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A "*DORATOPSIS*" LARVA OF THE SQUID FAMILY CHIROTEUTHIDAE IN CALIFORNIAN WATERS[1]

S. STILLMAN BERRY
Redlands, California

INTRODUCTION

Animals of planktonic habit, whether during their larval or adult stages, are notorious for their very weak speciation and their wide geographical dissemination. The student with training and experience principally with littoral or terrestrial, and particularly nesiotic faunas meets with frustration almost amounting to disbelief when brought face to face with a group where, for example, a form collected in Californian offshore waters cannot be separated taxonomically from one found in the North Atlantic, or perhaps in the China Sea. Thus all living violet-snails (*Janthina*), of which at least three occur at times in Californian waters, were recently claimed by one writer to fall into not more than five valid species. Such an estimate may seem a bit over-conservative but it does serve to illustrate my point. Among cephalopod mollusks, the present record will bring to at least four the number of species belonging in this weakly-localized or oceanic category, which have undergone so little differentiation we cannot divide them even into clear-cut geographic races. These are:

Californian	Japanese	Atlantic and Mediterranean equivalent
1. *Argonauta pacifica*	*Argonauta argo*	*Argonauta argo*
2. *Galiteuthis phyllura*	*Galiteuthis armata*	*Galiteuthis armata*
3. *Ocythoe tuberculata*	*Ocythoe tuberculata*	*Ocythoe tuberculata*
4. *Chiroteuthis* cf. *veranyi*	--	*Chiroteuthis veranyi*

In two instances the Californian forms have separate specific names. *Argonauta pacifica*, the actual position of which is still to be established, was named by Dall in 1871. It is not really rare, but so great has been the demand from curio dealers and shell collectors that complete specimens are apt to be posted at exorbitant prices. Whatever else their fate, not a single complete adult example has been studied and reported upon by a qualified student of the group. We are still without either an amplification of Dall's inconclusive description or a critical comparison with any related forms from other regions. Originally *Galiteuthis phyllura* was named (Berry, 1911: 592; 1912: 315) because our knowledge of the old-world species was imperfect and it did not seem quite safe to unite forms so widely sundered geographically (the Japanese representative was not known in 1912) without sound supporting data. Since then, European students, with additional

[1] Submitted for publication November 1962.

Atlantic and Mediterranean material have been practically unanimous in their inability to discover valid differentiating features among the *armata*-like forms. Possibly the capture and study of much more material will confirm or refute their absolute conspecificity, but there remains small doubt that any differentiation between the forms of the two oceans must be slight at best.

Ocythoe tuberculata Rafinesque is a spectacular pelagic animal which is rather infrequently encountered yet is widespread in the warmer seas. As the only recognized species of its genus and group it stands quite alone, its nearest affinity being with paper nautili (*Argonauta*). Berry (1955) gives an account of the west American occurrence of *Ocythoe* for those interested.

The fourth species, hitherto unrecorded from our area, is the principal subject of this paper. A small, very elongate, transparent squid, taken in plankton somewhere off southern California by collectors from Scripps Institution for Biological Research in 1916, was the first known Pacific capture of the strange larval "genus" *Doratopsis*, or any member of the family *Chiroteuthidae* from the west coast of North America. It was of such interest and import that a note would have been published long ago except that some of the staff then at the Institution thought they had obtained and preserved a similar form in some numbers previously. In view of this, they thought it best to defer publication on the chance this supposed additional material might come to light. Unhappily it never has. Thus, in spite of serious deterioration of the original specimen, observations originally made upon it seem valuable enough to exhume, revise, and place on record. I hope this publication will alert collectors in a position to take them to detect further examples and thus accomplish what the long and ill-advised wait has failed to do.

ACKNOWLEDGMENTS

I am indebted to the authorities of the former Scripps Institution for Biological Research (now Scripps Institution of Oceanography, University of California) and especially to its then director, the late William E. Ritter, for the gift of the unique specimen studied. Herbert J. Powell, now of San Marino, California, drew the sketches which add so greatly to this report. Carl L. Hubbs kindly read the first draft of the manuscript and made some valuable suggestions.

HISTORICAL SUMMARY

One of the most bizarre and strangely-formed of oceanic squids, the species first was made known by Férussac in 1835. It is characterized by a short, conical mantle running to a point between large, cordate fins. The head is large and subpyriform. From it spring the usual eight slender arms (the ventral pair relatively very large and bearing a string of conspicuous photophores) and a pair of exaggeratedly slender, long-stalked tentacles with lanceolately expanded, many-suckered clubs. This extraordinary creature was beautifully figured by its author and named *Loligopsis Veranii*, but some years later Férussac's colleague, Orbigny, (1845:377) signalized its unique position by establishing for it the genus *Chiroteuthis*.[2]

In 1844 a small, transparent, elongate squidlet of altogether different appearance was obtained at Messina by Rüppell and described as *Loligopsis vermicolaris*. More fully described and figured by Vérany in 1851, it was made the type of a new genus, *Doratopsis*, by Rochebrune in 1884. Specimens from the Bay of Naples were described in greater detail by Jatta in 1896. Examples of varying age led Ficalbi (1899) to advance the idea that *Doratopsis vermicularis* is not a mature squid but a larval stage of *Chiroteuthis veranyi*, although he was unable to demonstrate the actual transformation. In 1900 Ficalbi's hypothesis found a powerful opponent in the great German teuthologist, Pfeffer, only to be reasserted (1902) by its propositor, who found an able supporter in another German savant, Chun (1910:297-298). In rebuttal, each answered seriatim the points made by Pfeffer. Pfeffer asserted his position even more vigorously in 1912. More recently, fresh Mediterranean material led the Italian zoologist, Issel (1920; 1927), to follow Ficalbi and Chun. His additional evidence greatly strengthens their case, and though the specimens so far captured may not completely bridge the gap between the oldest known "*Doratopsis*" and the youngest unquestionable *Chiroteuthis*, all present workers seem to agree upon five points respecting their relationship:

1) No true "*Doratopsis*" found has been sexually mature, the internal organs sharing the juvenile aspect of most of the external structures.

2) *Doratopsis* and *Chiroteuthis* are enough alike in fundamental morphology to be safely placed in the same family.

3) Relative to the remaining arms, both ventral ones attain a similar enormous development.

4) Several described "species" of *Doratopsis*, notably *D. vermicularis* and the curious little *Leptoteuthis* or *Doratopsis diaphana* (Verrill), often show a series of conspicuous photogenic organs on the oral aspect of the ventral arms in a position corresponding to those in *Chiroteuthis*.

5) There are paired intrapallial photophores in both forms in the region of the ink-sac.

The evidence outlined, if not absolutely conclusive, is well integrated and surely very strong as far as it goes.

Whether all nominal species presently referred to "*Doratopsis*" are strictly congeneric and juvenile representatives of corresponding species of *Chiroteuthis* s. s. is quite another question and perhaps open to some pardonable doubt. In any event, *Doratopsis* is taxonomically a full genus or it is nothing, and the removal of its type-species into the absolute synonymy of *Chiroteuthis veranyi* must necessarily leave these

[2] The date of first publication of the genus *Chiroteuthis* is usually given as 1839, a year during which part of the plates of the "Histoire" were issued including the one carrying this name. This is upon the authority of d'Orbigny himself (1845: 375, 377), but it has never been shown beyond peradventure of doubt that this issuance actually constituted valid publication within the meaning of the International Code. According to the data given by Winckworth (1942:34-36) the "Mollusques vivants et fossiles" (1845) contains the earliest publication of the genus which we can claim with certainty.

remaining species without any claim to the name. Nor can we revive for them the cognate name *Hyaloteuthis* Pfeffer, for that was based upon the same generitype as *Doratopsis* and must share the same fate. Furthermore, both *Hyaloteuthis* Pfeffer and *Leptoteuthis* Verrill are still-born homonyms (Hoyle, 1886:43). At present no other generic name seems available for them. In view of the uncertainty which continues to enshroud the later stages of their life-history, it would be clearly unwise to clutter the literature with yet another generic name, especially since the definition of the larval "genus", *Planetoteuthis* Pfeffer, possibly could be amplified sufficiently to harbor them as a temporary expedient. I quite agree with Robson that systematists poorly serve science when they encumber it by applying new generic or specific names to known larval stages or doubtful juveniles.

PRINCIPAL SYNONYMY

Chiroteuthis veranyi (Férussac 1835) Orbigny 1845

(Adult)

1835. *Loligopsis Veranii* Férussac,—Mag. de Zool., (Cl. 5) : pl. 65.
1845. *Chiroteuthis Veranyi* Orbigny,—Moll. viv. et foss.: 377; pl. 24.
1848. *Loligopsis Veranii* Orbigny,—Céph. acét.; Calmaret (*Loligopsis*) pl. 2.
1848. *Chiroteuthis Veranyi* Orbigny,—id.: 325; *Loligopsis* pl. 4, figs. 17-23
1851. *Loligopsis Veranyi* Vérany,—Céph. médit.: 120; pls. 38-39.
1888. *Chiroteuthis Veranyi* Weiss,—Quart. Jour. Micr. Sci., 29:77; pl. 8, figs. 4-8
1899. *Chiroteuthis Veranyi* Ficalbi,—Monit. Zool. Ital., 10(4) : 93-118, pl. 1, figs. 4, 7, 10, 13-15.
1900. *Chiroteuthis veranyi* Pfeffer,—Syn. oeg. Ceph.:185.
1902. *Chiroteuthis Veranyi* Ficalbi,—Monit. Zool. Ital., 13(2) : 37-39.
1908. *Chiroteuthis veranyi* Watkinson,—Jena, Zeitschr. Naturw., 44: 364, 375, 377, 391, 393, text figs. 19, 20, 21i, 35 (olfactory organ).
1910. *Chiroteuthis Veranyi* Chun,—Oegops. Valdivia Exp.: 240, 281; pl. 40, fig. 1; 42, fig. 5; 44, figs. 1, 2, 4, 5.
1912. *Chiroteuthis Veranyi Veranyi* Pfeffer,—Monogr. Oegops.: 543, 544, 547, 552, 556, 558, 559, 563, 569, 584, 588, 590, 591, *593*, *594*-606, 607, 608, 789, 794; pls. 44-45.

