, a crewmember of the seiner *Lou Jean,* which caught the fish. When examined at CSFL, Guidi's ribbonfish was found to differ radically in external appearance from the description given for the species by Fitch (1964). Most obvious was the lack of scalloping (from whence the fish derives its common name) of the ventral profile between the pelvic fins and anus (Figure 5, bottom). Also missing were the elongate crest and pelvic rays, so prominent on the juveniles. The caudal rays of this large adult were considerably shortened, and the dark bars on its sides were vague and difficult to observe. The undulating lateral line scales posterior to the anus were present, however, and permitted positive identification, since this arrangement is unique to *Zu.*

Subsequently, an 811-mm SL adult in the SIO ichthyology collection (SIO 66-272) was examined and found to be nearly identical in external appearance to our Ranger Bank ribbonfish. The SIO specimen was caught in a purse seine some 32 km (20 miles) SW of Asuncion Bay, Baja California (lat 26°52'N,long 114°30'W).

The scalloped ribbonfish, known from tropical, subtropical, and temperate seas throughout the world, ranges in the eastern Pacific from just south of the equator (SIO 64-396:lat 00°59.8'S, long 101°42'W) to Newport Beach, California. The largest scalloped ribbonfish appears to be a specimen 1105 mm long from the Mediterranean (Tortonese 1958). The 980-mm specimen reported here seems to be the second largest known. It had the remains of a Pacific blackdragon, *Idiacanthus antrostomus,* 105 mm SL, in its stomach. Its sex and age were not determined. It has been deposited in the LACM ichthyology collection.

TRICHIURIDAE—CUTLASSFISHES

Benthodesmus elongatus pacificus—North Pacific frostfish

While the note by Anderson and Cailliet (1975) reporting the first two occurrences of *Benthodesmus elongatus pacificus* in Californian waters was in press, a third example was taken by the German stern trawler *Bonn.* This fish, 897 mm SL, was caught on April 19, 1975, at lat 37°00'N, long 122°37'W (approx. 25 km SW of Año Nuevo Point) where the bottom was 340 to 400 m beneath the surface. Fishing depth, according to F. Mombeck who saved the specimen and presented it to Fitch, was at 300 to 390 m. Dr. Mombeck reported taking approximately 5000 kg of Pacific hake, *Merluccius productus,* in the same tow, along with small quantities of splitnose rockfish, *Sebastes diploproa;* blackgill rockfish, *S. melanostomus;* rex sole, *Glyptocephalus zachirus;* spiny dogfish, *Squalus acanthias;* ribbonfish, *Trachipterus* sp.; lanternfish, Myctophidae; and "squids and shrimps." The *Bonn* frostfish represents the fourth known specimen from the eastern north Pacific, and very likely is the first individual taken in its normal habitat. It has been deposited in the ichthyology collection at LACM.

ACKNOWLEDGMENTS

We would have had little to report if it had not been for the curiosity of fishermen as to the identities of the "odd-balls" they catch from time to time. We have acknowledged these individuals in the body of this report but wish to reiterate their helpfulness at this time.

Others who have supplied us with data, furnished information regarding material they curate, called attention to pertinent literature, provided taxonomic assistance, or been otherwise helpful in our preparation of this report are E. H. Ahlstrom and John Butler (SWFC), Lillian Dempster and W. I. Follett (CAS), Robert J. Lavenberg and William Lewis (LACM), Richard Burge, Terese Hoban, Robert N. Lea, Howard Martin, Daniel J. Miller, Jim Phelan, and Lawrence Quirollo (DFG), and Richard H. Rosenblatt (SIO)

Jack W. Schott (CSFL) took the fish and otolith photos used in this report, and Laura Cartner typed the draft and final copy of the manuscript.

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AN EVALUATION OF DISK-DANGLER TAG SHEDDING BY STRIPED BASS (*MORONE SAXATILIS*) IN THE SACRAMENTO-SAN JOAQUIN ESTUARY [1]

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A total of 1,162 striped bass (*Morone saxatilis*) was tagged with disk-dangler tags below the anterior and posterior dorsal fins. Tags from 337 of these fish were returned within 7 years. Tags attached below the anterior fin, the normal tagging location, experienced no immediate losses and annual losses of 4.9% for 4 years thereafter. Tags below the posterior fin experienced 5.6% immediate and 8.4% annual losses.

INTRODUCTION

Since 1969, the California Department of Fish and Game has conducted an intensive mark-recapture study on legal-sized striped bass ($\geq$40.6 cm [16 inches]) total length (TL) in the Sacramento-San Joaquin Estuary. Study objectives include estimating bass abundance and mortality. The validity of these estimates depends on marked fish retaining their tags (Ricker 1975). This report describes disk-dangler tag shedding rates estimated from a double-tagging experiment conducted from 1969 to 1976.

METHODS

Tagging

Striped bass were captured for this study in fyke traps (Hallock, Fry, and LaFaunce 1957) in the Sacramento River near Isleton and Courtland between April 3 and July 7, 1969. A total of 1,162 double-tagged and 1,164 single-tagged fish were released.

Tagging methods are described by Chadwick (1963). Tags were individually numbered, laminated vinyl chloride disks 12.7 mm (0.5 inch) in diameter and 1.0 mm (0.04 inch) thick. Type 302 soft stainless steel wire 0.51 mm (0.02 inch) in diameter was used to attach the tags. Double-tagging was alternated with single-tagging. Fish with two tags had one tag placed halfway between the anterior dorsal fin and lateral line (A position) and the other halfway between the posterior dorsal fin and lateral line (B position). All fish with single tags were tagged in position A. Tag returns from double- and single-tagged fish enabled me to evaluate tag shedding, effects of double-tagging on the likelihood of recapture, and whether the presence of B tags enhanced recognition of A tags.

Recovery

Tags were recovered during a creel census in the San Francisco Bay Area, by mail, and during subsequent tagging operations. Anglers returning only one tag from a double-tagged fish or failing to give recapture date were contacted by mail to obtain accurate information. If the angler failed to respond to the inquiry,

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[2] Presently assigned to Environmental Services Branch, Sacramento.

I assumed the number of tags returned to be correct and the recapture date to be the postmark date on the angler's letter.

Data Analysis

Those A tags not detected and the proportion lost immediately after tagging (${}_{A}K$ or Type I loss) and the rate at which A tags are subsequently shed (${}_{A}S$ or Type II loss) are computed from a linear regression of tag retention on time (Myhre 1966). The equation is:

$$\log \left[{}_{A+B}N_i / ({}_{A+B}N_i + {}_{B-A}N_i)\right]$$

where: ${}_{A+B}N$ = Number of fish recovered with both tags.
${}_{B-A}N$ = Number of fish recovered with B tag only.
$1 - {}_{A}K$ = Portion of A tags which were detected and survived immediate tag shedding.
$1 - {}_{A}S$ = Portion of A tags retained during each time interval.
i = Midpoint of the respective time interval.

The quantity ${}_{A+B}N_i / ({}_{A+B}N_i) + ({}_{B-A}N_i)$ is an estimate of the proportion of A tags retained at time i; therefore, the regression provides estimates of tag retention rates, the compliments of which are loss rates. Estimates of B tag Type I and II losses were obtained by exchanging A and B in the equation. Confidence limits on the loss estimates were calculated by standard regression procedures (Steel and Torrie 1960).

Tag returns were grouped by 122 day intervals for the first 2 years and by 1 year intervals thereafter.

EVALUATION OF ASSUMPTIONS

The validity of the shedding estimates depends on several assumptions (Myhre 1966):

(1) Loss or non-detection of one tag is independent of the loss or non-detection of the other.

Chi-square analysis indicates the return rate of A tags from double-tagged fish was not significantly different than the return rate of A tags from single-tagged fish (Table 1). Hence, A tag loss was independent of B tag loss. Single B tags were not released, so the dependency of B tags on A tags cannot be tested. However, there is no reason to expect loss or non-detection of B tags to be dependent on A tag loss.

TABLE 1. Chi-square Analysis of A Tag Returns From Double- and Single-Tagged Striped Bass, April 1969–1976.

	Returned		*Not Returned*		
	Observed	*Expected*	*Observed*	*Expected*	*Total*
Single-tagged fish	310	316.27	854	847.73	1164
Double-tagged fish	322	315.73	840	846.27	1162
Total	632		1694		2326

$\chi^2 = 0.289$, d.f. = 1, $0.500 < P < 0.750$

(2) Shedding loss occurs at an average or uniform rate.

Visual examination of the data (Figure 1) suggests tag retention for both A and B tags was relatively uniform for the first 4 years. Between 4 and 7 years, however, the data were quite variable. Consequently, this assumption may not have been fulfilled after 4 years, so I limited my analysis to the first 4 years.

(3) Non-detection loss results in the failure to recover the same proportion of each tag type.

Both tags were prominently located and of the same size and material. So, non-detection was probably equal.

(4) Likelihood of recapture is independent of number and tag type.

The return rate for double-tagged fish was not significantly different from the return rate for single-tagged fish ($P < 0.250$) (Table 2). Thus, both groups were equally vulnerable to capture.

TABLE 2. Chi-square Analysis of Returns of Double- and Single-Tagged Striped Bass, April 1969–1976.

	Returned		*Not Returned*		
	Observed	*Expected*	*Observed*	*Expected*	*Total*
Single-tagged fish	310	323.78	854	840.22	1164
Double-tagged fish	337	323.22	825	838.78	1162
Total	647		1679		2326

$\chi^2 = 1.510$, d.f. $= 1$, $0.100 < P < 0.250$

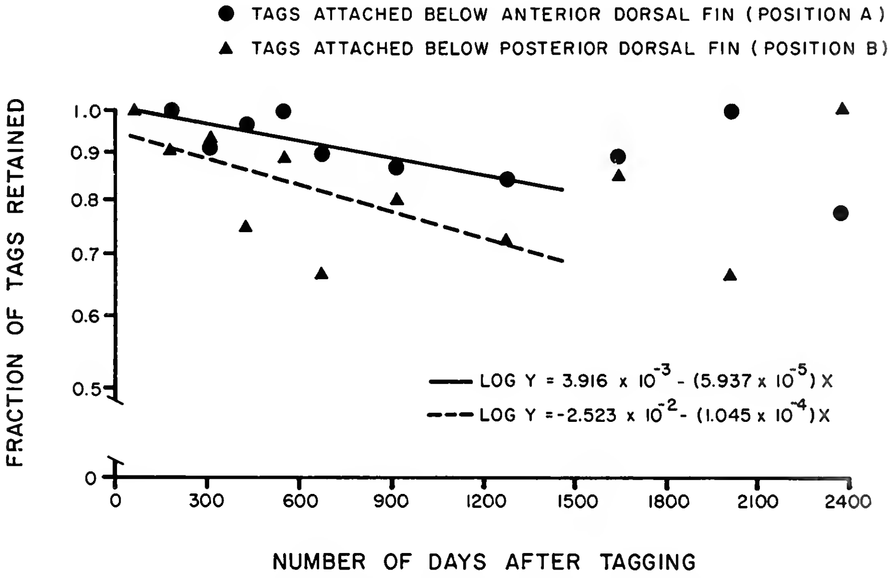

FIGURE 1. Fraction of disk-dangler tags retained by striped bass in the Sacramento-San Joaquin Estuary, California, April 1969–76. Data grouped in 122 (through 732) and 366 (733-2,562) day intervals. Numbers in parentheses indicate number of fish from which tags were obtained.

SHEDDING RATES

Tags were recovered from 337 of the double-tagged fish within 7 years of release. Anglers returned tags from 317 of these fish and the other 20 fish were observed during subsequent tagging operations. Most (279) of these bass were recaptured with both tags present. Fifteen fish were recaptured with A tag missing and 43 were recaptured with B tag missing. No losses of either tag were observed through the first 122 days. Five fish were recovered between 123 and 244 days after tagging with B tags missing. An A tag loss was not observed until 362 days after tagging. Chi-square analysis of the return data indicates A tags were retained significantly better than B tags (Table 3).

TABLE 3. Chi-square Analysis of Returns of Double-Tagged Striped Bass With One and Two Tags, April 1969–1976.

	Tags Retained		*Tags Lost*		
	Observed	*Expected*	*Observed*	*Expected*	*Total*
A Tags	283	270.50	11	23.50	294
B Tags	258	270.50	36	23.50	294
Total	541		47		588

$\chi^2 = 13.320$, d.f. = 1, $P < 0.005$

The difference in tag shedding is reflected in the estimates of the proportion of tags experiencing Type I and Type II losses during the first 4 years after tagging. No A tags (95% C.I. = −4.5 to 2.5%) experienced Type I losses (Table 4). Thereafter, 4.9% (95% C.I. = 1.6 to 8.0%) of the A tags were lost (Type II) each year. Estimated losses of B tags, on the other hand, were 5.6% initially (95% C.I. = −3.8 to 14.2%) and 8.4% annually thereafter (95% C.I. = −0.4 to 16.5%).

TABLE 4. Estimates of the Portion of Disk-Dangler Tags on Striped Bass Undetected or Lost Immediately (Type I Loss) and Loss Per Year (Type II Loss), Up to 4 Years After Tagging, April 1969–1973.