(Juvenile)

"*Doratopsis vermicularis*" (Rüppell 1844)

1844. *Loligopsis Vermicolaris* Rüppell,—Giorn, Gab. Messina, Ann. 3, T. 5 (F. 27-28) : 133 [5] (*teste* Ficalbi).
1851. *Loligopsis vermicularis* Vérany,—Céph. médit.: 123, pl. 40, figs. a, b.
1884. *Doratopsis vermicularis* Rochebrune,—Bull. Soc. Philomath. Paris, ser. 7, 8: 18, 19 [12, 13].
1884. *Doratopsis Rüppelli* Rochebrune,—id., 19 [13].
1884. *Leptoteuthis vermicolaris* Verrill,—Trans. Conn. Ac. Sc., 6(1) :143.
1884. *Hyaloteuthis vermicularis* Pfeffer,—Abh. Nat. Ver. Hamburg, 8 (1) : 22, 28, pl. 3, fig. 30.
1886. *Doratopsis vermicularis* Hoyle,—Ceph. Challenger Exp.; 43, footnote, 179, 217.
1896. *Doratopsis vermicularis* Jatta,—Ceph. viv. Golfo Napoli: 108, pl. 7, fig. 22; pl. 14, figs. 1-9.
1899. *Doratopsis vermicularis* Ficalbi,—Monit. Zool. Ital., 10 (3) : 80, 83 (after Rüppell).
1899. *Chiroteuthis Veranyi*, juv. Ficalbi,—id. (4) : 93-118, pl. 1, figs. 1-3, 5, 6, 8, 9, 11, 12.

1900. *Doratopsis vermicularis* Pfeffer.—Syn. oeg. Ceph.: 184, 186.
1902. *Chiroteuthis Veranyi*, juv., Ficalbi.—Monit. Zool. Ital., 13 (2) : 37.
1910. *Doratopsis vermicularis* Chun.—Oegops. Valdivia Exp.: 285, 288, 293, pl. 47, figs. 3-4.
1912. *Chiroteuthis (Doratopsis) vermicularis* Pfeffer.—Monogr. Oegops.: 543, 547, *548-550*, 551, 554, *555-569*, 581, 789; pl. 46, figs. 1-5, 8-12.
1920. *Chiroteuthis Veranyi*, juv., Issel.—R. Com. Talass. Ital., Mem. 73: 9, pl., figs. 8-12.
1920. *Chiroteuthis Veranyi*, juv., Issel,—id., Mem. 76: 11, pl., fig. 9 (cephalic pigmentation).
1925. *Chiroteuthis (Doratopsis) veranyi*, juv., Degner,—Ceph. Dan. Oceanogr. Exp., 2 (Biol.), C. 1: 48, 89.
1927. *Chiroteuthis veranyi (Doratopsis vermicularis)* Issel,—Ann. Idrogr., 11 (2) :3, 5, 6, 8-9, 11, 13-15, 17; pl. 1, figs. 1-3, 5; pl. 2, figs. 8, 10.
1931. *Toroteuthis vermicularis* Tomlin,—Proc. Malac. Soc. London. 19 (4): 175.

DESCRIPTION OF CALIFORNIAN SPECIMEN

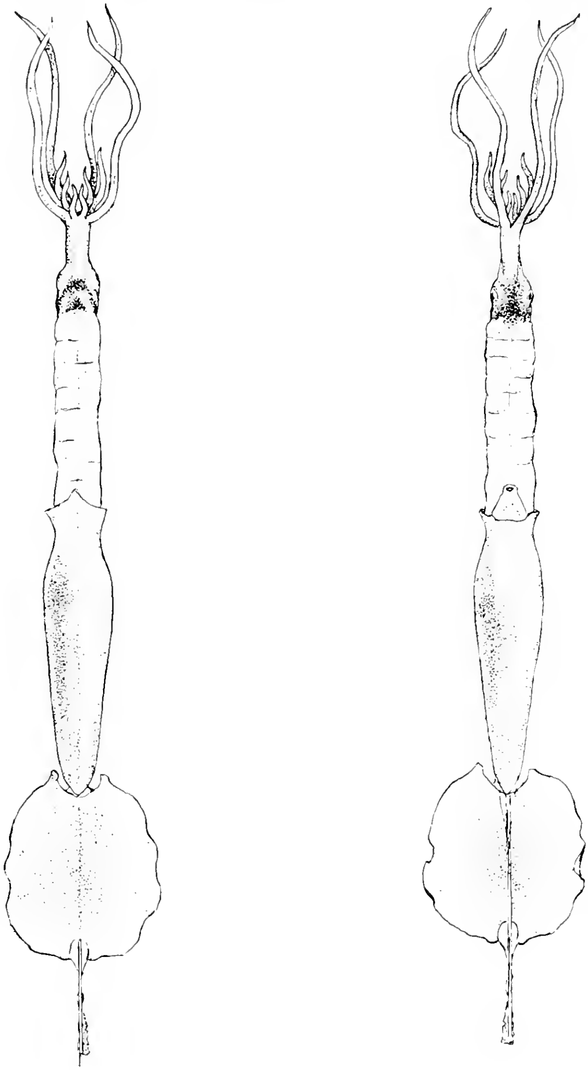
The **mantle** is membranous, elongate spindle-shaped (widest about one-fifth of its length from the anterior margin) and less than one-sixth as wide as long. There is a gentle constriction just behind the anterior margin, while more posteriorly there is a rapid tapering to the anterior attachment of the fins, between which the mantle suffers such extreme attenuation as to constitute little more than a bare covering for the very long and slender gladius.

The **fins** are about two-fifths as long as the mantle and almost perfectly circular with a conspicuous crescentic emargination in front (Figures 1, 2) projecting the fin on either side into a prominent angular lobe. The fleshy part of the fins shows a similar but smaller and narrower emargination posteriorly. Here the resulting embayment is partly or entirely filled in by a thin transparent membrane. At its edges the anterior emargination shows some traces of the possible former presence of a similar membrane. The gladius is produced posteriorly past the fins for some distance as a narrow rod-like structure, but has evidently been partly broken away in this example, so it is impossible to assert the presence of a supplementary fin. However, the persisting stump shows ragged traces of a narrow membrane along its sides.

The **head** (Figure 3), including the neck, is small, narrow, and extraordinarily lengthened. It is divisible into three distinct sections: a long, membranous, transparent, quite evenly tubular nuchal portion, somewhat narrower than the anterior part of the mantle, and showing traces of a rather regular recurrent transverse constriction or puckering; a narrower, short, opaque, true cephalic region, the anterior half mainly composed of the small, lustrous, laterally directed eyes; and a gently tapering, anterior, snout-like extension (rather squarish in transverse section), semitransparent, and showing outward traces of a somewhat alveolar internal structure.

The so-called **olfactory organs**, arising on either side of the ventral surface of the head just back of the lower part of the eyeball, are cylindrical, with elongate stalks terminating in opaque club-shaped organs and show a tendency to bend back and in toward the cephalic axis.

The **arms** (Figures 1, 2) are varyingly developed, but have the order 4, 3, 2, 1 in relative length. The dorsal pair are minute and

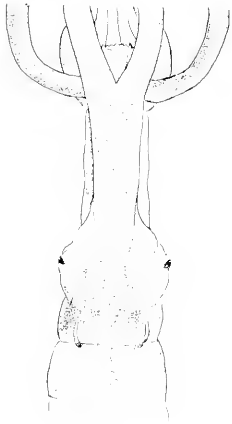


1 2.

FIGURE 1. *Chiroteuthis* cf. *veranyi* (Férussac): the "*Doratopsis*" stage in dorsal view; x 1½ [571]. Although the drawings give in general an excellent idea of the appearance of the animal, the artist intended certain minor corrective changes which he never had an opportunity to carry out. For example, the fins should probably be a little wider and rounder, and the suckers on the tentacle club (Figure 5) should appear somewhot more crowded.

FIGURE 2. *Chiroteuthis* cf. *veranyi* (Férussac): the "*Doratopsis*" stage in ventral view; x 1½ [571].

4



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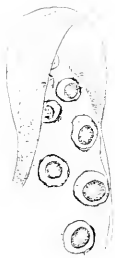

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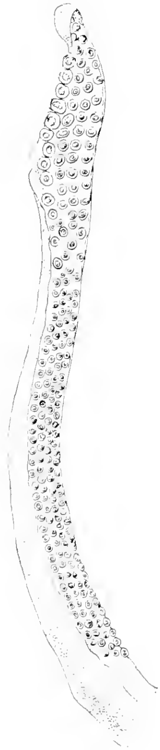

5.

FIGURE 3. *Chiroteuthis* cf. *veranyi* (Férussac): cephalic and buccal region of "*Doratopsis*" stage, ventral aspect; x 6 [571].

FIGURE 4. *Chiroteuthis* cf. *veranyi* (Férussac): oral aspect of right ventral arm of "*Doratopsis*" stage; x 7 [571].

FIGURE 5. *Chiroteuthis* cf. *veranyi* (Férussac): oral aspect of sucker-bearing portion of right tentacle of "*Doratopsis*" stage and its club; x 15 [571].

FIGURE 6. Chiroteuthis cf. veranyi (Férussac): hooded tip of right tentacle-club of "*Doratopsis*" stage, oral aspect; x ca. 50 [571].

slender, less than one-tenth as long as the body. The second arm-pair is somewhat better developed, being half again as long as the dorsal arms. The strongly keeled third pair is half again as long as the second. The suckers of the dorsal and all lateral arms are fairly large and closely ranked in two series. In most respects the ventral arms are conspicuously different from any of the others (Figure 4). They are much more transparent and very long, fully three-fifths as long as the mantle, thus even slightly exceeding the tentacles. While the actual oral (sucker-bearing) face of the ventral arms is very narrow, their apparent width is increased by the much wider aboral diameter, plus a conspicuous, broad, web-like keel on the outer margin of each arm. This keel is as wide as the arm proper at its widest, and several times as wide as the oral face at the same level. The helmet-shaped suckers of the ventral arms are biserial, but are exceedingly minute and widely spaced. They are, however, appreciably closer together near the base and again distally than on the central portion, with about 18 pairs present to the point of closer ranking and smaller size, or possibly 25 to 27 pairs in all.

The **tentacles** (Figure 5) are cylindrical, fleshy, and opaque, a little less than three-fifths as long as the mantle, but not quite as long as the ventral arms. The oral surface of the sucker-bearing portion is about two-fifths of the total and is flattened and armed with a multitude of minute, rather closely-placed suckers, arranged in four definite rows, and numbering perhaps 55 quartets in all (the exact number difficult to tally). The suckers are smallest distally, although there is little change in size until the last 15 or 16 quartets are reached and the tentacle-club becomes slightly expanded, its marginal webs better developed, and the suckers larger. This is particularly true of the ventro-marginal series, where the suckers gradually increase to a maximum of perhaps 1½ times the diameter of those in the other series, then diminish again to the tip of the club. The suckers of the two dorsal series are very nearly of a size, both within a given quartet and through the series as a whole until the extreme tip of the club is attained. The suckers of the ventro-marginal series increase a little more rapidly than those just described until they attain a slightly greater diameter than their more dorsal opposites, then diminish again toward the tip. Finally the suckers become exceedingly minute, the last half-dozen scarcely more than biserial. At the apex, a transparent hood-like membrane (Figure 6) rises over the face of the club and shelters the two or three terminal suckers as within the heel of a slipper.

No trace of **photogenic organs** was detected in this specimen.

Measurements

	mm	*Percentage of dorsal Body-length*
Total length	104	242
Length of body, dorsal mantle margin to posterior edge of fin	43	100
Length of body, ventral mantle margin to posterior edge of fin	41	95
Tip of fins to base of dorsal arms	64	149
Length of tail	9.2+	21+
Length of fins	17	40
Width of fin at widest point (ventral)	8.5	20
Width across fins at widest point	18	42
Width of body	7.5	17
Depth of body	6	14
Width of neck	5	12
Width of head across eyes	4	9
Length of neck (dorsal)	13.5	31
Length of head mediodorsally (dark portion)	2.5	6
Length of anterior prolongation of head	5.5	13
Length of funnel, median	4	9
Length of right dorsal arm	4	9
Length of left dorsal arm	4	9
Length of right second arm	6	14

	mm	*Percentage of dorsal Body-length*
Length of left second arm	6	14
Length of right third arm	9	21
Length of left third arm	9	21
Length of right ventral arm	26	60
Length of left ventral arm	26	60
Length of right tentacle	25	58
Length of right tentacle-club	3	7
Length of sucker-bearing area of right tentacle	10	23
Length of left tentacle	25	58
Length of left tentacle-club	3	7
Length of sucker-bearing area of left tentacle	10	23

Material Examined: The single immature specimen [SSB 571] described was given to me about 1917 or 1918 by William E. Ritter who stated it had been procured off southern California by the Scripps Institution for Biological Research. It is plainly labeled "Sta. 4988, #000, 0 M., 18 VII 1916." Prolonged search through Scripps Institution records disclosed no information for such a station on that date. There may have been some error in labeling, or the relevant data may have been lost. It is almost certain, however, that the specimen was taken at the surface ("0 M.") off southern California, and probably not far from La Jolla. With the current intensification of oceanic collecting in this region further and more complete material should be brought to light.

Commentary: Compared with the early and very crude figures of Vérany (1851: pl. 40, Figures a, b) our example has a relatively much longer neck, shorter tentacles, narrower head, and narrower fins. It is not too dissimilar to some of Issel's 1920 illustrations, but the snout is considerably longer, the tentacles shorter and more slender, and the third pair of arms longer. The measurements are fairly comparable with those of an individual figured by Ficalbi (1899: 100, pl. 1, Figure 2), which had a mantle length of 40 mm and total length of 130 mm; however, in detail, close resemblance ceases. The nuchal tract in Ficalbi's representation is much shorter, the head larger and showing only a comparatively slight indication of the proboscis-like projection in front which is an outstanding feature of our specimen, while the arms, especially the ventrals, are noticeably larger. Moreover, Ficalbi represents the tentacles as longer than the ventral arms, and the anterior fin lobes are not produced as in the Californian example. Discrepancies continue into still lesser details, and it might seem that we had almost a plethora of good specific characters to separate the two forms. However, these differences are no greater or more numerous than those encountered in various cited descriptions and figures of known Mediterranean forms which cannot be regarded as but a single species. In fact, our specimen compares much more closely with Ficalbi's Figure 2, cited above, than the latter does with most other published figures. Therefore, a restudy of the discrepancies alongside a good series of stages illustrating successive growth changes will likely resolve the entire problem. Probably the principal features which best signalize the Californian specimen among those so far described are:

1) the comparatively long snout;
2) the distinct and very peculiar fin lobation;

3) the longer and distinctly clavate olfactory papillae;
4) the transparent hood-like cap at the tips of the tentacles;[3]
5) the lack, or invisibility, of photophores on the ventral arms.

Just how much weight we should give to any of these points is not entirely clear at present. The first may be one of the proportional differences so frequently encountered in the literature pertaining to other regions of the body, notably the neck and arms. The second is conceivably explained either on the ground of better preservation or as a change taking place with age. The third again may be due to age, for it provides a distinct approach toward the remarkable clavate organ seen in mature *Chiroteuthis veranyi*, or it may be due to imperfect interpretation or delineation by some of the earlier observers. The fourth is possibly explained in the manner suggested for the second. The fifth may be more apparent than real, and due to the transparency of the photophores at this stage rather than to their actual absence. And there remains of course the *possibility* that some of these discrepancies, if not all, may represent genuine differential characters. Thus we are brought finally to two alternatives: either the variation of this species, in features which ordinarily show reasonable constancy in cephalopods, is great, or several distinct forms are even yet being confounded, as Joubin and others have intimated. Pfeffer, who seems to have had more material than most investigators and published voluminously on the subject (see especially 1912: 564-569), described a variation so wide, both in general form and in the detailed proportions of constituent structures, that it would seem sheer folly to attempt to discriminate this single eastern Pacific example on the mere basis of its individual peculiarities from among so heterogeneous a complex. Pfeffer found the most reasonable explanation for so many difficulties was a more than ordinary susceptibility of "*Doratopsis*" tissues to the exigencies of preservation. Since the tissues are among the most delicate and diffuse found among squids (witness here the serious deterioration of the present specimen since its capture), this suggestion well may prove to have been soundly based. Chun (1910) thought the following characters of special consequence in discriminating species of *Doratopsis:* 1) position of the olfactory tubercles; 2) form of eyes; 3) spacing between the sucker rows of the ventral arms; 4) form of club and presence or absence of a "Schwimmsaum." In all of these specifications my specimen is nothing but *vermicularis*.

In summary, we have a form which is admittedly larval with delicate tissues notoriously subject to serious alteration in preservation. Its full life-history remains to be worked out, and it is represented by very incomplete material. Therefore, I believe it wise to be frankly conservative and refrain from creating a new specific or subspecific taxon until either the adult of our Pacific form has received study or

[3] Chun (1910:287) describes the corresponding region in the material studied by him in the following words:

"An der aufgehellten Tentakelkeule von *D. vermicularis* erkenne ich nahe der Spitze auf der Aussenfläche eine kleine knopfförmige Verdickung des Gewebes, aus der sich sehr wohl der spätere Drüsenknopf herausbilden kann."

This "Verdickung des Gewebes," however, poorly pictures the delicately formed structure found by me, indicating that Chun interpreted a certain button-like tissue-thickening observed by him near the tip of the tentacle-club as an early stage of the large dark gland (now thought photogenic) which so conspicuously adorns a corresponding position in mature *Chiroteuthis*.

some new and crucial evidence otherwise is found. In any event, we have a most interesting addition to the still very incompletely known cephalopod fauna of the northeastern Pacific. Likewise the species may be of some indirect economic significance, as squids of this group and type constitute at least part of the food of some economically valuable fishes, especially albacore.

LITERATURE CITED

Berry, S. S.

1911. Preliminary notices of some new Pacific cephalopods. U. S. Nat. Mus., Proc., vol. 40, p. 589-592.

1912. A review of the cephalopods of western North America. U. S. Bur. Fish., Bull., vol. 30, p. 267-336, figs. 1-18; pls. 32-56.

1916. The octopod *Ocythoe* in California. Jour. Ent. and Zool., vol. 8, no. 1, pp. 1-4, 1 fig.

1955. On recent Californian occurrences of the rare octopod *Ocythoe*. Calif. Fish and Game, vol. 41, no. 2, pp. 177-181. fig. 1.

Chun, C.

1910. Die Cephalopoden. 1. Teil: Oegopsida Wiss. Ergebn. Deutsch Tiefsee Exped. "Valdivia", vol. 18, 402 p., 32 figs., 2 pls., Atlas 61 pls.

Férussac, A. E. de

1835. Note sur deux genres de céphalopodes encore peu connus, les genres calmaret et cranchie. et sur une nouvelle espèce fort remarquable de chacun de ces deux genres. Mag. Zool., vol. (cl. 5), 10 pp., pls. 65-66.

Ficalbi, E.

1899. Una pubblicazione poco conosciuta di Rüppel intitolata: "Intorno ad alcuni cefalopodi del mare di Messina (Messina 1844)." Monit. Zool. Ital., 10(3): 79-84, figs. 1-2.

1899a. Unicità di specie delle due forme di cefalopodi pelagici chiamate "Chiroteuthis Veranyi" e "Doratopsis vermicularis." Ibid., vol. 10, no. 4, p. 93-118, pl. 1.

1902. Doratopsis vermicularis larva di Chiroteuthis veranyi. Ibid., vol. 13, no. 2, p. 37-39.

Hoyle, W. E.

1886. Report on the Cephalopoda collected by H. M. S. Challenger during the years 1873-76. Zool. Chall. Exp., vol. 16, no. 44, p. i-viii, 1-246., figs. 1-10; pls. 1-33.

Issel, R.

1920. Primo contributo alla conoscenza dello sviluppo nei cefalopodi Mediterranei (Thysanoteuthis—Chiroteuthis—Galiteuthis). Com. Talassogr. Ital. Mem. 73, p. 1-19 pl.

1927. Larve di Chiroteuthis del Mediterraneo e del Golfo di Aden, con particolare reguardo allo variazione geografica. Annali Idrografici, vol. 11, no. 2, p. 1-18, pls. 1-2.

Orbigny, A. d'

1845. Mollusques vivants et fossiles ou description de toutes les especes de coquilles et de mollusques classees suivant leur distribution geolgique et et geographique. Paris, vol. 1, 605 p. Atlas, 35 pls.

Pfeffer, G.

1900. Synopsis der oegopsiden Cephalopoden. Mitt. Naturh. Mus. Hamb. vol. 17, p. 145-198.

1912. Die Cephalopoden der Plankton-Expedition. Zugleich eine monographische Übersicht der oegopsiden Cephalopoden. Ergebn., Plankton-Expedition der Humboldt-Stiftung, 2: i-xxi, 1-815; Atlas 48 pls.

Rochebrune, A. T. de

1884. Étude monographique de la famille des Loligopsidae. Bull. Soc. Philom. Paris., ser 7, vol. 8, p. 7-28 [1-22]; pls. 1-2.

Rüppell, E.