	Tag Position	
	A	*B*
Type I loss	−0.009	+0.056
Variance	3.032×10^{-4}	1.282×10^{-3}
95% C.I.	−0.045 to +0.025	−0.038 to +0.142
Type II loss	+0.049	+0.084
Variance	2.680×10^{-10}	2.017×10^{-9}
95% C.I.	+0.016 to +0.080	−0.004 to +0.165

DISCUSSION

Results of the 1969 double-tagging experiment indicate no disk-dangler tags attached beneath the first dorsal fin experienced a Type I loss, but 4.9% were shed annually up to 4 years after tagging. B tags, on the other hand, experienced Type I losses and were shed almost twice as fast as A tags each year up to 4 years. This difference may be partly due to anatomical differences between the two dorsal fins. Ptergiophores of the anterior dorsal fin (A position) are more substantial than those of the posterior dorsal fin (B position), thus providing a more secure attachment. Additionally, muscle action due to swimming is less pronounced near the anterior dorsal fin, resulting in less tag movement, and tags in B position may be more susceptible to becoming entangled in debris. Except for this experiment, all bass tagging in the estuary since 1958 has been done with tags in the A position, so B tag shedding does not affect results of the mark-recapture studies.

Limiting the analysis to returns during the first 4 years may have caused an overestimate of A tag shedding. Although returns were erratic, all tag retention estimates for years 5 through 7 were higher than an extrapolation of the regression line for the first 4 years (Figure 1). A regression calculated from all data yields an annual shedding rate of 2.3%

The A tag annual loss rate of 4.9% indicates about 2.5% of the tags are shed by mid-year. The percentage loss at that time is a reasonable estimate of the reduction in tag returns over the first year attributable to shedding. Hence, population abundance (Stevens 1977) and harvest rates (Chadwick 1968; Miller 1974) based on first year returns are underestimated by about 2.5%. Annual natural mortality rates would be overestimated to the same degree as harvest rates are underestimated. Estimates of annual survival (Chadwick 1968) are unaffected by shedding. When recapture data are accumulated during subsequent years, bias due to shedding should gradually increase. However, these effects are not apparent (Stevens 1977).

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TAXONOMY OF THE COLORADO CUTTHROAT TROUT (*Salmo clarki pleuriticus*) OF THE WILLIAMSON LAKES, CALIFORNIA

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We have examined 13 meristic characteristics, 19 morphometric measurements, coloration and spotting, and dentition from 21 specimens of cutthroat trout from the Williamson Lakes of the southern Sierra Nevada, California. According to records of the California Department of Fish and Game, these trout are descendant from fertilized eggs of the Colorado cutthroat trout, *Salmo clarki pleuriticus,* which were taken in 1931 from Trapper's Lake, Colorado. A comparison of selected meristic characteristics revealed no differences between the Williamson Lakes cutthroat trout and *S. c. pleuriticus* from Colorado, Wyoming, and Utah. Life colors, spotting, and the presence of basibranchial dentition also identify the Williamson Lakes cutthroat trout as *S. c. pleuriticus.* The similarities between the Williamson Lakes *pleuriticus* and those from present day Trapper's Lake suggest that the stocking of Trapper's Lake (subsequent to the California transplant) with Yellowstone cutthroat trout, *S. c. lewisi,* has had no detectable effect on the native Trapper's Lake *pleuriticus* population.

INTRODUCTION

Cope (1872) first described the Colorado cutthroat trout on the basis of specimens taken from the Green River basin in Wyoming, and from several streams in Idaho and Montana. He named the trout "*Salmo pleuriticus*", and believed it to be the native form of the Colorado—Green River drainage. At present, *pleuriticus* is recognized as a subspecies of the polytypic inland cutthroat trout, *Salmo clarki* (Miller 1950).

The past distribution of *S. c. pleuriticus* apparently included the upper Green and Colorado River system of Wyoming, Colorado, Utah, and New Mexico (Behnke 1970, 1974, 1975). The southernmost distribution of *pleuriticus* was the Dirty Devil River in Utah to the west, and the San Juan River in New Mexico to the east. Reports of *pleuriticus* from the Little Colorado River in Arizona are considered erroneous (Behnke 1974). Phenotypically pure populations of *pleuriticus* presently exist only in a few, isolated headwater tributary streams in a small part of its native range (Behnke 1974; Behnke and Zarn 1976). Taxonomic information on *pleuriticus* is limited to the early observations of Cope (1872) and Jordan (1891) and to the recent studies of Behnke (1970, 1974, 1975). In this note, we present taxonomic data on a population of *pleuriticus* which was transplanted from Colorado to California.

According to records of the California Department of Fish and Game, 30,000 fertilized trout eggs were taken in 1931 from Trapper's Lake, Colorado, and the resulting fry stocked in the five barren Williamson Lakes of the southern Sierra Nevada, Inyo County, California. In 1931, Trapper's Lake apparently contained pure *pleuriticus,* although Yellowstone cutthroat trout (*S. c. lewisi*) subsequently stocked in Trapper's Lake may have hybridized with the native *pleuriticus* population (Snyder and Tanner 1960; but see Behnke 1974). We have examined 21 specimens from the Williamson Lakes to compare with pure *pleuriticus* populations from Colorado, Wyoming, and Utah. The purposes of this study were to document the occurrence of pure *S. c. pleuriticus* in the Williamson Lakes, to add to the limited taxonomic data on the subspecies, and to assess whether the existing Trapper's Lake *pleuriticus* population might have been affected by the introduction of *S. c. lewisi.*

METHODS

The 21 specimens were collected by the California Department of Fish and Game on September 11, 1974, from the lower three of the five Williamson Lakes. Counts of meristic characters and morphometric measurements followed Hubbs and Lagler (1947). The latter were converted to permillage proportions of standard length. Vertebrae, interneurals, interhaemals, and epurals were counted from radiographs. Life colors and other pigmentation traits were observed from color slides and photographs (courtesy of E. P. Pister of the California Department of Fish and Game), and from the preserved specimens. Basibranchial dentition was examined using a staining technique suggested by R. J. Behnke (cited in Gold 1977).

To normalize the morphometric data, the permillage proportions were transformed to arcsin values (see Gold 1977). Means of taxonomic characters for males and females were subjected to "t" tests, each having 19 degrees of freedom.

RESULTS AND DISCUSSION

No sexual dimorphism for 13 meristic characters (Table 1) was revealed by the "t" tests. The means and ranges of 12 characters for both sexes combined are similar to those reported for other subspecies of *S. clarki* except the lacustrine-adapted *S. c. henshawi* (Behnke and Zarn 1976). The high mean number of scales in the lateral series ($\overline{X} = 188.9$) is a characteristic trait of *pleuriticus.* Among other western *Salmo,* only *S. c. stomias* of the Arkansas and Platte rivers and *S. aguabonita* of the Kern River are as finely scaled (Dieffenbach 1966, Behnke 1969, 1973; Gold and Gall 1975*a, b*; Behnke and Zarn 1976).

TABLE 1. Meristic Characteristics of 21 Cutthroat Trout from the Williamson Lakes, California.†

Character	*Females (n = 10)*	*Males (n = 11)*	*Combined (n = 21)*
Fork length (cm)	23.4 ± 0.9 (19.0–27.3)	22.0 ± 1.0 (15.8–28.1)	22.7 ± 0.6 (15.8–28.1)
Pyloric caecae	39.7 ± 0.4 (37–41)	38.0 ± 1.2 (30–45)	38.8 ± 0.7 (30–45)
Dorsal rays	11.2 ± 0.1 (11–12)	11.2 ± 0.2 (10–12)	11.2 ± 0.1 (10–12)

Anal rays	11.0 ± 0.2 (10–12)	10.7 ± 0.1 (10–11)	10.9 ± 0.1 (10–12)
Pectoral rays	14.6 ± 0.2 (13–15)	14.4 ± 0.1 (14–15)	14.5 ± 0.1 (13–15)
Pelvic rays	9.2 ± 0.1 (9–10)	9.0 ± 0.0 (9–9)	9.1 ± 0.1 (9–10)
Branchiostegal rays (left)	11.3 ± 0.2 (10–12)	11.3 ± 0.2 (10–12)	11.3 ± 0.1 (10–12)
Vertebrae	61.6 ± 0.2 (60–63)	61.6 ± 0.2 (61–63)	61.6 ± 0.1 (60–63)
Gill rakers (left)	20.5 ± 0.4 (18–22)	20.3 ± 0.3 (19–22)	20.4 ± 0.3 (18–22)
Scales in lateral line	126.0 ± 1.3 (121–134)	126.5 ± 1.1 (119–133)	126.2 ± 0.8 (119–134)
Scales in lateral series	186.9 ± 2.9 (173–203)	190.7 ± 2.3 (180–209)	188.9 ± 1.8 (173–209)
Interneurals	13.1 ± 0.2 (12–14)	13.3 ± 0.2 (12–14)	13.2 ± 0.1 (12–14)
Interhaemals	12.8 ± 0.2 (12–14)	12.5 ± 0.1 (12–13)	12.6 ± 0.1 (12–14)
Epurals	2.6 ± 0.2 (2–3)	2.8 ± 0.1 (2–3)	2.7 ± 0.1 (2–3)

† Data are shown as mean ± standard error, with ranges shown below in parentheses.

Significant sexual dimorphism in six morphometric characteristics was indicated by the "t" tests: body depth, head length, distance from occiput to snout tip, maxillary length, width of gape, and length of anal fin base (Table 2). In all but length of anal fin base, the values for males exceeded those of females.

TABLE 2. Permillage Proportions of 21 Cutthroat Trout from the Williamson Lakes, California.†

Measurement	*Females (n = 10)*	*Males (n = 11)*	*Pooled s. e.††*	*"t"*
Standard length (cm)	16.6–24.2 (20.6)	13.8–25.0 (19.5)	1.221	0.93
Body depth	196–238 (215)	221–254 (239)	0.414	−3.89**
Head length	227–258 (245)	235–275 (259)	0.325	−2.83*
Head width	99–114 (106)	101–121 (111)	0.229	−1.88
Interorbit, least width	57–63 (60)	51–72 (64)	0.210	−1.76
Occiput to snout, length	155–176 (168)	165–190 (176)	0.284	−2.29*
Maxillary length	98–118 (111)	104–149 (123)	0.387	−2.87**
Caudal peduncle length	155–175 (162)	159–174 (166)	0.187	−1.76
Caudal peduncle depth	99–114 (104)	99–115 (108)	0.188	−1.70
Width of gape	132–164 (145)	138–187 (160)	0.436	−2.71*
Predorsal length	462–525 (486)	473–514 (497)	0.389	−1.64
Preanal length	726–773 (748)	726–780 (750)	0.455	−0.26
Prepectoral length	206–239 (224)	215–251 (233)	0.296	−2.03
Prepelvic length	519–559 (539)	525–577 (547)	0.409	−1.12
Dorsal fin base length	121–148 (131)	118–147 (131)	0.325	0.00
Anal fin base length	109–128 (120)	103–119 (112)	0.250	3.00**
Pectoral fin length	158–176 (166)	159–184 (172)	0.236	−1.86
Pelvic fin length	125–148 (136)	127–148 (141)	0.282	−1.49
Preadipose length	835–868 (849)	835–869 (853)	0.391	−0.84
Eye diameter	44–56 (49)	44–58 (50)	0.230	−0.26

† For each proportion, the range is shown, followed by the mean in parentheses.

†† Pooled standard errors for "t" tests were computed using a weighted analysis for unequal sample size and using arcsin transformed means.

* $P < .05$; ** $P < .01$.

Detailed morphometric data on western *Salmo* are generally lacking, and some authors (e.g. Schreck and Behnke 1971) feel that these characters have little discriminatory value in western *Salmo* taxonomy. However, comparing morphometric characteristics of *S. c. pleuriticus* from Williamson Lakes with those of *S. gairdneri* (Needham and Gard 1959) and *S. apache* (Miller 1972), we found that *pleuriticus* has a narrower head than both *S. gairdneri* and *S. apache,* and is shorter than *S. apache* in occiput to snout tip length, head length, length of dorsal fin base, and pectoral and pelvic fin lengths.

All 21 specimens from Williamson Lakes had well developed basibranchial teeth ($\overline{X} = 12.5$, range = 2–22). The teeth were arranged fairly uniformly, usually in 1 to 3 anterior to posterior rows. The unusal glossohyal teeth, found occasionally on the undescribed redband trout and rarely on *S. aguabonita* (Gold 1977), were not observed.

Life colors and spotting of *S. c. pleuriticus* from Williamson Lakes are similar to those described by Behnke (1970, 1974) for *S. c. pleuriticus.* The ventral region is a bright, almost gaudy crimson. Laterally, the colors become bronze-gold with overlying shades of light red. The blood-red cutthroat marks are conspicuous. Spots on the body are large, pronounced, and concentrated posteriorly; they are most numerous on the caudal peduncle. Spots on the dorsal, anal, and particularly the caudal fins are numerous (Figure 1).

Figure 1. *S. c. pleuriticus* from Williamson Lakes, California. *Photograph by E. P. Pister, 1974.*

No apparent differences in meristic characters exist between *S. c. pleuriticus* from Williamson Lakes and *S. c. pleuriticus* from Wyoming, Colorado, and Utah (Table 3). In conjunction with the similarities in coloration and spotting, and the presence of basibranchial dentition, we conclude that the Williamson Lakes trout are a phenotypically pure population of *S. c. pleuriticus.* We also note that the similarities between the Williamson Lakes *pleuriticus* and those from present-day Trapper's Lake, particularly in the distinctive lateral series scale count (Table 3), suggest that the stocking of Trapper's Lake with *S. c. lewisi* apparently has had no detectable effect on the purity of the native *pleuriticus* population.