1844. Intorno ad alcuni cefalopodi del mare di Messina. G. Gabinetto letterario Messina, fasc. 27-28, ann. 3, tom, 5, p. 129-135. (Reprinted in Ficalbi, E., 1899, *q. v.*)

Vérany, J. B.
1851. Mollusques mediterranéens, observés, décrits, figurés, et chromo-lithographiés d'après nature sur des modèles vivants. I. Céphalopodes de la Méditerranée. Gènes, p. i-xvi, 1-132; pls. 1-41.

Winckworth, R.
1942. Notes on the publication of Férussac and Orbigny's Histoire des Céphalopodes. Proc. Malac. Soc. London, 25 (1): 34-36.

THE SEA TURTLE FISHERY OF BAJA CALIFORNIA, MEXICO[1]

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INTRODUCTION

Sea turtles, particularly green turtles (*Chelonia mydas carrinegra* Caldwell), long have provided an abundant and ready source of food for coastal inhabitants of Baja California (Caldwell and Caldwell, 1962; West Coast Fisheries, 1929). This is especially true for the Gulf of California shores and along the outer coast from about Scammon's Lagoon south. In the early days, passing ships, particularly whalers, were supplied with fresh meat from this abundant resource.

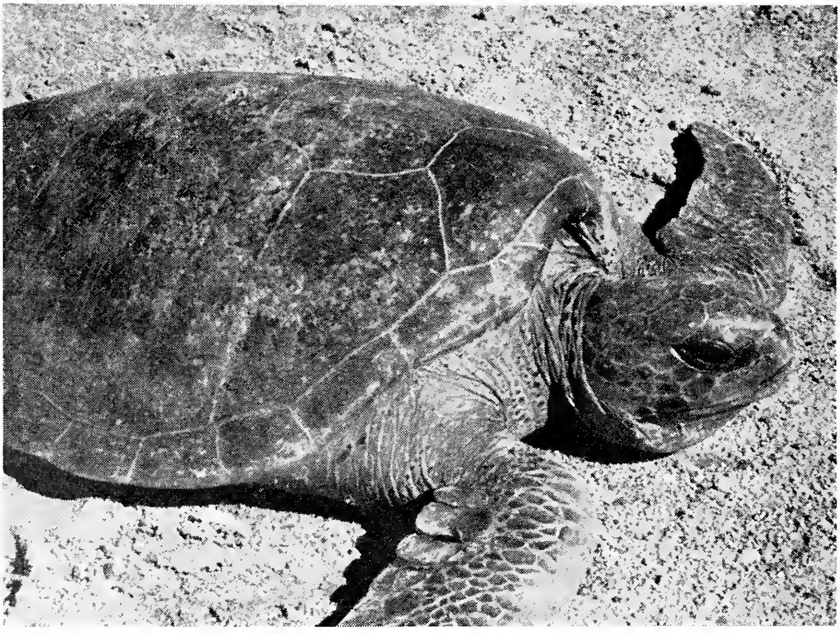

FIGURE 1. A green sea turtle, *Chelonia mydas carrinegra*, from the central Gulf of California and landed at Los Angeles Bay, Baja California. *Photograph by the author, February 1962.*

It now seems appropriate to take stock of the present and past status of the sea turtle fishery, and especially that for green turtles (Figure 1), as a point of departure for possibly developing a potentially more important source of food for the inhabitants of that arid region.

[1] Submitted for publication January 1963.

HISTORICAL SUMMARY

Modern-day guidebooks to Baja California rarely omit mentioning the small but widespread green turtle fisheries, and Dawson (1944: 133) noted that it provided food for the Seri Indians of that region even in pre-Columbian times. While not generally considered Baja California Indians, the Seris live on the central Gulf of California island of Tiburon and might have fished further afield, into Baja California waters, in early times when they were a more widespread people than today. They were, and still are, sea turtle fishermen (Figure 2), and their ancient methods have survived and strongly influence the present-day style of fishing. McGee (1898: 186 ff.) discussed in great detail the use of green turtles by Seris and the capture methods they used. He noted that turtles were used not only in varied ways for food, but also

FIGURE 2. Modern Seri Indians unloading their green turtle catch in Sonora, Mexico, at the northern Gulf of California village of Desemboque. *Photograph by Borys Malkin, about 1953-1955, courtesy Los Angeles County Museum.*

that their shells were used for covering living shelters (see his Plate VII) and the flipper integument for the Seri's only known foot-gear. He also suggested that turtles were taken as they nested on beaches in the vicinity of Tiburon Island, but as yet the species involved, if indeed such nesting occurs, has not been determined by a modern herpetologist (Caldwell, 1962a), although McGee inferred it was the green turtle. If Seris did take nesting turtles, this would have been a seasonal source only and McGee reported many turtles were taken in the water as well.

At one time, numerous green turtles were taken commercially near Magdalena Bay (Alger, 1913; Averett, 1920), Scammon's Lagoon (Walker, 1949) and San Bartolome (Turtle) Bay (Townsend, 1916: 445). In the early 1920's, most were shipped alive to San Diego in a specially outfitted vessel for processing into canned soup and meat (Averett, 1920; Karmelich, 1937). Some were shipped also to San Francisco (True, 1887: 499; Townsend, 1916: 445), and before this, some financially unsuccessful attempts were made at canning local green turtles near Magdalena Bay (Nelson, 1921: 135). Although turtles still are taken commercially as far north as San Quintin Bay, they no longer are shipped to California or appear in reports of fishery products landed in the State. Turtles landed in these areas presently find markets in Baja California, mostly locally, although I saw Magdalena Bay turtles at a small soup factory in Ensenada during the past year. A few turtles from other outer Baja California coastal villages reach this factory as well.

PRESENT FISHERY

Present-day methods of harpooning turtles differ little from those employed by Seris, and account for most that are taken, although in some areas a few are captured with entangling nets or large seines, and some are taken accidentally in shrimp trawls.

The harpoon fishery is pursued from small open boats (Figures 3 and 4). While outboard motors are used to propel the boats to the fishing grounds, wooden paddles still are utilized during actual fishing. The turtles generally are sought at night, and are observed with the aid of lanterns as they sleep or swim at the surface. Sometimes they are tracked by the tell-tale trail of phosphorescence they leave as they swim through the water just below the surface.

FIGURE 3. A typical open boat, approximately 18 feet long, used in the central Baja California sea turtle fishery. *Photograph by the author, February 1962.*

The fishermen usually work in pairs, and while one paddles the boat from the stern, the other wields the long harpoon from the bow. The harpoon shaft may be as long as 10 feet, and is usually made of pipe. The harpoon's metal head (Figure 5) is held onto the wooden shaft tip by a friction connection and backward pull on the harpoon line which is tightly held along the shaft by the harpooner. When a turtle is struck, the harpoon head comes off the shaft and the animal is played on the heavy attached line. The harpoon must be heaved with considerable force to penetrate a turtle's carapace (shell); the force is in-

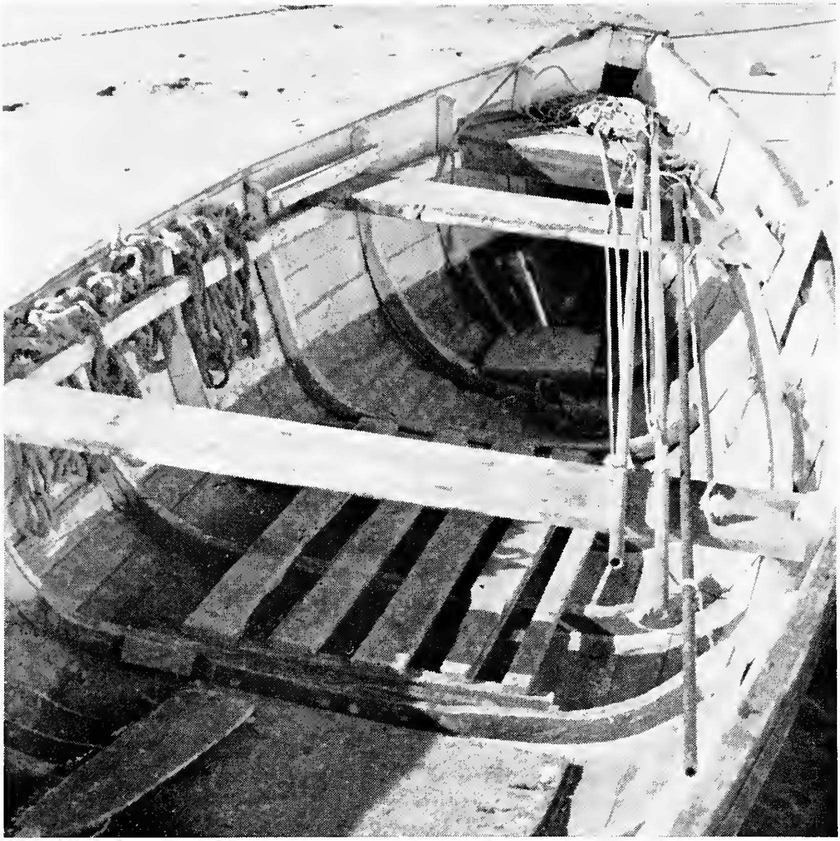

FIGURE 4. Interior of a turtle boat. Note harpoons across the seats along the starboard side, and line for tying turtles stowed on the port side. *Photograph by the author, February 1962.*

creased by the weight of the heavy pipe shaft. To prevent serious injury to turtles, which often must be kept alive for several weeks, the short shaft of the harpoon head behind the barbs is encircled with rubber or leather washers which limit its penetration; the barbs only sink in far enough to secure the animal without damaging vital organs. The resulting hole is usually plugged with cloth or thick mud. Harpooners attempt to hit turtles in the posterior region to decrease the chance of mortal injury. The same-sized harpoon head is used for all species and sizes of turtles. In the case of green turtles, the most common species captured, the smallest normally taken is about 18 inches in carapace length and the largest is some 40 inches. I have seen one dried carapace that measured nearly 43 inches. Even huge trunkbacks (*Dermochelys coriacea*), which attain carapace lengths of 6 feet and a weight of 1,500 pounds, are taken with this same-sized harpoon.

After capture, the turtles are tied up to prevent them from flapping about and are laid on the floorboards of the boat (Figure 6). The fishermen may stay out as long as 2 weeks, fishing at night and landing on

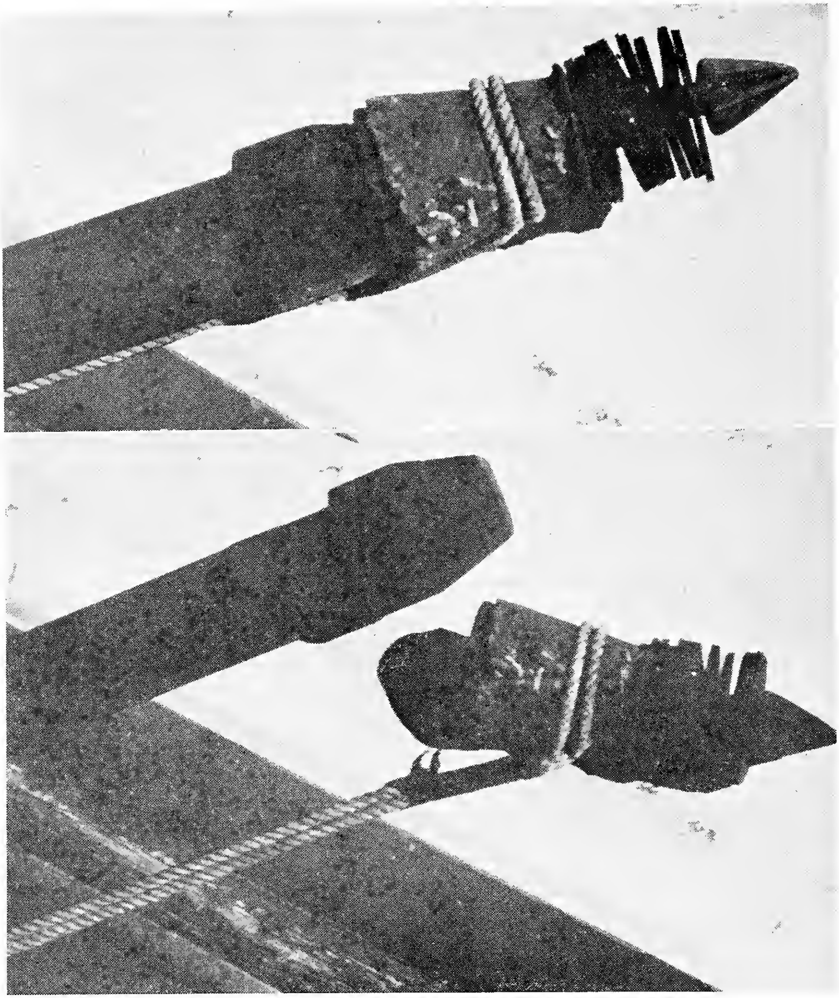

FIGURE 5. Typical harpoon head as used in the Baja California sea turtle fishery. *Upper:* In position on the wooden end of the long metal shaft. *Lower:* Head off the shaft as it is after a turtle is struck. *Photograph by the author, March 1961.*

a nearby shore to sleep during the day. When fishing is exceptionally good, a larger vessel sometimes is dispatched to the fishing grounds to bring in the combined catches from a number of the small boats. Usually, however, the fishermen are ready to return to home base for recreation after about a week and they bring in their own turtles, sometimes as many as 30 or 40 in a dangerously overloaded boat. The turtles are then untied and released belly up, thereby identifying them as new arrivals. Later they are placed belly down on the sand floor of a shaded pen near the water's edge (Figures 7 and 8) and kept until needed. In winter, they may be held as long as 2 weeks with few deaths, but in the hot summer months death may ensue in 3 or 4 days.

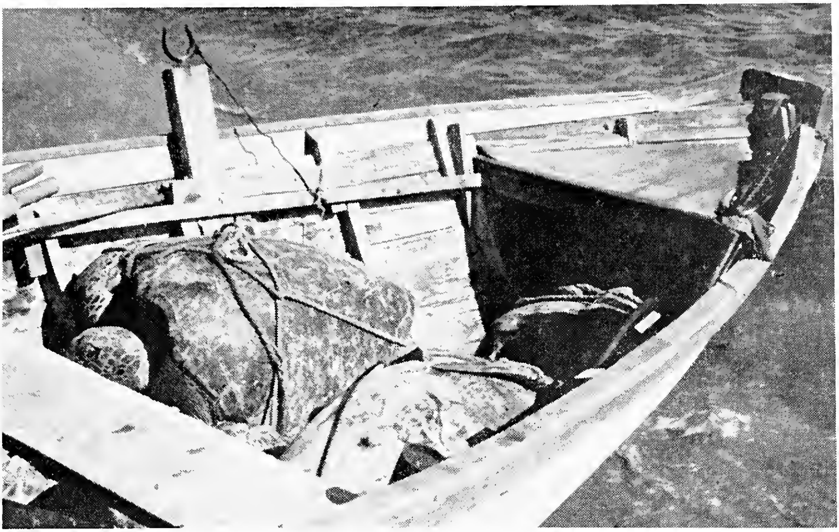

FIGURE 6. A load of live green turtles in the bottom of a turtle boat at Los Angeles Bay. Turtles are tied to prevent them from injuring themselves. *Photograph by the author, February 1962.*

Perhaps because the climate is warmer, turtles landed in the southern part of Baja California often are kept in pens built in the water or on tidal flats that are flooded with up to several feet of water each day.

Carr (1961: 67) found that turtles captured around the central Gulf of California islands, and landed on the Mexican mainland, were being trucked to San Diego. Malkin (1962: 23) found that turtles captured by Seri Indians often were sold alive to Mexican fish traders headquartered in Nogales and Hermosillo, who shipped them along with fish as far as Phoenix and Tucson, Arizona. However, I found that the green

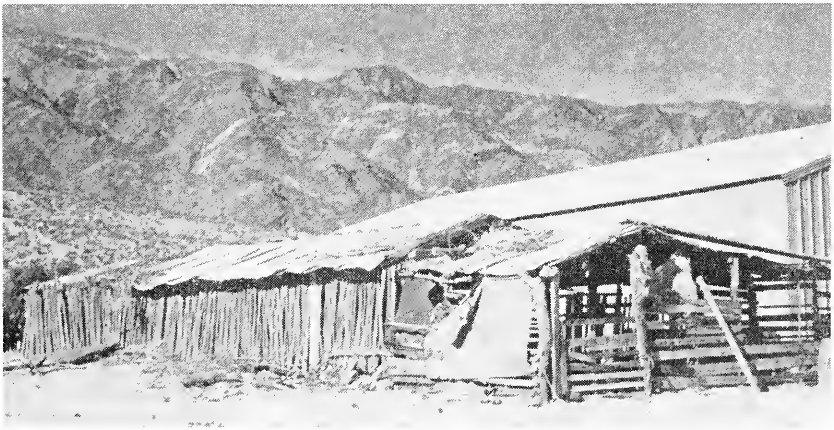

FIGURE 7. Rude pen at Los Angeles Bay used to keep live turtles. Pen is located near the water's edge for convenience of the fishermen and the attendant who must douse the turtles with water several times each day. *Photograph by the author, February 1962.*

turtles presently landed in Baja California, many from those same central Gulf fishing grounds, are consumed either locally or trucked alive or as salted and air-dried meat to markets in larger towns on the peninsula. In the summer of 1962, trucks from the Gulf of California village of Los Angeles Bay turned back rather than enter the United States when they could not find a market for their turtles in Ensenada, Tijuana, or Mexicali. Such long trips over rough roads, particularly in summer, often result in the death of almost an entire load of turtles. In these cases, or when turtles die in the holding pens, they are cut up when freshly dead and the meat salted and dried for human consumption.

My investigations showed no evidence of present-day turtle canning in Baja California. However, Parsons (1962:75) reported a turtle-soup

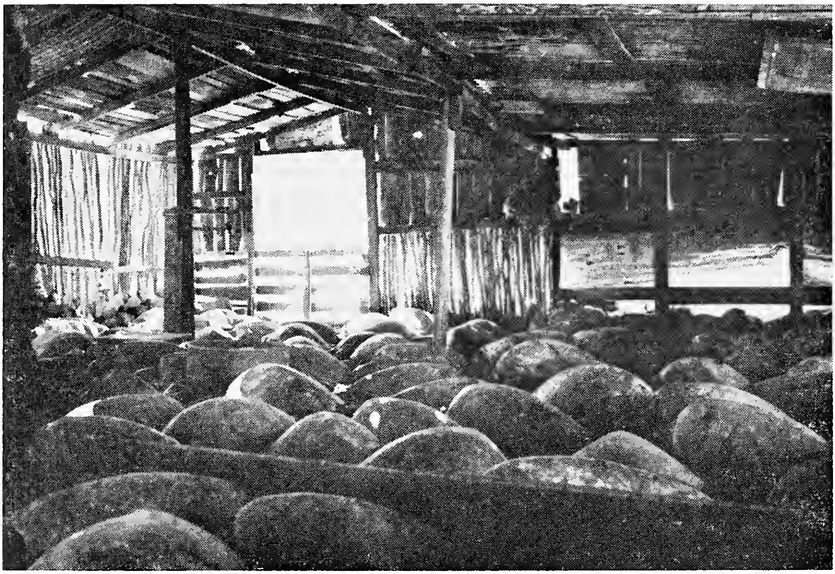

FIGURE 8. Inside a pen filled with live green turtles at Los Angeles Bay. *Photograph by the author, February 1962.*

cannery has been working in recent years at Asuncion Bay. While in the area, Kenneth E. Stager of the Los Angeles County Museum was informed in March 1963, that a seafood cannery, which included sea turtles among its products, was operating on Santa Margarita Isl. near Magdalena Bay. Parsons was informed that the Asuncion canner's product was used almost exclusively in Baja California; Stager could not find where the Margarita products were sold.

I found two soup and turtle stew factories in Ensenada, but apparently their product is sold only over the counter. Similar establishments probably occur in all Baja California cities where sea turtles are readily available.

Some of the oil skimmed off the soup pot in Ensenada is saved for medicinal purposes. Craig (1926: 167) related that sea turtles landed at San Felipe, in the northwestern Gulf of California, were taken primarily for their oil, although some of the rendered meat was salted and dried for food. Giral and Cascajares (1948: 177) noted that as long ago as Columbus's time, Mexican turtle oils had supposed therapeutic value for human afflictions of the chest, especially tuberculosis and leprosy. A similar use was expressed to me in 1962 at Ensenada. Giral (1948), Giral and Marquez (1948) and Giral *et al.* (1948) in a series of short papers discussed the composition of various Mexican sea turtle oils. The flesh of male turtles is said to have a purgatory effect on humans. However, before I heard this, during a general inquiry at Los Angeles Bay about the relative merits of male and female turtles, I was told only that females were preferred because of the taste and texture of their flesh, and that immature turtles of either sex were equally good.