TABLE 3. Selected Meristic Characters from Colorado Cutthroat Trout of the Colorado-Green River Drainage and Williamson Lakes, California. †

Character	*Vertebrae*	*Gill rakers*	*Pyloric caecae*	*Scales in lateral series*
Location				
Rock Creek, Wyoming	60–64 (62.0) n = 14	18–20 (18.8) n = 14	27–46 (35.4) n = 14	175–200 (187.3) n = 14
North Fork Beaver Creek, Wyoming	60–62 (61.4) n = 14	18–22 (20.2) n = 15	35–44 (39.4) n = 15	163–197 (182.3) n = 15
Douglas Creek, Wyoming	61–63 (62.0) n = 14	18–21 (19.4) n = 14	31–42 (37.1) n = 14	159–197 (178.6) n = 14
Little West Fork Black Fork, Utah	61–63 (62.2) n = 21	18–21 (19.1) n = 10	32–41 (37.4) n = 10	164–204 (185.4) n = 10
Trapper's Lake, Colorado	59–63 (60.5) n = 24	18–22 (20.1) n = 15	32–41 (37.4) n = 15	162–204 (185.4) n = 15
Williamson Lakes, California	60–63 (61.6) n = 21	18–22 (20.4) n = 21	30–45 (38.8) n = 21	173–209 (188.9) n = 21

† All data except for Williamson Lakes are from Behnke (1970, 1975). Data are shown as ranges, means (in parentheses), and sample sizes.

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AN ANALYSIS OF FISH CATCHES OBTAINED WITH AN OTTER TRAWL IN SANTA MONICA BAY, 1969–73 [1]

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Studies of the benthic biota in Santa Monica Bay from the period of April 1, 1969, to July 13, 1973, are summarized and reported. Five hundred ninety-six hauls were completed with an 8-m (26-ft) otter trawl. Depths sampled ranged from 5 to 198 m (17 to 653 ft). One hundred and nine species of fishes were identified. A coefficient of community analysis was calculated to compare catches of fishes taken in four different areas of the bay. Three distinctly different assemblages of fishes were defined by this analytical method. This method was employed to compare the catches made in one area in 1971 with catches made in 1972. No significant differences were determined in the species diversity present from one year to the next. A test of the otter trawl as a sampling device was undertaken. It was concluded that under the conditions employed, approximately 100 hauls, timed to include each season, were needed to obtain specimens of about 95% of those catchable species of fishes on an area of soft bottom in Santa Monica Bay.

INTRODUCTION

During 1973, approximately 340 million gallons of sewage per day (mgd) were discharged into Santa Monica Bay, California; 240 mgd by way of a 5-mile effluent outfall line, and 100 mgd by way of a 7-mile sludge outfall line. This is the majority of the domestic and industrial waste of the City of Los Angeles (Southern California Coastal Water Research Project [SCCWRP] 1973). Waste input has increased steadily to the current rate of discharge since 1894 when the first sewage outfall began to discharge into this bay (Tillman and Bargman 1973).

Ulrey and Greeley (1928) provided some data on fish species caught in Santa Monica Bay. In a more recent study, Carlisle (1969) attempted to demonstrate the effects of wastes on the demersal fishes of the bay. He concluded that the spreckled sandab, *Citharichthys stigmaeus,* was attracted to the sludge outfall and avoided the effluent outfall. In addition, the yellowchin sculpin, *Icelinus quadriseriatus,* and the California tonguefish, *Symphurus atricauda,* tended to avoid the effluent outfall. Carlisle also noted a considerable annual variation in the average catch per haul but was unable to relate the catch data to the waste discharge. In an analysis of trawl catches similar to the present study, Day and Pearcy (1968) used indices of similarity to prepare a trellis diagram which revealed that four defined associations of benthic fishes were present on the continental shelf and slope off Oregon. Recently, computer techniques have been used to identify some associations of fishes in southern California coastal waters, and the distributions of these associations in local waters, as indicated by sampling with trawl nets, have been mapped (SCCWRP 1973). Similar computer analyses of the demersal fish populations of San Pedro Bay have been made by Stephens, Gardiner, and Terry (1973).

Water quality in Santa Monica Bay is expected to change markedly in the next few years as a result of compliance with the Water Quality Plan for waste waters

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adopted by the State of California in 1972 which, in part, proposes to ban the discharge of chlorinated hydrocarbons, heavy metals, and sludge into marine waters (California State Water Resources Control Board 1972). Thus, this may be a suitable time for an attempt to demonstrate the anticipated effects of an improvement in waste treatment on the local bottomfish community. This paper describes the first step in such a study.

A simple, qualitative method, which seemed adequate to detect major differences in fish communities, was used to analyze otter trawl samples from waters within the zone influenced by the waste field in Santa Monica Bay. As the water quality changes, we plan to use this method to monitor quantitative changes in the fish biota of the bay.

This analysis is a by-product of collecting specimens of marine animals for research programs and would not have been possible without the cooperation of the California Department of Fish and Game which permitted us to work in a bay that is closed to commercial trawling.

The data reported are for stations at which this specimen collecting was conducted, and they (stations) were not selected to represent a particular dilution zone with regard to the influence of the waste field. However, our sample stations are within the area around the sewage outfall monitored by the City of Los Angeles (SCCWRP 1973), indicating that they are within the dilution zone of the discharge.

METHODS

Trawling was conducted from the "PISCES", an 8-m (26-ft) fishing vessel provided with a flasher/recorder depth meter, omnigator (VHF-FM radio direc-

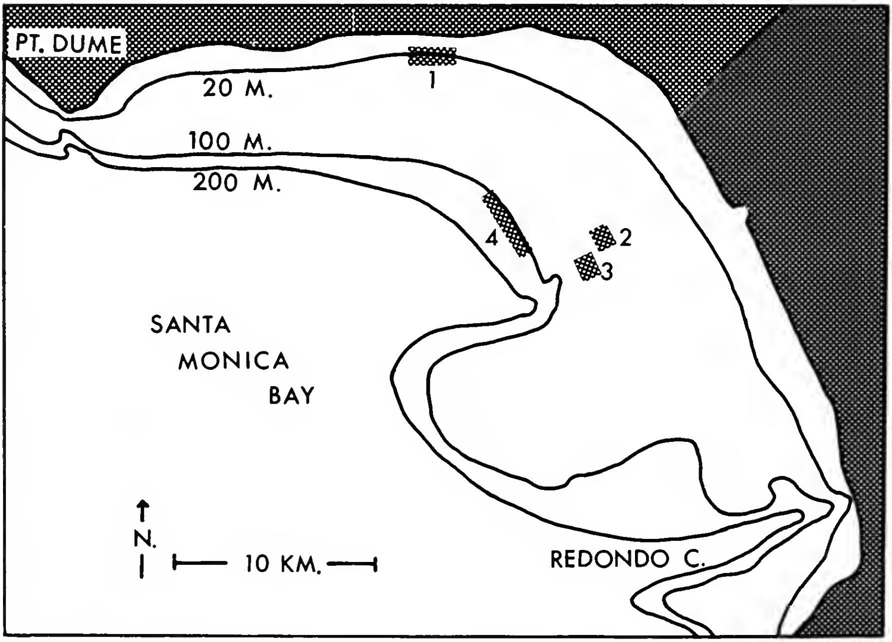

FIGURE 1. Locations of the four study areas selected for the coefficient of community analyses.

tion finder), and hydrographic winch, which was used to lower and retrieve an 8-m (26-ft) otter trawl. The body of the net had a stretch mesh of 3.8 cm (1.5 inches) with a liner of 1.3-cm (0.5-inch) stretch mesh. The dimensions of the otter trawl boards were 86 x 38 cm (34 x 15 inches). The area of study extended from Dume Submarine Canyon to the Redondo Submarine Canyon (Figure 1). Depths sampled ranged from 5 to 198 m (17 to 653 ft). A cable scope of 5:1 (length of cable:depth) was used at depths of 20 m (66 ft) or less and a ratio of 4:1 was used at greater depths. The study period extended from April 1, 1969, to July 13, 1973. The duration of each trawl was 15 min measured from the time the net was on the bottom to when the winch was started to pull in the net. The towing speed was one knot. The catch obtained was sorted, fish species present noted, and the catch returned to the water. Any species not recognized was returned to the laboratory for identification, using Miller and Lea (1972) or previously published works.

In addition to this general survey, four specific study areas were selected for a coefficient of community analysis by selecting 15 hauls from each study area (Figure 1, Table 1). Areas 1, 2, 3, and 4 were 13 km (7.8 miles), 333°; 3 km (1.8 miles), 358°; 2½ km (1.5 miles), 338°; and 5½ km (3.3 miles), 315° (True), respectively, from the end of the effluent outfall.

TABLE 1. Location, Depths and Sampling Periods of Hauls Selected for Coefficient of Community Analyses.

Area	*Location*	*Coordinates*	*Depth (m)*	*Sampling Period*
1	Off Big Rock	118°36'W 34°02'N	15–22 m	May 3, 1970–May 27, 1971
2	Off Venice	118°31'W 33°57'15'N	37–48 m	Nov. 23, 1970–Jan. 20, 1972
3	Off Marina Del Rey	118°32'W 33°56'N	55–64 m	Feb. 25, 1971–Aug. 17, 1971
	Off Marina Del Rey	118°32'W 33°56'N	51–59 m	Aug. 2, 1972–Nov. 8, 1972
4	West Side of Santa Monica Submarine Canyon	118°34'30"W 33°57'30"N	99–121 m	Aug. 6, 1970–Feb. 25, 1971

The coefficient of community analysis is defined as the percentage of species which are common to any two samples, and is calculated according to the following equation:

$$\text{Coefficient of community} = c/a + b - c \times 100$$

where "a" is the number of species in the first sample, and "b" is the number of species in the second sample, and "c" is the number of species common to both samples (Johnson and Brinkhurst 1971). This analysis does not consider the relative abundance of the species present, thus the presence of one specimen of a less common species is given a status (present) equivalent to that of a species which may be present in abundance. In order to reduce this bias, only those fish which occurred in over one-half the catches in each of the four study areas were included in the coefficient of community analysis. The 15 hauls from each of the four study areas were arranged in order of increasing depth on a trellis diagram, and the coefficient of community calculated for all possible haul pairs (1770 pairs). A coefficient of 50 or more was taken as representative of a high degree of similarity between two hauls. For example, a coefficient of community of 50 results if two catches containing six species each have four species in common. This level was appropriate for the present study since sets of data from the same area (where similarity should be high) generally had values over 50, while sets from different areas (where similarity should be low) generally did not. Mean coefficients of community and standard deviations were also determined for each study area and for the comparisons between study areas.

A coefficient of community analysis also was conducted to compare the catches made in Area 3 from February 25 to August 17, 1971, with catches made in the same area more than 1 year later (August 2 to November 8, 1972).

RESULTS AND DISCUSSION

Five hundred and ninety-six hauls were made, resulting in a total of 109 identified species of fishes (Table 2). Unidentified juvenile rockfishes, *Sebastes* spp., were not included in the analysis. Eighty-seven of the species obtained in the present study also were reported by Carlisle (1969), who recorded a total of 104 species. It is not too surprising that only 87 of the species were common in both studies. The differences between these two studies are accounted for by apparently rare species which were represented by only a few specimens in one survey and were absent in the other. Thus, Carlisle listed 30 species which were represented by five or fewer individuals, and of these, only 17 were obtained in the present study, while 22 species collected by us were not reported by Carlisle (1969). It is of historical interest to note that Ulrey and Greeley (1928) reported taking 27 species of fishes by trawl in Santa Monica Bay. However, the fact that they made far fewer hauls (64) in a narrower depth range of 5 to 92m (17 to 304 ft) with less restrictive gear than that used by the present study, may well account for the low number of species reported by them.

TABLE 2. Fish Species Trawled in Santa Monica Bay

Scientific name	*Common name*	*Depth (m)*
Agonopsis sterletus *	Southern spearnose poacher	40
Amphistichus argenteus	Barred surfperch	9–16
Anisotremus davidsonii	Sargo	7–11
Anoplopoma fimbria *	Sablefish	55–110
Aprodon cortezianus *	Bigfin eelpout	51–198
Argentina sialis *	Pacific argentine	27–110
Artedius notospilotus *	Bonyhead sculpin	15
Atherinops affinis	Topsmelt	27
Brosmophycis marginata *	Red brotula	51–79
Caulolatilus princeps	Ocean whitefish	20
Cheilotrema saturnum	Black croaker	7–11
Chilara taylori *	Spotted cusk-eel	11–113
Chitonotus pugetensis *	Roughback sculpin	37–49
Citharichthys sordidus *	Pacific sanddab	44–188
Citharichthys stigmaeus *	Speckled sanddab	16–108
Citharichthys xanthostigma *	Longfin sanddab	22–113
Coryphopterus nicholsii *	Blackeye goby	22–84
Cymatogaster aggregata *	Shiner surfperch	5–108
Damalichthys vacca *	Pile surfperch	7–22
Embiotoca jacksoni *	Black surfperch	7–49
Embiotoca lateralis	Striped surfperch	15
Engraulis mordax *	Northern anchovy	7–27
Eopsetta jordani *	Petrale sole	46–104

Genyonemus lineatus *	white croaker	7–92
Glyptocephalus zachirus *	Rex sole	68-188
Heterodontus francisci *	Horn shark	7–46
Heterostichus rostratus *	Giant kelpfish	9–20
Hexagrammos decagrammus	Kelp greenling	37
Hippoglossina stomata *	Bigmouth sole	13–183
Hydrolagus colliei *	Ratfish	44–198
Hyperprospon argenteum *	Walleye surfperch	9–27
Hypsopsetta guttulata *	Diamond turbot	5–20
Hypsurus caryi *	Rainbow surfperch	7–22
Icelinus fimbriatus *	Fringed sculpin	33
Icelinus quadriseriatus *	Yellowchin sculpin	18–134
Icelinus tenuis *	Spotfin sculpin	7
Icosteus aenigmaticus	Ragfish	73–132
Lepidogobius lepidus *	Bay goby	22–95
Leptocottus armatus	Staghorn sculpin	9–64
Leuroglossus stilbius	California smoothtongue	40–115
Lycodopsis pacifica *	Blackbelly eelpout	48
Lyconema barbatum *	Bearded eelpout	168
Lyopsetta exilis *	Slender sole	90–198
Macrorhamphosus gracilis	Slender snipefish	55
Menticirrhus undulatus	California corbina	5–9
Merluccius productus *	Pacific hake	82–102
Microstomus pacificus *	Dover sole	18–198
Myliobatis californicus	Bat ray	7–20
Neoclinus blanchardi *	Sarcastic fringehead	40
Neoclinus uninotatus	Onespot fringehead	13–55
Ondontopyxis trispinosa *	Pygmy poacher	15–73
Otophidium scrippsi *	Basketweave cusk-eel	11–66
Oxylebius pictus *	Painted greenling	7–11
Oxyjulis californica	Senorita	11
Paralabrax clathratus *	Kelp bass	7–20
Paralabrax nebulifer *	Barred sand bass	7–9
Paralichthys californicus *	California halibut	7–20
Parophrys vetulus *	English sole	13–113
Peprilus simillimus *	Pacific butterfish	7–40
Phanerodon furcatus *	White surfperch	5–70
Platyrhinoidis triseriata *	Thornback	7–51
Pleuronichthys coenosus *	C-O turbot	20–53
Pleuronichthys decurrens *	Curlfin turbot	9–84
Pleuronichthys ritteri *	Spotted turbot	9–31
Pleuronichthys verticalis *	Hornyhead turbot	7–95
Porichthys myriaster *	Specklefin midshipman	11–37
Porichthys notatus *	Plainfin midshipman	18–183
Radulinus asprellus *	Slim sculpin	97
Raja kincaidii *	Sandpaper skate	135
Raja stellulata	Starry skate	104–115
Ramphocottus richardsoni *	Grunt sculpin	55–90
Rathbunella hypoplecta *	Smooth ronquil	92
Rhacochilus toxotes *	Rubberlip surfperch	7–22
Rhinobatos productus *	Shovelnose guitarfish	7–22
Scorpeana guttata *	Sculpin	11–81
Scorpaenichthys marmoratus *	Cabezon	9–20
Sebastes alutus *	Pacific ocean perch	27–82
Sebastes auriculatus *	Brown rockfish	37
Sebastes carnatus	Gopher rockfish	7
Sebastes chlorostictus *	Greenspotted rockfish	97
Sebastes constellatus *	Starry rockfish	82
Sebastes diploproa *	Splitnose rockfish	110
Sebastes elongatus *	Greenstriped rockfish	31–198

Sebastes flavidus	Yellowtail rockfish	24–101
Sebastes goodei *	Chilipepper	55–198
Sebastes helvomaculatus	Rosethorn rockfish	165
Sebastes levis *	Cowcod	31–135
Sebastes miniatus *	Vermillion rockfish	18–101
Sebastes mystinus	Blue rockfish	11–55
Sebastes paucispinis *	Bocaccio	11–198
Sebastes ruberrimus	Yelloweye rockfish	84
Sebastes rubrivinctus *	Flag rockfish	49–93
Sebastes saxicola *	Stripetail rockfish	31–92
Sebastes semicinctus *	Halfbanded rockfish	20–134
Sebastes serranoides *	Olive rockfish	92
Sebastes spp.*	Unidentified juvenile rockfish	9–183
Sebastes vexillaris *	Whitebelly rockfish	27–93
Seriphus politus *	Queenfish	7–27
Squalus acanthias *	Spiny dogfish	7–27
Sygnathus sp.*	Pipefish	5–95
Symphurus atricauda *	California tongufish	11–183
Synodus lucioceps *	California lizardfish	7–192
Torpedo californica *	Pacific electric ray	7–115
Triakis semifasciata	Leopard shark	7–11
Xeneretmus latifrons *	Blackedge poacher	44–198
Xeneretmus triacanthus *	Bluespotted poacher	15–57
Xystreurys liolepis *	Fantail sole	15–27
Zalembius rosaceus *	Pink surfperch	18–113
Zaniolepis frenata *	Shortspine combfish	40–198
Zaniolepis latipinnis *	Longspine combfish	18–110

* also taken by Carlisle.

Lists were made of the fish species taken in the 15 coefficient of community hauls selected from each of the four study areas and the frequency of occurrence of each species noted (Table 3). It was observed that 12, 9, 7, and 6 species were present in over one-half the catches in areas 1, 2, 3, and 4, respectively. Eighteen species were caught over 50% of the time in one or more of the study areas, and of these 18 species, nine were present in all of the study areas in at least one haul. Four species were limited to only one study area. The white surfperch, *Phanerodon furcatus,* and the black surfperch, *Embiotoca jacksoni,* were found only in area 1, and the slender sole, *Lyopsetta exilis,* and the rex sole, *Glyptocephalus zachirus,* were found only in area 4. These differences are undoubtedly due primarily to differences in the depth and bottom type preferences of the species involved.

TABLE 3. Frequency of Occurrence of Fish Species Taken in the Hauls Used in Coefficient of Community Analysis.

	Frequency of occurrence (%)				
Species	*Area 1*	*Area 2*	*Area 3 1971*	*Area 3 1972*	*Area 4*
Symphurus atricauda	93.3	100.0	53.3	80.0	6.7
Icelinus quadriseriatus	86.7	100.0	73.3	86.7	6.7
Phanerodon furcatus	80.0				
Citharichthys stigmaeus	80.0	100.0	93.3	86.7	46.7
Zalembius rosaceus	73.3	53.3	46.7	66.6	20.0
Zaniolepis latipinnis	73.3	86.7	66.6	53.3	13.5
Synodus lucioceps	73.3	6.7	6.7	6.7	

Porichthys notatus	66.6	80.0	93.3	80.0	100.0
Embiotoca jacksoni	66.6				
Parophrys vetulus	60.0	6.7	86.7	53.3	66.6
Genyonemus lineatus	60.0		13.5		
Scorpaena guttata	60.0	6.7	6.7	20.0	
Hyperprospon argenteum	40.0				
Sygnathus sp.	40.0	26.7			
Paralichthys californicus	33.3				
Cymatogaster aggregata	26.7		33.3	53.3	
Pleuronichthys ritteri	20.0		6.7		
Otophidium scrippsi	13.5				
Hypsurus caryi	13.5				
Microstomus pacificus	6.7	66.6	93.3	86.7	100.0
Hypsopsetta guttalata	6.7				
Paralabrax clathratus	6.7				
Seriphus politus	6.7				
Squalus acanthias	6.7				
Porichthys myriaster	6.7	6.7			
Damalichthys vacca	6.7		6.7		
Xystreurys liolepis	6.7				
Heterodontus francisci	6.7				
Leptocottus armatus	6.7				
Lepidogobius lepidus	6.7	60.0	6.7		13.5
Pleuronichthys decurrens		66.6	13.5	20.0	
Sebastes miniatus		33.3		6.7	
Pleuronichthys verticalis		33.3		46.7	
Odontopyxis trispinosus		26.7		20.0	
Zaniolepis frenata		26.7	6.7	6.7	66.6
Hippoglossina stomata		20.0	33.3	26.7	
Sebastes semicinctus		6.7			
Torpedo californica		6.7	13.5	20.0	20.0
Chilara taylori			40.0	26.7	20.0
Sebastes levis			20.0		33.3
Citharichthys xanthostigma			20.0		33.3
Eopsetta jordani			6.7		
Sebastes paucispinis			6.7		
Sebastes goodei			6.7		20.0
Anoplopoma fimbria			6.7	13.5	6.7
Citharichthys sordidus			6.7		
Lyopsetta exilis					53.3
Glyptocephalus zachirus					53.3
Leuroglossus stilbus					40.0
Aprodon cortezianus					40.0
Argentina sialis					13.5
Merluccius productus					13.5
Raja stellutata					13.5
Sebastes diploproa					6.7

Comparisons of the fish catches in the four study areas are shown in a trellis diagram (Figure 2), and in a diagram showing the mean coefficient of community for each of the four study areas and for the comparisons between study areas (Figure 3). As expected, most of the catch comparisons made within each area showed a high degree of similarity. That is, most of the coefficients are 50 or more within areas 1 through 4. Areas 1 through 4 have relatively high mean coefficients of 57.0, 69.1, 67.5, and 62.7, respectively. When area 1 is compared with areas 2, 3, and 4, most of the coefficients obtained are less than 50. The mean coefficients for these comparisons are 38.2, 37.5, and 15.3, respectively.

Thus, the catches from area 1 show a moderate affinity with those from areas 2 and 3, and a very low affinity with those from area 4. Also, most of the coefficients are found to be less than 50 when areas 2 and 3 are compared with area 4. A mean coefficient of 25.2 is obtained when area 2 is compared with area 4, indicating that the catches from these two areas have a low affinity with one another, and the catches from areas 3 and 4 show a moderate degree of affinity as indicated by the mean coefficent of 41.3.

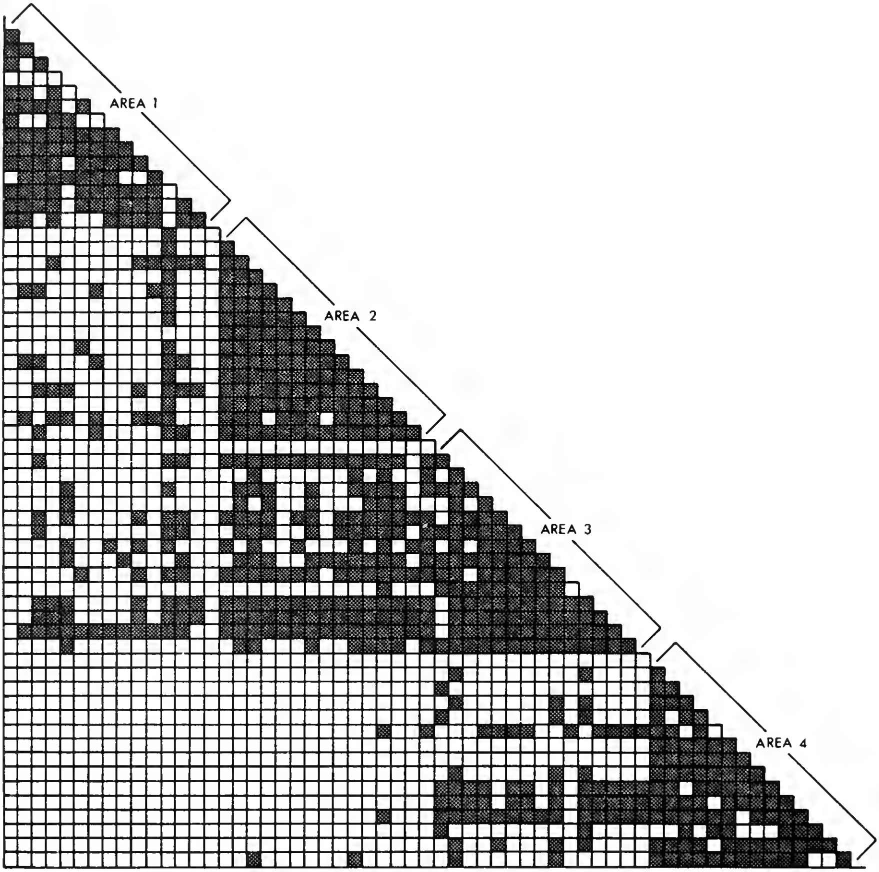

FIGURE 2. Trellis diagram comparing fish catches taken in the four study areas. A Black square represents a coefficient of community of 50 or more, a blank square one of less than 50.

When areas 2 and 3 are compared, most of the coefficients are found to be greater than 50, and a mean coefficient of 51.9 is obtained from this comparison. Thus, examination of the trellis diagram and the mean coefficients of community indicates that three distinctly different species assemblages are defined in the four study areas. These differences are undoubtedly caused primarily by differences in the bathymetric ranges of the areas studied. Similar differences in fish populations with depth were described by Stephens, et al. (1973).

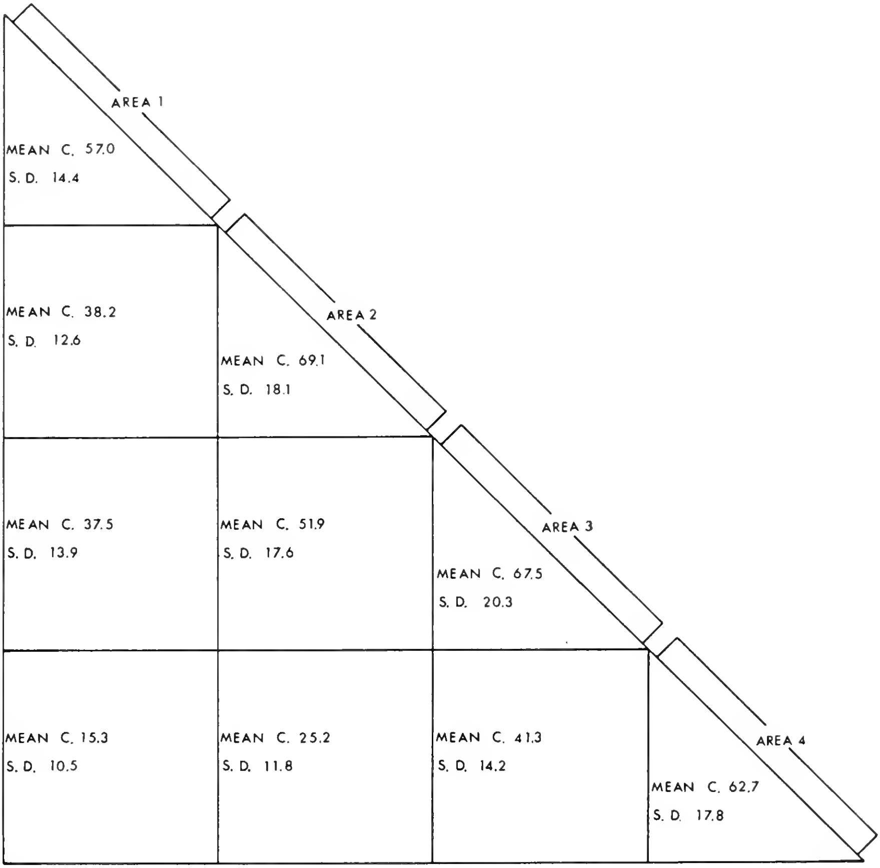

FIGURE 3. Mean coefficients of community for the fish catches of the four study areas, and for the comparisons between the study areas (S.D. = standard deviation).