TABLE 1

Seasonal Size Distribution of Four Samples of the Northeastern Pacific Green Sea Turtle, *Chelonia mydas carrinegra*, from the Central Gulf of California and Landed at Los Angeles Bay, Baja California, Mexico. Sexes Combined

	March 1961	*June 1961*	*February 1962*	*June-July 1962*
Range of Carapace Length (inches)[1]	18¾–36¼	19¾–36½	19¼–35½	17½–38½
Mean Carapace Length (inches)[2]	26	26½	26½	26
Number of Individuals	113	232	291	513
Days of Observation	7	5	7	21
Average Number of Individuals per Day of Observation	16	46	41	24
Number of Turtle Pens in Operation[3]	2	4	4	3
Number of Turtles per Day of Observation per Pen[4]	8	12	10	8

[1] Measured to the nearest ¼ inch in accord with Carr and Caldwell (1956: 4)
[2] Rounded to nearest ½ inch
[3] Suggests degree of fishing pressure (see text)
[4] Number of turtles actually not evenly-distributed among pens, but this figure gives a relative abundance of turtles for the seasonal sample

Most green turtles now landed in Baja California come from the central and southern Gulf of California. I saw over 500 landed during a 3-week summer period in 1962 at Los Angeles Bay alone, and a comparable number, considering fishing effort, per week in winter (Table 1). The number of turtle pens in operation is used as an index of fishing effort. An inactive pen means the fishermen who work for that pen operator are engaged in some other activity; they are not merely fishing for some other operator (i.e., fewer pens in operation mean fewer fishermen are working and fishing effort is lower). Recorded turtles were marked or segregated so they would not be counted more than once. The means and ranges of carapace length also were consistent in four samples taken in both winter and summer during two consecutive years (Table 1).

Fishermen say turtles are harder to find in winter as they are less active and in deeper water. The weather also limits the fishermen's activities; however, turtles are present in good numbers all year and the fishery does not close except when compelled to do so by Mexican law. Such a closure occurred in the early fall of 1961 when Mexican authorities experimentally imposed a short closed season on all sea turtles. Several thousand turtles are landed at Los Angeles Bay each year where, along with tourists, they form the economy of the area. It is the same at other villages, where turtles often are the sole source of income.

BIOLOGICAL INFORMATION

Little is known of the biology of Pacific Mexican green turtles and even less about other turtle species taken there. The present knowledge of the herbivorous (algae feeding) green turtle in Baja California recently was presented in some detail by Caldwell (1962a, 1962b). A brief summary is given here to make the reader aware of what is *not* known and thus be on the alert for needed information. Data on nesting activity are particularly needed for suggesting conservation practices.

In Baja California, green turtles, or *caguamas*, occur along the entire length of both coasts, although the major fisheries for them are limited approximately to the waters of the lower three-fourths of the peninsula.

While there are nebulous references to green turtle nesting on many beaches along southern Baja California, and in the Gulf of California, there are no positive modern data on the subject. Green turtles do nest far to the south on beaches of the mainland Mexican State of Michoacan, and are said to nest at Socorro Island (Caldwell, 1962a). Nesting is also reported at Clarion Island (Brattstrom, 1955: 220; John E. Fitch, pers. commun.); however, green turtles in these three areas may belong to a different subspecies than those of Baja Cali-

FIGURE 9. Ventral aspect of female *(left)* and male *(right)* green turtles from the central Gulf of California. Note the dark color of the plastrons (undersides) typical of *Chelonia mydas carrinegra*, and the comparative lengths of the tails. *Photograph by the author, February 1962.*

fornia (the olive-colored *Chelonia mydas agassizi* Bocourt occurs south of the peninsula, and the recently-described, almost black, *C. m. carrinegra* Caldwell occurs in the Gulf of California and along the Pacific Coast north of Cape San Lucas). Where and when Baja California green turtles nest is not known for certain. Individuals of both sexes (Figure 9) and of breeding size apparently occur in sufficient numbers to account for a large population, at least along the central and southern Baja California shores.

Nesting areas usually are determined by observing nesting turtles or the tank-like tracks they leave on the beach as they crawl out and back when burying their eggs in the sand, high on the shore. Copulating turtles in the water are usually evidence of nesting activity nearby, and hatchling turtles on the beach are positive proof. While observing turtles as they nest is the most desirable way to identify the species involved, it is sometimes possible to determine this by other means: (1) eggs may be hatched in the laboratory, (2) barriers may be placed around nest sites to retain young turtles as they hatch, (3) interviews may be held with local residents and descriptions of the nesting turtles obtained, and (4) refuse heaps may be found and examined for identifiable remains of turtles taken while nesting.

CONSERVATION PRACTICES

Although the green turtle fishery in Baja California is an old one, no serious attempts have been made to study it from the standpoint of proper utilization under fisheries management procedures. The present condition of the fishery probably does not warrant restricting the number of free-swimming turtles harvested. However, note should be made of the overfished and depleted population of the Caribbean green turtle (Carr, 1954) and measures should be taken in Baja California to prevent such depredation there. The loss of the green turtle in Baja California would constitute a serious hardship to the people of this economically poor area. Therefore, when the nesting grounds of these turtles are discovered, immediate steps should be taken to prevent the harvesting of nesting females or eggs.

Detailed data on length-weight relationships and numbers of each size of green turtle taken in the fishery are available (Caldwell, 1962b) and I hope these data will prove useful if it becomes necessary to manage the sea turtle fishery.

Although the other sea turtle species taken in the Baja California fishery are of much less economic importance, the same conservation practices should be considered for them as well.

Turtles of all species frequently are taken by accident in the bottom trawls used in the Gulf of California shrimp fishery. John E. Fitch, California Department of Fish and Game, informs me he has seen as many as nine turtles taken in a single haul. Whether or not they reach the surface alive depends on how long they have been trapped underwater. It has been my experience that in the Atlantic coast shrimp fishery only about half, or fewer, survive. The loss is unavoidable, and probably is not of great biological importance to the turtle population. Dead or alive, most of the turtles so taken are returned to the water, except for the occasional one retained for food by the boat crew. However, the meat is still fresh, and shrimp fishermen should be encouraged to utilize it themselves or butcher the carcasses and refrigerate the meat for sale along with the shrimp.

FISHERY FOR OTHER SEA TURTLE SPECIES

Four other kinds of sea turtles are utilized in Baja California; I found no evidence that any species is not retained if captured. The only turtles not kept are very small ones (15 to 20 pounds or less) which are not seen in the markets or pens. The fishermen state positively that they see small ones, but do not bother to harpoon them. Hawksbills (*Eretmochelys*), a more tropical form, are taken frequently in the southern-most waters off the peninsula, especially near La Paz. They are utilized both for food and for their colorful shells, the tortoise shell of commerce. Some ridleys (*Lepidochelys*), trunkbacks and apparently a few loggerheads (*Caretta*) are taken for food along the length of both coasts of the peninsula (Caldwell, 1962a).

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LITERATURE CITED

Alger, W. E.
1913. Green turtles in Lower California. *In* U. S. Bureau of Foreign and Domestic Commerce, Daily Consular and Trade Reports, no. 55, p. 1181, March 6.

Averett, W. E.
1920. Lower California green turtle fishery. Pac. Fisherman, vol. 18, no. 7, pp. 24-25.

Brattstrom, Bayard H.
1955. Notes on the herpetology of the Revillagigedo Islands, Mexico. Amer. Midl. Nat., vol. 54, no. 1, pp. 219-229.

Caldwell, David K.
1962a. Sea turtles in Baja Californian waters (with special reference to those of the Gulf of California), and the description of a new subspecies of northeastern Pacific green turtle. Los Angeles County Mus., Contrib. Sci., no. 61, pp. 1-31.
1962b. Carapace length—body weight relationship and size and sex ratio of the northeastern Pacific sea turtle, *Chelonia mydas carrinegra*. Los Angeles County Mus., Contrib. Sci., no. 62, pp. 1-10.

Caldwell, David K., and Melba C. Caldwell
1962. The black "steer" of the Gulf of California. Los Angeles County Mus., Quarterly, Sci. and Hist., vol. 1, no. 1, pp. 14-17.

Carr, Archie
1954. The passing of the fleet. Amer. Inst. Biol. Sci., Bull., vol. 4, pp. 17-19.
1961. Pacific turtle problem. Nat. Hist., vol. 70, no. 8, pp. 64-71.

Carr, Archie, and David K. Caldwell
1956. The ecology and migrations of sea turtles, 1. Results of field work in Florida, 1955. Amer. Mus. Nov., no. 1793, pp. 1-23.

Craig, J. A.
1926. A new fishery in Mexico. Calif. Fish and Game, vol. 12, no. 4, pp. 166-169.

Dawson, E. Yale
1944. Some ethnobotanical notes on the Seri Indians. Desert Plant Life, vol. 16, no. 9, pp. 133-138.

Giral, Francisco
1948. Mexican turtle oils, IV. *Lepidochelys olivacea* Esch. Arch. Biochem., vol. 16, pp. 191-193.

Giral, Francisco, and Maria Luisa Cascajares
1948. Mexican turtle oils, I. Arch. Biochem., vol. 16, pp. 177-179.

Giral, Francisco, and Andres Marquez
1948. Mexican turtle oils, III. *Caretta caretta* Linn. Arch. Biochem., vol. 16, pp. 187-189.

Giral, Jose, Francisco Giral and Maria Luisa Giral
1948. Mexican turtle oils, II. *Chelone mydas* Linn. Arch. Biochem., vol. 16, pp. 181-186.

Karmelich, Katherine
1937. Turtles. *In* The commercial fish catch of California for the year 1935. Calif. Div. Fish and Game, Fish Bull. 49, pp. 122-123.

McGee, W. J.
1898. The Seri Indians. U. S. Bur. Amer. Ethnology, 17th Ann. Rept. (for 1895-96), pp. 1-344.

Malkin, Borys
1962. Seri ethnozoology. Idaho St. Coll. Mus., Occ. Pap., no. 7, 68 pp.

Nelson, Edward W.
1921. Lower California and its natural resources. Natl. Acad. Sci., Mem., vol. 16, no. 1, pp. 1-194.

Parsons, James J.
1962. The green turtle and man. Gainesville, Univ. Florida Press, 126 pp.

Townsend, Charles H.
1916. Voyage of the "Albatross" to the Gulf of California in 1911. Amer. Mus. Nat. Hist., Bull., vol. 35, art. 24, pp. 399-476.

True, Frederick W.
1887. The turtle and terrapin fisheries. *In* G. Brown Goode, *et al.*, The fisheries and fishery industries of the United States. Sec. 5. History and methods of the fisheries, vol. 2, pt. 19, pp. 493-503. Wash., Govt. Print. Off.