In addition to comparing the specific composition of catches made in different parts of the bay, the coefficient of community analysis also can be used to compare catches made in the same location but at different times. A trellis diagram was constructed comparing the catches made in Area 3 in 1971 with those made in the same area in 1972 (Figure 4). It can be seen that the catches made in 1972 show somewhat less affinity with one another than do the catches of 1971. That is, the coefficients are less than 50 more often in 1972 than in 1971. Nevertheless, the coefficients are greater than 50 for the majority of the sample pairs within each study period, and for the majority of the sample pairs obtained from a comparison of the two study periods indicating that the catches for both periods are similar. This is supported by the observation that the mean coefficients of community are high for each period (67.5 and 57.0) and for the comparison between study periods (57.8) (Figure 5). It is clear that no major changes in the specific composition of fish catches occurred between 1971 and 1972 in Area 3.

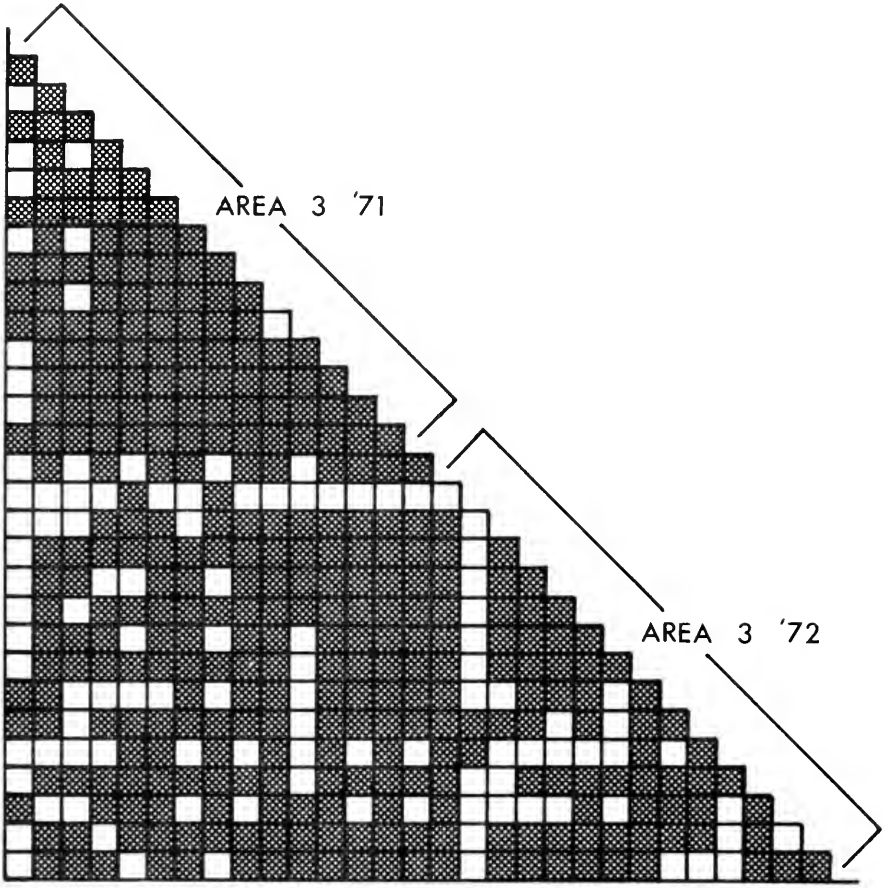

FIGURE 4. Trellis diagram comparing the fish catches taken in Area 3 in 1971 with those taken in the same area in 1972. A black square represents a coefficient of community of 50 or more, a blank square one of less than 50.

It should be pointed out that not all changes in the specific composition of fish catches are detectable by this technique. Thus, the replacement of the species found only in one sample with species which are also unique to a subsequent sample will not alter the coefficient of community obtained when both are compared to a third sample. Reference must then be made to species lists to detect this kind of change.

An attempt was made to determine the adequacy of the otter trawl as a sampling device by comparing the cumulative number of species caught to the number of hauls made in each of the study areas (Figure 6). In Area 1 the frequency with which additional species were being caught decreased markedly after 15 hauls were made, although a few additional species continued to be obtained up to the 50th and last haul made in the area. Forty-eight species of fishes were caught in this area. In Area 2, a similar trend can be seen, although only six additional species were caught subsequent to the first 15 hauls. Forty-

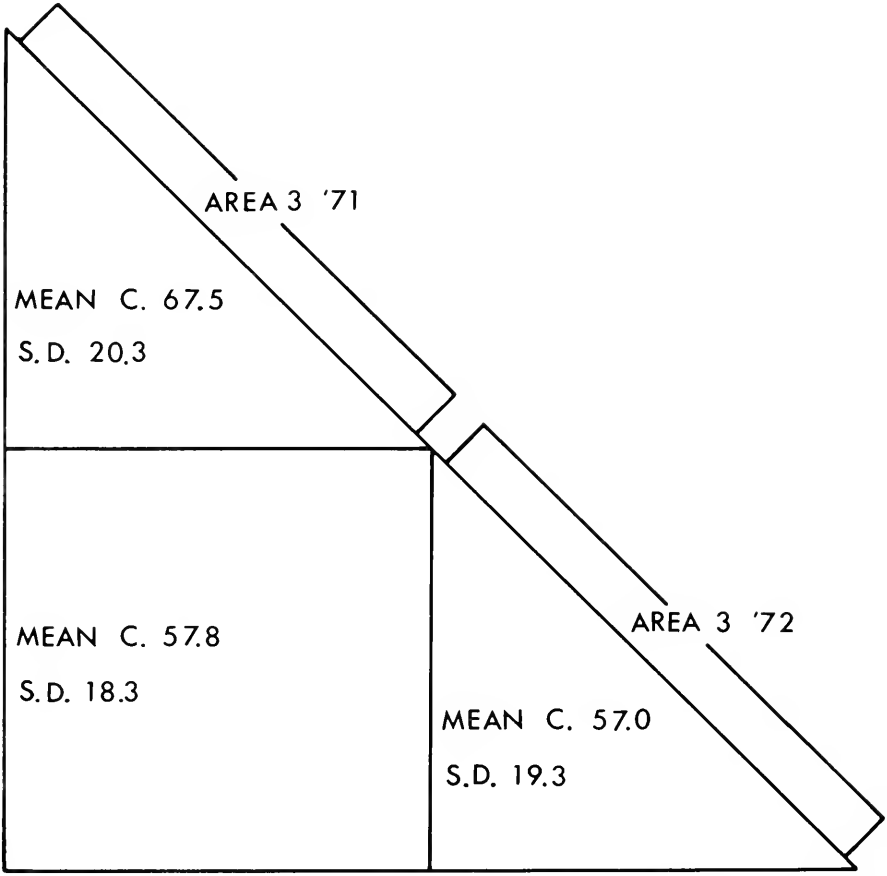

FIGURE 5. Mean coefficients of community for the fish catches made in Area 3 in 1971 and 1972, and for the comparisons of these two periods (S.D. = standard deviation).

seven species were obtained in the 46 hauls made in the area. One hundred and thirty-six hauls were made in Area 3, where 43 species of fishes were caught. It should be noted that no additional species have been taken to date after haul number 106 in this area. Only 15 hauls were made in Area 4, resulting in a catch of 25 species of fishes. Although a definite reduction in the rate at which additional species were being caught can be seen in later hauls, it is clear that additional hauls would be needed to obtain a complete sampling of this area. Based on the comparison described above, approximately 100 hauls are needed in any one area in Santa Monica Bay, utilizing the equipment and procedures described in this study, to obtain specimens of about 95% of those species of fishes (including rare species) which may be expected to be caught, provided that sampling is extended to include all seasons.

Anticipated changes in waste water quality may result in several changes in the ecology of the benthic communities in Santa Monica Bay. Source control of toxins such as DDT and heavy metals, and the gradual leaching of toxins from the local sea floor may result in a gradual change in the sessile biota, while the elimination of suspended solids and sludge solids from waste waters may result in a relatively rapid change in the populations of the more mobile species, e.g., fish. The data presented in the present study may serve as a baseline against which future sampling by this technique may be compared in an attempt to quantify such changes in fish populations.

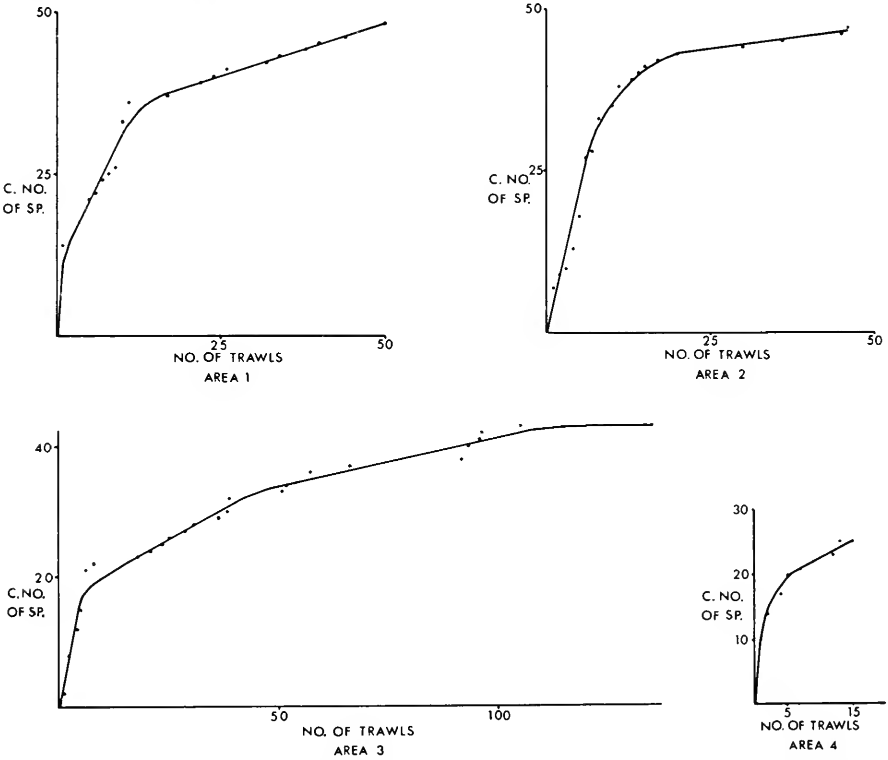

FIGURE 6. Graphs of the cumulative number of species caught versus the number of hauls made in each of the four study areas.

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PARASITES OF SILVER (COHO) SALMON AND KING (CHINOOK) SALMON FROM THE PACIFIC OCEAN OFF OREGON [1]

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During the summer of 1972, 80 silver salmon *(Oncorhynchus kisutch)* and 15 king salmon *(O. tshawytscha)* caught in the Pacific Ocean off Newport, Oregon, were examined for parasites. A total of 16 parasite species (11 of marine origin) were found in silver salmon and seven species (six of marine origin) in king salmon. Larval *Anisakis* sp were found commonly in both host species. These nematodes are of potential public health importance since larval anisakids have been implicated elsewhere as human pathogens. Data on the prevalence of *Nanophyetus salmincola* and *Salvelinema walkeri* in silver salmon indicates that these species have potential value as biological tags.

INTRODUCTION

A survey of the protozoan and metazoan parasites of silver *(Oncorhynchus kisutch)* and king *(O. tshawytscha)* salmon caught in the Pacific Ocean was conducted during the summer of 1972. Salmon were caught between 1 and 30 km (0.6–19 miles) off Newport, Oregon, before their return to fresh water. The purpose of the investigation was to provide information on the parasite faunas of these species during the oceanic phase of their life cycle, to obtain data on the longevity of parasites of freshwater origin, to explore the possibility that parasites might be used as biological tags to indicate geographical areas of salmonid origin, and to obtain information on the prevalence of parasites that are of potential public health importance.

MATERIALS AND METHODS

Salmonids were collected by trolling with commercial salmon gear that was raised and lowered with a hand winch. On shipboard, the fish were measured to the nearest cm (FL), a blood smear made from blood obtained by heart puncture, the viscera removed and both viscera and carcass placed on ice until returned to the laboratory.

After weighing the carcass and viscera the following areas were examined for parasites the day following collection: skin, fins, eyes, musculature, gills, heart, liver, gall bladder, stomach, intestine, mesenteries, swim bladder and kidneys.

Blood smears were fixed in methanol and stained with Giemsa. Myxosporidians were studied in wet mounts before preparing smears fixed in methanol and stained with Giemsa. Whole mounts of trematodes, cestodes, and acanthocephalans were prepared after fixation in AFA and staining in Semichon's acetocarmine. Nematodes were fixed in 70% ethyl alcohol containing 5% glycerine and cleared in lactophenol for study. Copepods were preserved in 70% ethyl alcohol.

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RESULTS AND DISCUSSION

The 80 silver salmon examined ranged from 47.0 to 77.5 cm (18.5–30.5 inches) FL and from 1.1 to 6.1 kg (2.4–13.4 lb) in weight and harbored 16 species of parasites (Table 1). Based upon length, these fish were all determined to be 3 years old and to have been at sea for 2 years (Robert McQueen, Oregon Department of Fish and Wildlife, Pers. commun.). Fifteen king salmon ranged from 41.0 to 87.0 cm (16.2–34.3 inches) FL and from 0.9 to 7.9 kg (2.0–17.4 lb) in weight. King salmon age could not be determined from data on fish length.

No blood parasites were found and myxosporidians were uncommon. Of the 3 species of myxosporidians found in silver salmon, *Myxosoma squamalis* and *Myxidium minteri* are known to be acquired by hosts in fresh water (Iverson 1954; Sanders and Fryer 1970; Yasutake and Wood 1957). It is probable that spores are released when the salmon die after spawning and that the parasites are capable of living for the life of the host. *Henneguya salmonicola* has been reported from adult salmonids (Fish 1939) and has apparently not been observed in salmonids prior to their entry into salt water; this argues that the infections are of marine origin.

The hemiurid trematodes *Brachyphallus crenatus* and *Tubulovesicula lindbergi* are acquired by salmon in marine waters where these parasites are found in a wide variety of hosts (Pratt and McCauley 1961; Yamaguti 1971). Though the marine trematode *Syncoelium katuwo* has previously been reported from pink salmon (*O. gorbuscha*) and sockeye salmon (*O. nerka*) (Lloyd and Guberlet 1936; Margolis 1963) this is the first report of this parasite in silver salmon. Intestinal trematodes were absent in king salmon and uncommon in silver salmon. Two species were observed: *Plagioporus shawi,* a parasite acquired in fresh water (Margolis 1970) and therefore with a life span of at least 2 years; and *Podocotyle* sp, probably of marine origin.

The prevalence of *Nanophyetus salmincola* metacercariae (as determined by microscopic examination of kidney tissue) was low when compared with that reported by Milleman, Gebhart and Knapp (1964) from salmon collected in the same area. They found *N. salmincola* in 24 of 43 silver and three of four king salmon. The low prevalence observed in this study (4/80 silver salmon and 2/15 king salmon) could indicate that the bulk of the fish sampled were not from the endemic area for this parasite (southwestern Washington to northern California) or that they were from endemic areas where the parasite was not common. Unfortunately, data on the prevalence of *N. salmincola* in streams of high silver salmon production, such as the Columbia River system, are not available.

Both silver salmon and king salmon were commonly parasitized by the larval cestodes *Phyllobothrium* sp. and *Bothriocephalus* sp, the larval nematodes *Anisakis* sp. and the adult nematode *Thynascaris* sp. These parasites are of marine origin and are found in many species of marine fishes. Larval *Anisakis* sp are of potential public health importance since it has been shown that members of this group can infect man and cause pathology when improperly prepared or uncooked fish containing them is ingested (Asami et. al. 1965; Van Thiel, Kuipers and Roskam 1960).

Salvelinema walkeri, a freshwater nematode that locates in the swim bladder (Margolis 1967) was found in silver salmon, but not king salmon. This parasite occurred more commonly in fish collected in May and June (14/40) than in fish

Table 1. Prevalence and Intensity of Parasitic Infections in Silver and King Salmon (Ranges in parentheses)

	Silver salmon (N = 80)			*King salmon (N = 15)*		
Parasite	*Prevalence*	*Intensity/infected fish*	*Location*	*Prevalence*	*Intensity/infected fish*	*Location*
PROTOZOA:						
Henneguya salmonicola	2.5%	**	Musculature	0		
Myxosoma squamalis	2.5%	**	Scales	0		
Myxidium minteri	1.3%	**	Gall bladder	0		
TREMATODA:						
Brachyphallus crenatus	11.3%	4.9 (1–19)	Stomach	13.3%	1.0	Stomach
Tubulovesicula lindbergi	8.8%	2.3 (1– 4)	Stomach	0		
Plagioporus shawi	2.5%	2.5 (1– 4)	Intestine	0		
Podocotyle sp.	1.3%	1.0	Intestine	0		
*Syncoelium katuwo**	20.0%	1.4 (1– 4)	Gills	0		
Nanophyetus salmincola (metacercaria)	5.0%	**	Kidney	13.3%	**	Kidney
CESTODA:						
Phyllobothrium sp. (larval)	78.8%	5.3 (1–17)	Intestine	73.3%	6.2 (1–15)	Intestine
Bothriocephalus sp. (larval)	11.3%	2.9 (1– 8)	Intestine	13.3%	4.0 (2– 6)	Intestine
NEMATODA:						
Salvelinema walkeri	21.3%	10.6 (1–30)	Swim bladder	0	0	
Thynascaris sp.	45.0%	5.2 (1–54)	Intestine	60.0%	5.0 (1–15)	Intestine
Anisakis sp. (larval)	73.8%	3.6 (1–16)	Body cavity	80.0%	4.2 (1– 8)	Body cavity
ACANTHOCEPHALA:						
*Nipporhynchus trachuri**	12.5%	1.0	Intestine	0	0	
COPEPODA:						
Lepeophtheirus salmonis	80.0%	3.2 (1–10)	Skin	73.3%	3.4 (1–10)	Skin

* New host record.

** Intensity of infection not calculated.

collected in July and August (3/40). The known geographic distribution of *S. walkeri* indicates that British Columbia is the primary source of infected fish although a single record exists from northern California (Margolis 1967). Based upon the preponderance of reports of this parasite from British Columbia and on the low numbers of California silver salmon that are known to occur in the Oregon salmon troll catch (Robert McQueen, pers. commun.), it is likely that fish infected with this nematode were destined for British Columbian streams. In this regard, it is interesting to note that none of the four fish infected with *N. salmincola* carried *S. walkeri* infections.

The acanthocephalan *Nipporhynchus trachuri* was found in silver salmon. This constitutes a new host record. The only other report of this parasite from the northeastern Pacific is that of Margolis (1963) who found it in sockeye salmon.

Lepeophtheirus salmonis was the only copepod found. It occurred commonly on both silver salmon and king salmon where it located on the body surface, usually just above the anal fin.

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NOTES

Comparison of Floy Internal Anchor and Disk Dangler Tags on Largemouth Bass (*Micropterus salmoides*) at Merle Collins Reservoir

As part of an evaluation of mortality and survival rates of largemouth bass before and after a 305-mm (12.0-inch) size limit went into effect at Merle Collins Reservoir, Yuba County, we initiated a tagging study of bass greater than legal length. This study compared the Floy internal anchor tag [1], described by Thorson (1967) and Dell (1968), and the disk dangler tag.

Stobo (1972) showed that the Floy tag Model FD-67 was suitable for field use on yellow perch (*Perca flavescens*). Results of the senior author's work with FD-67 on several salmonids were excellent (Rawstron 1973). However, subsequent use of this tag on rainbow trout (*Salmo gairdneri*) resulted in an 85% separation of the tubing from the nylon "T" bar. This experience was shared by Wilbur and Duchrow (1973) in their work with largemouth bass. They reported losses of up to 78% for FD-67 and 53% for FD-67C, a similar tag, from fish held in small hatchery ponds. The FD-68B, a stronger Floy tag, was the most satisfactory internal anchor tag tested by these workers. Largemouth bass retained 88% of the tags after 97 days in a 0.28 ha (0.70 acre) pond.

The main difference between these internal anchor tags is the amount of surface available for gluing between the nylon shaft and the vinyl tubing. In the FD-67 and FD-67C tags only about 0.3 to 0.6 cm (0.13 to 0.25 inch) of nylon contacts the vinyl irrespective of tube length, whereas in the FD-68B the nylon shaft is inserted about 3.8 to 5.1 cm (1.5-2.0 inches). In addition, the distal end of the vinyl tube has a nylon monofilament insert which contacts the nylon shaft. This bonding of similar materials further strengthens the FD-68B and overcomes the inherent weakness at the base of the other models. Therefore, because of the speed with which it can be applied and its commercial availability, we chose this tag to compare with a tag proven to be effective, the disk dangler. The latter has been widely and successfully used on a variety of fish species in California, including striped bass (*Morone saxatilis*) (Chadwick 1963); channel catfish (*Ictalurus punctatus*) (McCammon and La Faunce 1961); white catfish (*I. caust*) and brown bullheads (*I. nebulosus*) (McCammon and Seeley 1961); bluegill (*Lepomis macrochirus*) (Rawstron 1967); largemouth bass (Rawstron 1967; Rawstron and Hashagen 1972).

All bass were caught by electrofishing during April 1974, held in live cages, tagged, and released along the sections of shoreline from which they were captured. Totals of 239 and 145 fish were tagged with disk dangler and FD-68B internal anchor tags, respectively. All tags advertised a $5 reward, and were attached below the dorsal fin, approximately a third to a half the distance from the base of the longest spine to the lateral line. Chadwick (1963) described the application technique for the disk dangler tag. Rawstron (1973) enlarged on the application technique for the internal anchor tag on salmonids provided by Thorson (1967) and Dell (1968).

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[1] Tags and specifications obtainable from: Floy Tag and Manufacturing, Inc., 2909 Northeast Blakeley Street, Seattle, Washington 98105.

Anglers returned a total of 180 (75.3%) disk dangler and 91 (62.8%) internal anchor tags through March 1977 (Table 1). Proportional first year tag returns amounted to 0.60 and 0.56, respectively. However, proportionally fewer internal anchor tags were returned during the second and third years. Assuming bass retained all disk dangler tags and that these tags did not induce mortality, the percentage of internal anchor to disk dangler tags returned was 93% for the first year and 83% for the 3 years covered by this study. Survival rates calculated from disk dangler and internal anchor tag returns were 0.21 and 0.11, respectively.

TABLE 1. Number of Tags Returned by Month

	Year 1 1974–75		*Year 2 1975–76*		*Year 3 1976–77*	
Month	*Disk dangler*	*Internal anchor*	*Disk dangler*	*Internal anchor*	*Disk dangler*	*Internal anchor*
April	29	13	5	3	0	0
May	69	43	14	3	3	0
June	21	16	5	3	1	0
July	15	3	2	0	1	1
August	1	0	1	0	0	0
September	0	0	2	0	0	0
October	4	3	0	0	1	0
November	1	1	0	0	0	0
December	2	1	0	0	0	0
January	1	0	0	0	0	0
February	0	0	0	0	0	0
March	1	1	1	0	0	0
TOTAL	144	81	30	9	6	1

We do not recommend that the internal anchor tag be used on largemouth bass when precise estimates of survival and natural mortality rates as defined by Ricker (1958) are required; the disk dangler should be used. However, our findings demonstrate that the internal anchor tag can be a useful tool. Rawstron (1967) and Rawstron and Hashagen (1972) showed that in California, the major component of mean annual exploitation rate for largemouth bass was generated from first year disk dangler tag returns. Since the two tag types showed no significant difference in first year returns, we conclude that the more rapidly applied internal anchor tag can be used in short-term ($\overline{<}$ 1 year) studies of largemouth bass, and can yield a sufficiently accurate estimate of mean annual exploitation rate. This tag would prove particularly useful when large numbers of black bass must be tagged in a short time such as at bass tournaments. It could also be rapidly applied for identification of individual hatchery fish, or for verification of exploitation rates determined in earlier studies.

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SUCCESSFUL REPRODUCTION OF GIANT PACIFIC OYSTERS IN HUMBOLDT BAY AND TOMALES BAY, CALIFORNIA

On May 11, 1974, a naturally set giant Pacific oyster, *Crossostrea gigas* (Thunberg 1795), was discovered in Humboldt Bay. It was found attached to the center pilings of the Humboldt Bay bridge across the Samoa channel. Four additional naturally set oysters were located on other pilings later in the month. On July 18, 1974, investigation of a small rock pile near Mad River channel yielded another naturally set giant Pacific oyster.

All the oysters attached to the Humboldt Bay bridge belong to the 1973 year class (Ronald Warner, pers. commun.). Measurements range from 37 x 32 mm (1.5 x 1.3 inches) to 68 x 60 mm (2.7 x 2.4 inches). The specimen discovered near the Mad River channel is from an earlier year class. The measurements for this oyster are 104 x 62 mm (4.1 x 2.4 inches) and the valves are thicker than those collected from the bridge. The oysters on the bridge were attached approximately at the −0.1 ft tide mark. Heavy concentrations of bay mussels, *Mytius edulis* (Linnaeus 1758), surrounded the oysters. The oyster on the rock pile was attached approximately at the −1.0 ft tide mark. It was located in heavy concentrations of native oysters, *Ostrea lurida* (Carpenter 1864).

The above specimens are not the first naturally set oysters to be collected in Humboldt Bay. F. "Doug" Douglas of Coast Oyster Company in Eureka has found naturally set oysters in Humboldt Bay as early as 1962 (F. Douglas, pers. commun.). His first discovery was made at Bird Island; the oyster had set on a bay mussel shell. The oyster valve measured 64 mm (2.5 inches) in length. The oyster was located at the +1.0-ft tide mark on the dike around Bird Island.

A second specimen was found by Douglas in January 1969. The oyster was attached to a discarded giant Pacific oyster shell. The valve of the natural set measured 102 mm (4 inches) in length and was estimated to be 18 to 20 months old (F. Douglas, pers. commun.). Exact collection location is not known.