Walker, Lewis W.
1949. Nursery of the gray whales. Nat. Hist., vol. 58, no. 6, pp. 248-256.

West Coast Fisheries
1929. The last stand of the turtle. West Coast Fish., p. 8, Sept.

TRAWLING IN THE MONTEREY BAY AREA, WITH SPECIAL REFERENCE TO CATCH COMPOSITION[1]

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INTRODUCTION

Trawl fishing has always caused considerable controversy among people concerned with the resources of the sea. On the one hand, many people regard this fishery, for which only limited detailed information is available, with suspicion. On the other hand, trawling is quite efficient and produces bottomfish catches at less cost than any other method. To meet the need for factual information on trawling in the Monterey Bay area, the California Department of Fish and Game initiated a 1-year study in 1960. This paper presents the results of that study.

The Monterey Bay area trawling grounds, extending from Pigeon Point to Point Sur (Figure 1), are fished almost exclusively by trawlers from Monterey and Moss Landing. At times, these vessels have worked outside this area and San Francisco trawlers occasionally have entered the fishery. These extralimital movements of vessels are so insignificant that trawling by the Monterey Bay fleet is considered representative of the fishery.

In any fishery, more fish are taken at sea than are brought ashore. Some fish are discarded because they are shorter than either legal size or desired market size, or have no market value. Unusable fish normally are discarded by the fishermen and not enumerated.

A knowledge of total catch was vital in understanding this fishery. To describe total catch, data were needed to show species and amounts discarded. This information, plus species and amounts landed, gives a comprehensive picture of the fishery.

A program at sea was instigated to obtain information on discarded fish and consisted of biweekly sampling aboard various trawlers from Monterey and Moss Landing. Sixteen trips were made between March and November 1960. Each tow was examined and species, amounts and sizes of fish discarded were recorded. This information, combined with records of market landings for each trip, formed the basis for this report.

Fifty-three species representing 23 families were encountered (Table 1). Common names in this report follow Roedel (1962).

[1] Submitted for publication January 1963.

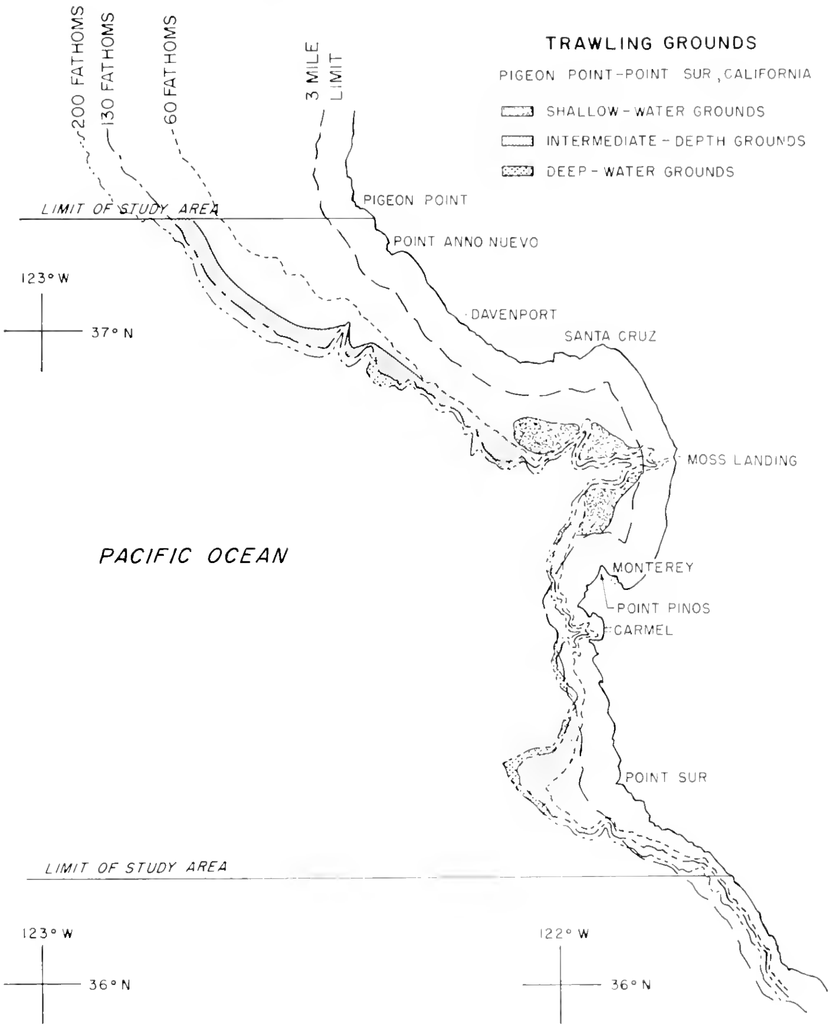

FIGURE 1. Principal trawling grounds in the Monterey Bay area.

DESCRIPTION OF THE FISHERY

General

Eight trawlers, based at Monterey Bay ports, fished during 1960, but only five worked consistently throughout the year. Four to seven fished during any one month.

TABLE 1

Common and Scientific Names of Species Observed in Monterey Bay Area Trawl Catches

Family Scyliorhinidae—cat sharks	
Brown cat shark	*Apristurus brunneus* (Gilbert)
Filetail cat shark	*Parmaturus xaniurus* (Gilbert)

Family Carcharhinidae—requiem sharks

Soupfin shark ________________ *Galeorhinus zyopterus* Jordan & Gilbert

Family Squalidae—dogfish sharks

Spiny dogfish ________________ *Squalus acanthias* Linnaeus

Family Torpedinidae—electric rays

Pacific electric ray ____________ *Torpedo californica* Ayres

Family Rajidae—skates

Sandpaper skate ______________ *Breviraja kincaidi* (Garman)
Big skate ___________________ *Raja binoculata* Girard
California skate ______________ *Raja inornata* Jordan & Gilbert
Longnose skate _______________ *Raja rhina* Jordan & Gilbert
Starry skate _________________ *Raja stellulata* Jordan & Gilbert

Family Chimaeridae—chimaeras

Ratfish _____________________ *Hydrolagus colliei* (Lay & Bennett)

Family Clupeidae—herrings

American shad ______________ *Alosa sapidissima* (Wilson)
Pacific herring ______________ *Clupea pallasi* Valenciennes

Family Gadidae—codfishes and hakes

Pacific hake _________________ *Merluccius productus* (Ayres)

Family Carangidae—jacks, scads and pompanos

Jack mackerel _______________ *Trachurus symmetricus* (Ayres)

Family Sciaenidae—croakers

White croaker _______________ *Genyonemus lineatus* (Ayres)

Family Embiotocidae—surfperches

Pile perch __________________ *Rhacochilus vacca* (Girard)
Pink seaperch _______________ *Zalembius rosaceus* (Jordan & Gilbert)

Family Scorpaenidae—rockfishes

Aurora rockfish ______________ *Sebastodes aurora* (Gilbert)
Greenspotted rockfish _________ *Sebastodes chlorostictus* (Jordan & Gilbert)
Darkblotched rockfish _________ *Sebastodes crameri* Jordan
Splitnose rockfish ____________ *Sebastodes diploproa* (Gilbert)
Greenstriped rockfish _________ *Sebastodes elongatus* (Ayres)
Widow rockfish ______________ *Sebastodes entomelas* (Jordan & Gilbert)
Yellowtail rockfish ____________ *Sebastodes flavidus* Ayres
Chilipepper _________________ *Sebastodes goodei* Eigenmann & Eigenmann
Shortbelly rockfish ___________ *Sebastodes jordani* Gilbert
Cow rockfish ________________ *Sebastodes levis* (Eigenmann & Eigenmann)
Blackgill rockfish ____________ *Sebastodes melanostomus* Eigenmann & Eigenmann
Vermilion rockfish ___________ *Sebastodes miniatus* (Jordan & Gilbert)
Speckled rockfish ____________ *Sebastodes ovalis* Ayres
Bocaccio ___________________ *Sebastodes paucispinis* (Ayres)
Canary rockfish ______________ *Sebastodes pinniger* (Jordan & Gilbert)
Stripetail rockfish ____________ *Sebastodes saxicola* (Gilbert)
Sharpchin rockfish ___________ *Sebastodes zacentrus* (Gilbert)
Shortspine channel rockfish ___ *Sebastolobus alascanus* Bean

Family Anoplopomatidae—sablefishes

Sablefish ___________________ *Anoplopoma fimbria* (Pallas)

Family Hexagrammidae—greenlings

Lingcod ____________________ *Ophiodon elongatus* Girard

Family Zaniolepidae—combfishes

Longspine combfish __________ *Zaniolepis latipinnis* Girard

Family Cottidae—sculpins

Threadfin sculpin ---------- *Icelinus filamentosus* Gilbert

Family Agonidae—poachers

Poachers ------------------- not identified to species

Family Anarhichadidae—wolffishes

Wolf-eel ------------------- *Anarrhichthys ocellatus* Ayres

Family Zoarcidae—eelpouts

Eelpouts ------------------- not identified to species

Family Ophidiidae—cusk-eels

Spotted cusk-eel ------------- *Otophidium taylori* (Girard)

Family Bothidae—lefteye flounders

Pacific sanddab ------------- *Citharichthys sordidus* (Girard)

Family Pleuronectidae—righteye flounders

Petrale sole ---------------- *Eopsetta jordani* (Lockington)
Rex sole ------------------- *Glyptocephalus zachirus* Lockington
Rock sole ------------------ *Lepidopsetta bilineata* (Ayres)
Slender sole ---------------- *Lyopsetta exilis* (Jordan & Gilbert)
Dover sole ----------------- *Microstomus pacificus* (Lockington)
English sole ---------------- *Parophrys vetulus* Girard
Curlfin turbot --------------- *Pleuronichthys decurrens* (Jordan & Gilbert)

Family Batrachoididae—toadfishes

Plainfin midshipman ---------- *Porichthys notatus* Girard

The fleet's size and activities in 1958 and 1959 were about the same as for 1960. In 1956, however, 14 boats trawled, with 6 to 13 operating in any one month, while during 1954, 17 vessels operated at one time or another. The number of active vessels depended on demand and price for trawl fish, availability of various species, and conditions in alternate fisheries that might attract fishermen.

This change in size of the trawl fleet is reflected by the effort expended. Total fishing days rose during the period 1951 through 1954, dropped in 1955, increased to an all-time high in 1956 and then decreased each year through 1960 (Figure 2).