On May 24, 1974, it was confirmed that naturally set giant Pacific oysters are in Tomales Bay. Several giant Pacific oysters were collected along the abandoned railroad bed near Tomales Bay Oyster Company. The oysters were attached to rocks in water ranging from the 0.0 ft tide mark to the −1.5 ft tide mark. The oysters were large, ranging in size from 128 x 80 mm (5.0 x 3.1 inches) to 162 x 105 mm (6.4 x 4.1 inches) with well thickened valves making age determination difficult. Their age was estimated to be approximately 10 years (W. Dashlstrom, pers. commun.). The oysters were located by Brian Sanford.

There also have been reports of naturally set giant Pacific oysters north of Tomales Bay Oyster Company, near Tony's Seafood Restaurant. The oysters were removed either by theft or were added to the bottom culture by an employee (F. Konatich, pers. commun.). The oysters were attached to cement pilings and nearby rocks at the 0.0 ft to −1.5 ft tide mark. The naturally set oysters at Tony's Seafood were smaller than those from Tomales Bay Oyster Company (F. Konatich, pers. commun.).

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My special appreciation goes to F. Douglas of Coast Oyster Company, F. Konatich of Tony's Seafood, and Gordan and Ruth Sanford of Tomales Bay Oyster Company for the information they contributed.

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STATUS OF THE OREGON RUFFED GROUSE IN NORTHWESTERN CALIFORNIA

Grinnell and Miller (1944) delineated the range of the resident Oregon ruffed grouse (*Bonasa umbellus sabini*) in California to the "extreme northern humid coast strip, in Del Norte, Siskiyou and Humboldt Counties." They had records "east in Siskiyou County to Horse Creek near Klamath River and Salmon River district and south and east in Humboldt County to Redwood Creek at 800 feet in 1942, . . . to Van Duzen River, 6 miles east of Carlotta and to 4 miles northeast of Bridgeville . . ."

Since 1954, I have recorded observations on ruffed grouse throughout its range in northwestern California. The locations are indicated by dots accompanied by the year of the observations (Figure 1). The counties involved are Del Norte, Siskiyou, Humboldt and Trinity. My records extend the known breeding range of the ruffed grouse to southern Humboldt County, about 35 miles farther south than indicated over 30 years ago by Grinnell and Miller (1943).

I am indebted to Humboldt State University students, colleagues, field biologists of the U.S. Forest Service and California Department of Fish and Game and personnel of the State and National Park Services for many of the sight records.

Apparently the status of this species has remained as an uncommon breeder throughout its range in California for a period of over 30 years (see Figure 1). Grinnell and Miller (1943) refer to it as "formerly fairly common locally, but apparently never, in California portion of general range, abundant . . ."

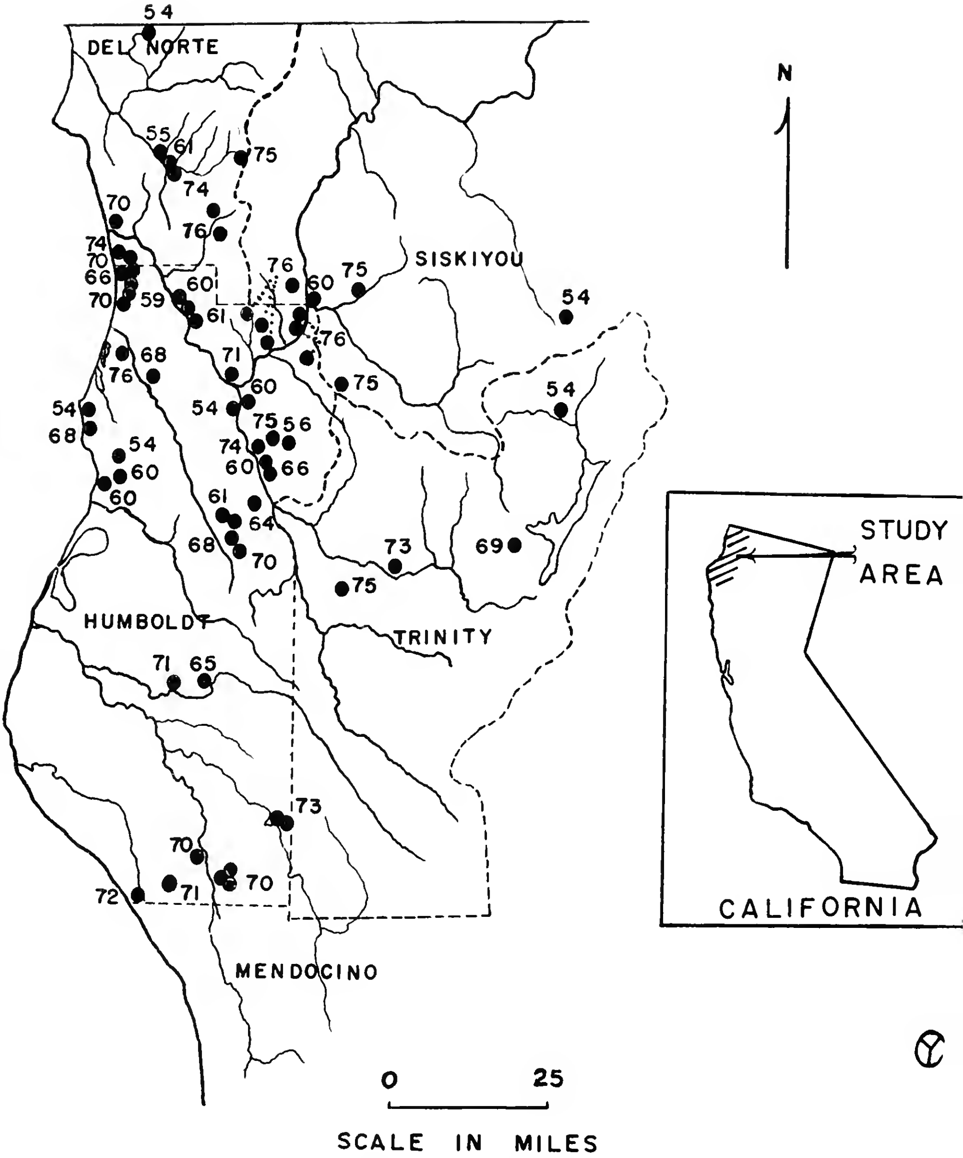

Figure 1. Dots indicate locations of observed ruffed grouse in northwest California since 1954 and the numbers near the dots indicate the year of the observation. Major rivers from north to south are the Smith, Klamath, Redwood Creek, Mad and Eel. The Trinity River flows into the Klamath River about 48 km (30 miles) from the coast and drains most of Trinity County. The Van Duzen River is the first major stream to run into the Eel River from the east.

The cutting of the virgin stands of redwood (*Sequoia sempervirens*) and Douglas-fir (*Pseudotsuga menziesii*) from the 1850's to the present (Vaux 1953) with the great increase of cutting of inland stands of Douglas-fir starting after World War II (Figure 2) did not cause a noticeable increase in ruffed grouse populations as it did with deer, porcupines (Yocom 1971) and fisher (Yocom and McCollum 1973). Cutting of forests in the lake states starts a succession of plant growth favorable to increases in ruffed grouse populations (Gullion, pers. commun.). After logging, aspens and numerous shrubs provide food and cover for ruffed grouse for as long as 40 years after the actual logging.

In our Pacific Coastal region (Yocom and Dasmann 1965), (Franklin and Dyrness 1969), the succession after logging on the coast often involves red alder (*Alnus rubra*), and inland several species of *Ceanothus, Salix,* and several other species, none of which are in the genus *Populus.* The lack of *Populus* species occurring in succession may account for the failure of ruffed grouse to increase in numbers after logging in our mountainous coastal area of northwestern California. Apparently *Alnus* is a poor substitute for *Populus* as an outstanding food supply for ruffed grouse.

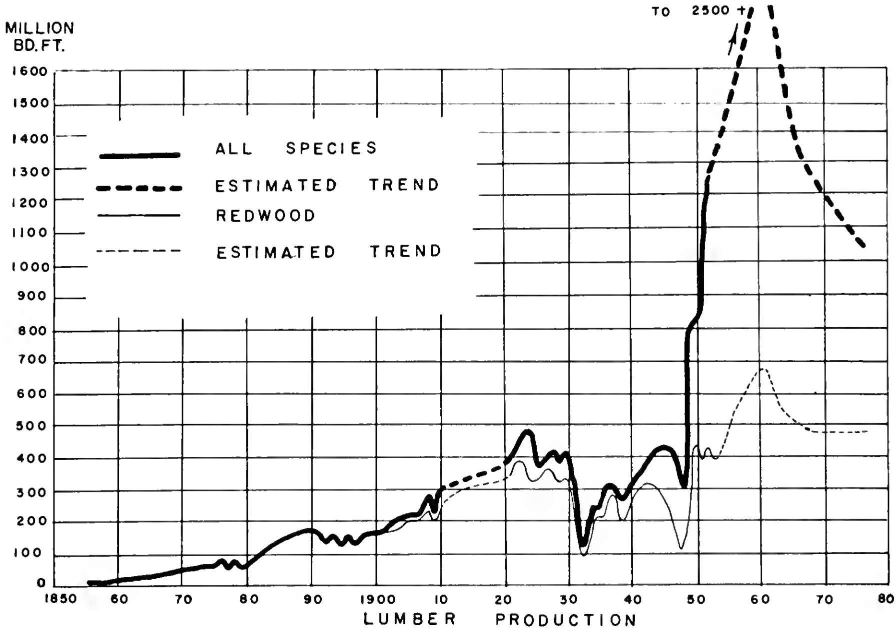

Figure 2. Lumber production in board feet of redwood and all species of trees in Humboldt County, California, from 1850 to 1976. This graph has been modified from Vaux (1955) and Yocom (1971).

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Charles F. Yocom, Department of Wildlife Management, Humboldt State University, Arcata, California. Accepted November 1977.

HARBOR SEALS IN AND ADJACENT TO HUMBOLDT BAY, CALIFORNIA

INTRODUCTION

Five species of pinnipeds occur along the northern California coast, *Eumetopias jubata, Zalophus californianus, Callorhinus ursinus* (migrating females), *Mirounga angustirostris,* and *Phoca vitulina* (Orr 1972). This paper summarizes data from a census of the harbor seal, *P. vitulina,* population along a 61.6-km (38-mile) section of northern California during 1973.

The study area extended from the Eel River north to Patrick's Point State Park (Figure 1). The entrance to Humboldt Bay is 15.9 km (9.5 miles) north of the Eel River and is located at Lat. 40°45′ N, Long. 124°10′ W.

Harbor seals in the Humboldt Bay area haul-out on exposed shoreline and in protected bays. Within the study area, three primary hauling-out areas existed, the mouth of the Eel River, south Humboldt Bay, and the area between Patrick's Point and Trinidad (Figure 1). The major hauling-out area for the entire study was south Humboldt Bay.

South Humboldt Bay is a large shallow area 6.4 km (3.8 miles) long and 3.2 km (1.9 miles) wide. At low tide most of the area is exposed mudflats drained by two main channels; Hookton Channel on the east and Southport Channel on the west (Figure 1). At mean higher high tide the water surface area is 11.1 km^2 (6.9 miles^2) and at mean lower low tide the area is 4.0 km^2 (2.5 Miles^2) (Skeesick 1963). The remainder of the study area was exposed open coastline. The area including Patrick's Point and Trinidad is rocky jagged coast and the area to the south, including the coast near the Eel River, is sandy and relatively straight.

METHODS

I collected data by direct observation with the naked eye or with optical aids during ebb tides. A tripod-mounted Bausch & Lomb 20-45X zoom spotting scope was used frequently. Observations on the Patrick's Point population were facilitated by utilizing rocks and logs on the beach which allowed me to approach to within 10 m (33 ft) of the seals that were hauled-out on the nearby rocks. Observations on the Humboldt Bay population were from hills bordering South

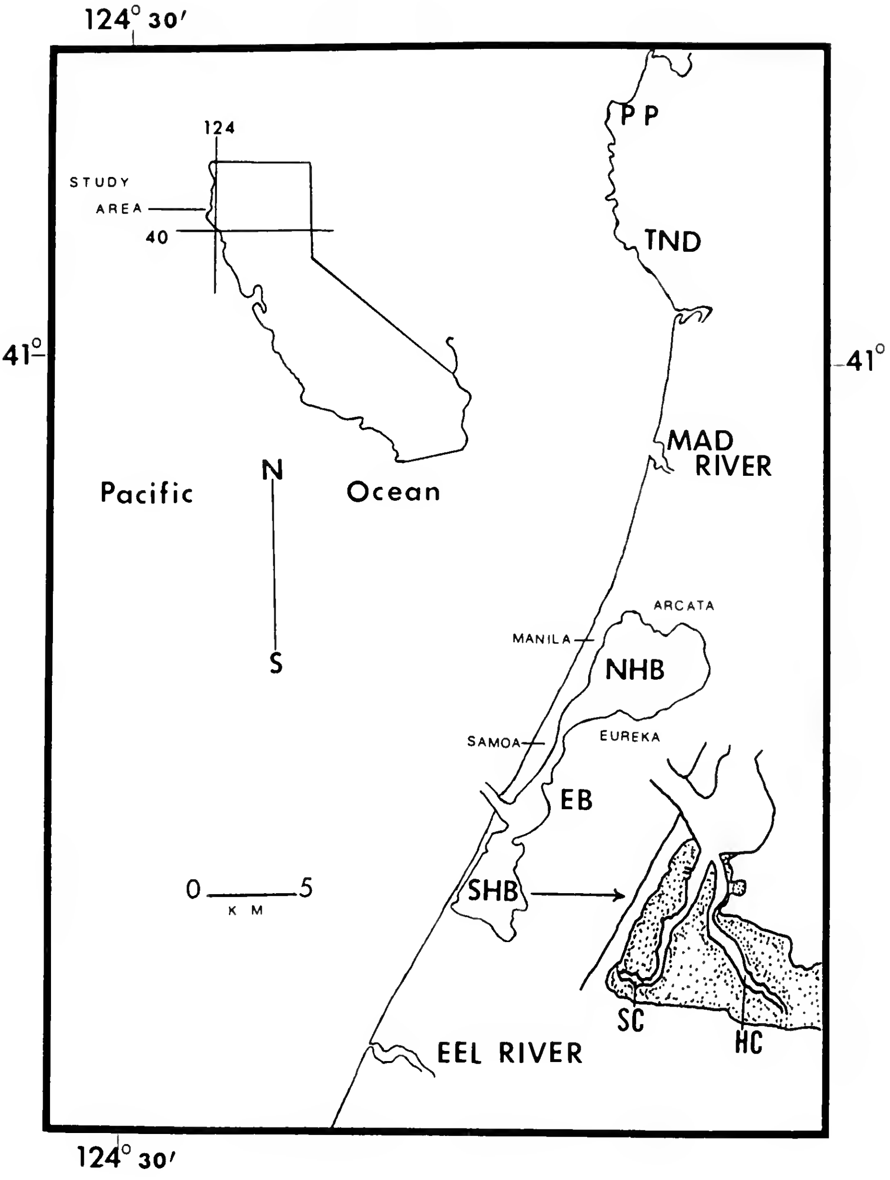

FIGURE 1. Map of the northern California study area. EB = Entrance Bay; HC = Hookton channel; NHB = North Humboldt Bay; PP = Patrick's Point; SC = Southport channel; SHB = South Humboldt Bay; TND = Trinidad.

TABLE 1. Mean Number of Harbor Seals, *Phoca vitulina,* For Each Major Haul-Out Location.

Area	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
South Humboldt Bay	44	58	92	203	257	234	314	204	219	104	31	20
Trinidad to Patrick's Point	18	24	36	46	41	97	126	83	64	60	25	56
Eel River	*	*	6	59	20	261	153	80	40	28	12	9
Total For Study Area	62	82	134	308	379	592	593	367	323	192	68	85

* No count

TABLE 2. Mean Number of Harbor Seals, *Phoca vitulina,* For Southport and Hookton Channels, South Humboldt Bay.

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
Southport	43	51	61	91	82	24	2	31	53	42	30	19
Hookton	1	7	31	112	173	212	312	173	166	62	1	1

Bay or from selected vantage points around the entire bay. Maximum viewing distance did not exceed 1.5 km (0.9 miles). The Eel River population was observed from the north bank of the river mouth. Observation time varied from 20 min to 15 hr, usually depending upon the amount of time and light available. I censused the study area at least three times per month then computed the arithmetic mean of these counts to determine the number of seals observed for each month.

RESULTS

The total number of harbor seals within the study area varied monthly (Table 1). The numbers increased from a mean of 62 in January to a mean of 593 in July, then steadily decreased again to a mean of 85 in December.

Fluctuations in the number of seals observed in South Humboldt Bay were great (Table 1). Actual counts for this area range from 404 (July 24, 1973) to a low of six (December 16, 1973). The means ranged from a minimum of 20 during December to a high of 314 in July. May, June, and July had the highest means of 257, 234, and 314, respectively. The means increased from 44 in January and then decreased, except for a nominal increase in September, to a low of 20 in December. July was also the month with the highest mean number of seals in the Trinidad and Patrick's Point areas. The highest total count occurred on July 19, 1973, when the total number of *P. vitulina* peaked at 640 with a large percentage occurring at the Eel River (190 animals = 30%) and the remainder primarily in south Bay.

Phoca vitulina on either of the channels in south Bay was variable (Table 2). Hookton Channel was utilized by more seals for hauling-out than was Southport. Also apparent was the continual usage of Hookton Channel during the period of weaning (through July) when the maximum usage of the channel occurred. Hookton Channel was rarely used during the winter months and then by only a few animals. Southport Channel was used consistently throughout the year, but never to the extent of Hookton Channel. *P. vitulina* hauled-out at specific areas of each channel. The extreme southern end of Hookton Channel was used most extensively by the seals and the most southern one-third of Southport Channel was used most frequently. There were no obvious physicial limitations restricting the seals from hauling-out at the upper ends of the channel; however, there may have been other factors such as commercial and sportboat traffic at these upper regions that forced the seals to haul-out further south where they were less apt to be disturbed.

Observations of *P. vitulina* in the Eel River were restricted to the river mouth. The seals hauled-out onto sand on the inland side of the south spit at the river mouth or onto sandbars exposed at ebb tides to the southwest of Cock Robin Island (0.5 km upriver). The mean number of seals in the area varied from six in March to 261 in June. Of the number of seals that constituted the large increase in numbers from May ($\overline{X} = 20$) to June ($\overline{X} = 261$), 40 of them were newly weaned pups. The first weaned pup arrived on May 3, 1973. Pup numbers diminished through September at which time it became too difficult to separate weaners from small juveniles.

Harbor seals hauled-out onto offshore rocks in the Patrick's Point area where a group of approximately 70 animals occurred 0.5 km south of Patrick's Point. In the Trinidad area a group of about 35 animals occurred directly offshore from

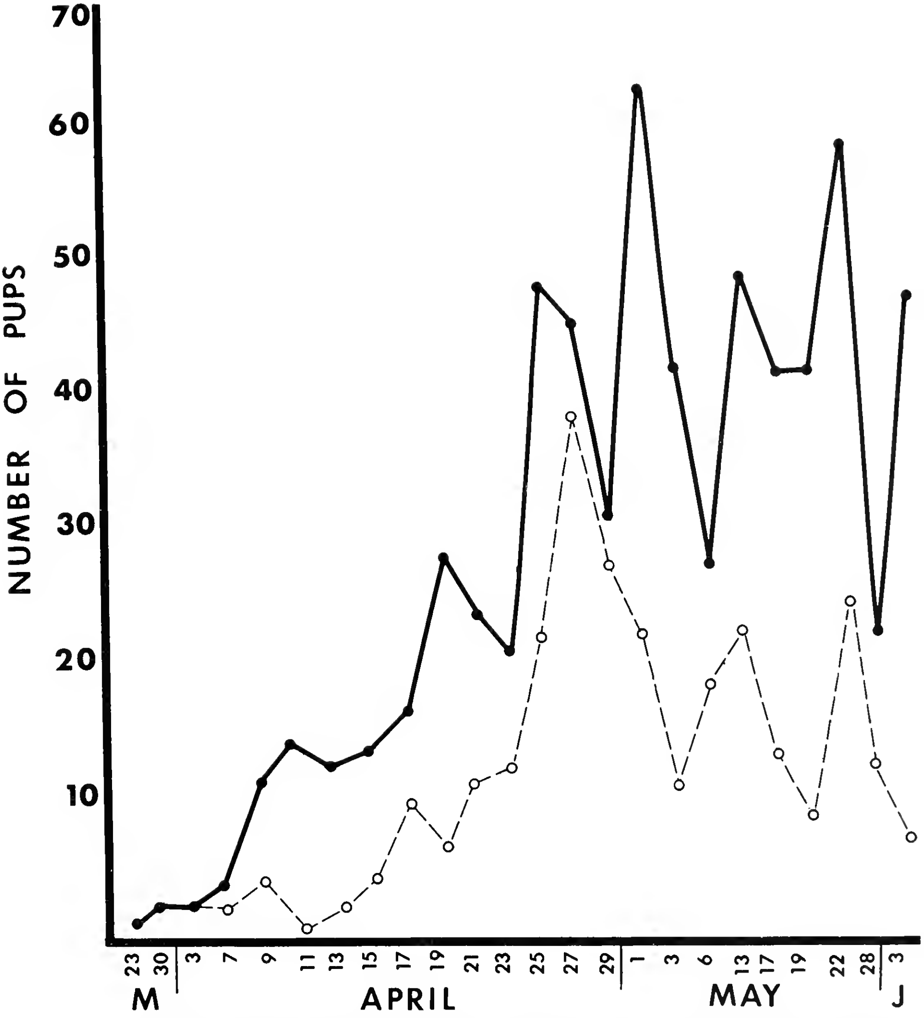

FIGURE 2. Number of harbor seal pups observed in South Humboldt Bay, California, on the dates given for 1973. Solid line equals Hookton channel; broken line equals Southport channel.

the Humboldt State University Marine Laboratory. This group could be found in the more protected areas south of Trinidad harbor when inclement weather restricted their hauling-out onto the more exposed rocks. A similar situation was described by Bishop (1968) where *P. vitulina* in the Gulf of Alaska were forced from their hauling areas by heavy seas. Scattered groups of from one to eight harbor seals sometimes were seen on rocks located between these two points. The number of *P. vitulina* at these two sites was variable with a maximum peak in July and a minimum in the fall and winter months (Table 1).

Pupping locations for the study area were primarily in south Bay. Pups occurred at Patrick's Point and at Trinidad, and although parturition was not observed, I assumed that births occurred at these locations. There were four pups at Trinidad and five at Patrick's Point; these areas were not considered important pupping grounds for harbor seals within the study area.

Pupping in south Bay began on March 23, 1973, and continued through late May with the most intense parturition occurring in April. The number of observed pups increased appreciably during April (maximum count of 87 on April 27, 1973), remained somewhat constant through most of May, and began decreasing in late May (Figure 2).

Both Hookton and Southport Channels were utilized for pupping, with Hookton channel used significantly more than Southport (p less than .01; t=3.453; df=44). The physical characteristics of these two channels are essentially the same (Gast and Skeesick 1964). Both consist of the same soil type, incline, exposure to winds, etc. Thus, any reason why a preference for Hookton Channel should occur was not apparent.

DISCUSSION

The number of harbor seals in the Humboldt Bay region appears to be increasing. Carlisle and Aplin (1966) censused the California pinnipeds on June 1–3, 1965, and found only six harbor seals in Humboldt Bay. Rosenthal (1968) recorded a maximum count of 294 harbor seals and 10 pups in May, 1966, and 308 plus 12 pups in May, 1967. I recorded a maximum of 311 adults plus 83 pups in May, 1973 (this is not the maximum count for the study period). The increase in numbers appears to have been an increase in the number of pups which indicates an increase in the usage of south Humboldt Bay as a pupping ground for harbor seals.

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REVIEWS

Fish Remains in Archaeology and Paleo-environmental Studies

By Richard W. Casteel; Academic Press Inc., New York, 1976; 180 p., illustrated. $14.75.

In the first paragraph of the introduction, the author informs the reader that "the present work is not intended to be a 'cookbook' for the archaeologist or paleontologist," rather it is "presented as an introduction to some of the literature on fish remains as it pertains to archaeology and paleontology." Toward this end, he certainly has succeeded. In fact, so many unculled references are used to document concepts, methods, and techniques that one commences to wonder if he is getting a "snow job." On the other hand, it is extremely gratifying to see the 65 Russian references that Casteel has included. It is unfortunate, however, that he did not see fit to translate these titles, and the Russian author's names, into English.

In addition to the introduction and a chapter on making a comparative osteological collection of fish, there are chapters entitled "Otoliths" (20 p), "Scales" (34 p), "Vertebrae" (20 p), "Comparison of methods for estimating fish size from bones" (31 p), and "Some applications" (18 p). References (24 p) and author and subject indexes complete the book. Although emphasis throughout is upon freshwater fish remains, there is no good excuse for overlooking the potential usefulness of piscine dentition in unraveling primitive food habits and life styles.

As a fishery biologist familiar with a fish's physical attributes, I believe that any archaeologist who can arrive at minimal fish numbers in a subfossil or fossil assemblage based upon recovered scales and vertebrae is missing his calling. By rights, that person should call himself a miracle worker. Regardless of my pessimistic opinion, Casteel's philosophy deserves consideration, namely, "it seems far better to exploit these potentials, keeping in mind the limitations involved, than to simply ignore this type of material when it is present in an assemblage."

Unfortunately unless or until archaeologists commence to employ fine screens in their investigations, such concepts, methods and techniques as offered by Casteel will never be needed, and archaeology can retain its reputation as being one of the most backward fields of science in the world today.—*John E. Fitch*

The Caddis and the Angler.

By Larry Solomon and Eric Leiser. Stackpole Books, Harrisburg, PA, 1977; 224 p., illustrated. $13.95.

It's almost to the point now where you can't go fly fishing unless you have a degree in entomology. *The Caddis and the Angler* provides the angler with sufficient information on the caddis life history, identification, emergences, and the tying and fishing of imitations to continue doing what most of us have been doing for years—catching fish with caddis imitations.

I found the book to be nicely done but of relatively little value to me; perhaps the brand new angler would find it useful. The detailed life history information and scientific names really aren't necessary to catch fish and the book doesn't provide sufficient information to key out collected specimens. Emergence data for a particular genus are of limited value when given for an entire section of the country (East, for example); local information is much more valuable. As usual "the West" stops at Montana/Idaho, except for two pages from an Oregon correspondent. The excellent photographs and detailed tying instructions are the book's one strong point, in my opinion. Patterns are given for all life stages except the egg. Most of the patterns are nothing particularly new in tying techniques but they do appear to be good fishable patterns for the most part. All-in-all a good effort but it won't be an instant classic.—*K. A. Hashagen, Jr.*

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