During the decade 1951 to 1960, trawl landings rose from 2.0 million pounds in 1951 to 5.8 million in 1954, dipped to 4.7 million in 1955 and then rose to the all-time high of 7.3 million pounds in 1956. Subsequently, the catch from this area declined to 3.4 million pounds in 1959 and remained there in 1960 (Figure 2). The paralleling fluctuations in effort (days fished) and total catch indicate that catch was more dependent on fishing effort than availability or abundance of fish. That is, increased effort produced greater catches.

During this 10-year period, catch-per-day showed a rising trend, largely independent of effort or total catch (Figure 2). In fact, catch-per-day in the low-catch year, 1960, was higher than during the peak-catch years 1954 and 1956. A fishery with a rising catch-per-day and with total catch dependent primarily on effort should be in good condition.

However, catch-per-day varies markedly in different areas, on different boats, and for different species. If any change occurs in the fleet's

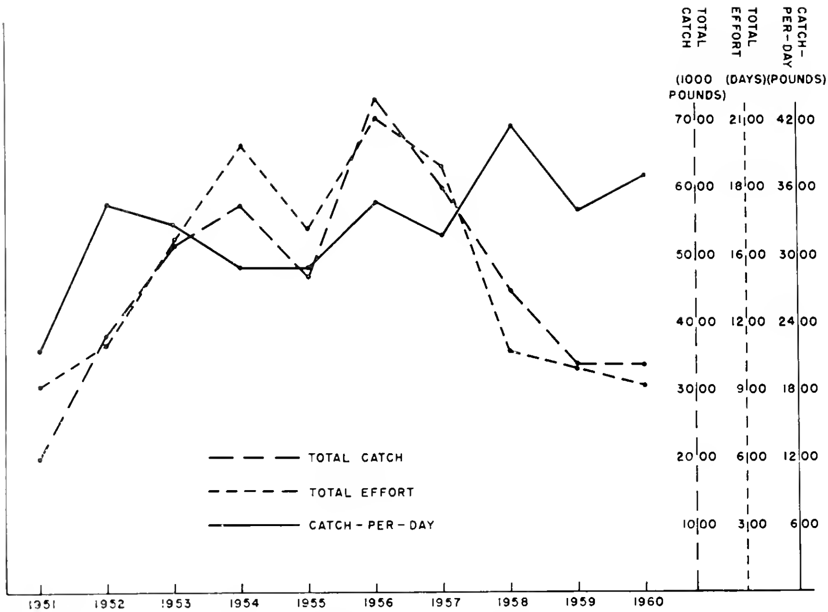

FIGURE 2. Total catch, total days fished, and catch per day from Pigean Point to Point Sur, California, 1951 through 1960.

composition or in fishing methods, a change may occur in catch-per-day that does not reflect the actual condition of the fish stocks. We must examine catch composition through these years to evaluate catch-per-day.

Species Landed

Since trawlers catch several marketable species, landing statistics of the entire fleet become complex. Fundamental information comes to light if the species with yearly landings of 150,000 pounds or more are considered (Figure 3).

Prior to 1950, rockfish were of only minor importance in the trawl catch. Their increased utilization in the past 10 years has been the principal factor influencing the fishery's rapid expansion. Since 1950, the combined catch of all rockfish species has dominated landings from this area. The catch of associated species, especially sablefish, increased with greater rockfish effort. As a result, total catch increased by more than the additional rockfish caught.

In recent years, proportions of the several rockfish species landed have changed. In 1959 and 1960, some trawlers fished in deeper water than previously. Their catches were largely splitnose rockfish, a species previously discarded. In 1960, this species made up 16.8 percent of the total trawl catch, with landings of over 0.5 million pounds. Catches of splitnose rockfish have not increased total landings because this species replaced others in the catch.

Catches of English and petrale sole, which are taken in much shallower water than rockfish, remained fairly stable through 1957, then

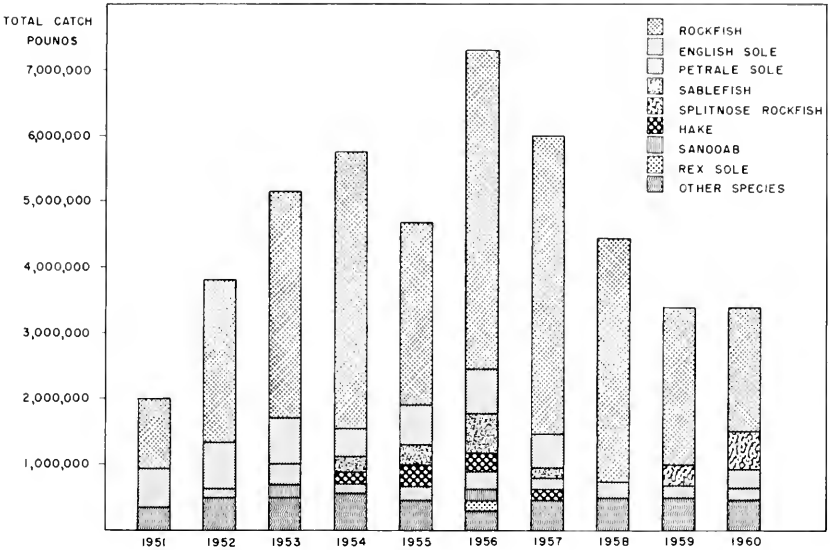

FIGURE 3. Composition of trawler landings from the area between Pigeon Point and Point Sur, California, during 1951-1960. All categories with landings of over 150,000 pounds are shown separately; all others are lumped as "other species."

dropped abruptly to about one-half their former level from 1958 through 1960.

Changes in rockfish species composition and decreased catches of English and petrale sole may have influenced catch-per-day in the study area. Two observable changes in the fishery seem at odds with a rising trend in catch-per-day. First, increased use of splitnose rockfish indicates a shortage of the more-desirable rockfishes such as bocaccio and chilipepper on the fishing grounds. Second, the sudden decrease in English and petrale sole catches in 1958 indicates less effort was expended on them, suggesting the rewards of this fishery were not as great as in past years. These observations indicate a decline in the fishery which is not evidenced by catch-per-day because of a drop in effort on high-value species with a low catch-per-day (English and petrale sole) and an increase in effort on a low-value species with a high catch-per-day (splitnose rockfish).

Fishing Areas

A trawl fishery is actually a complex of several sub-fisheries, with the trawler taking different groups of fish in different areas and depths. The Monterey Bay area trawl fishery is characterized by three sub-fisheries; a shallow-water one in 30 to 60 fathoms, an intermediate-depth one in 60 to 130 fathoms, and a deep-water one in 130 to 200 fathoms (Figure 1). Since the catch of each sub-fishery is independent of the others, each must be considered separately before it is possible to understand the total trawl fishery.

The amount of ocean floor available for trawling is limited by bottom topography and legal restrictions prohibiting trawling within 3 nautical miles of the mainland. Since trawling entails dragging a net along the ocean floor, the bottom must be relatively smooth. Much of the area within Monterey Bay over 60 fathoms deep, and many other local areas are rough and must be avoided by trawlers. The law prohibiting trawling within 3 miles of shore has its greatest effect on the shallow-water sub-fishery where a great deal of trawlable area lies. This law also eliminates from the deep-water sub-fishery areas off Carmel and south of Point Sur, where depths exceeding 200 fathoms occur within 3 miles of shore.

Shallow-water sub-fishery

Flatfishes most abundant in 30 to 60 fathoms make up the bulk of the shallow-water sub-fishery catch. During 1960, 35.7 percent of the trawlers' fishing days were spent on this sub-fishery. Although this effort produced only 12.8 percent of the landings, the higher prices paid for flatfish partially compensated for smaller catches.

The principal shallow areas exploited are flats within Monterey Bay available to relatively small trawlers which could not travel to more distant grounds.

Intermediate-depth sub-fishery

This was the most important of the three sub-fisheries. Rockfish are most abundant in 60 to 130 fathoms and several species make up the bulk of the catch. Trawlers expended 50.1 percent of their effort (days) on this sub-fishery during 1960, and produced 64.6 percent of the total landings.

Most of the trawlable bottom in these depths is off Point Sur and Santa Cruz. Small trawlable areas off Point Pinos and Point Año Nuevo are fished when the primary areas fail to yield adequate catches.

Deep-water sub-fishery

The sub-fishery at 130 to 200 fathoms became significant in 1959 and 1960. These grounds produce mainly splitnose rockfish, a species previously shunned by markets. In 1960, this sub-fishery received 14.2 percent of the total trawling effort and produced 22.6 percent of the total catch. The market price for splitnose rockfish is among the lowest paid for trawled species. As a consequence, catches must be large to make their harvest profitable.

The areas utilized by this sub-fishery are, for the most part, adjacent to the intermediate-depth rockfish grounds off Santa Cruz and Davenport. Some catches are made between Carmel and Point Sur and off Point Pinos.

CATCH SAMPLING AT SEA

Eight 1-day trips were made to sample the intermediate-depth sub-fishery, 5½ to sample the shallow-water sub-fishery and 2½ to sample the deep-water sub-fishery. The half days occurred when, on one trip, half a day was spent on the deep-water sub-fishery and the rest of the day on the shallow-water sub-fishery. Thus, 50.0 percent of the sampling effort was on the intermediate-depth sub-fishery, 34.4 percent on the shallow-water sub-fishery, and 15.6 percent on the deep-water sub-fishery. This compares well with the days of effort spent on the respective sub-fisheries by the fleet during 1960.

Each tow on each trip was enumerated separately. When possible, we counted and weighed all fish to be discarded and measured all important species. Minor constituents of the marketable catch were also enumerated at sea. The catch of major marketable species was recorded from landing receipts for the day a vessel was sampled.

Occasionally catches were so large or contained so many unmarketable fish that we could take only a sample of the catch. In these cases, the sample was related to total take of the drag, and its composition calculated.

Sampling data included a complete breakdown of each tow by weight of fish caught, marketed, and discarded. These data were combined to show the species composition of each sub-fishery. Similar species in each sub-fishery were combined into four groups: rockfish, flatfish, sharks and rays, and miscellaneous. In the following discussion, all percentages relate to weight.

Shallow-Water Sub-Fishery

The average catch of 10 shallow-water tows was 961.3 pounds (Table 2). By weight, the catch was composed of 9.2 percent rockfish, 51.5 percent flatfish, 18.2 percent sharks and rays, and 21.1 percent miscellaneous (Figure 4).

Large amounts of unmarketable species resulted in an overall discard of 43.1 percent. The major objective of this sub-fishery was flatfish; other marketable fish were a bonus.

Rockfish

Rockfish made up 9.2 percent of the catch, and because comparatively large proportions were unmarketable, 44.3 percent were discarded. Bocaccio were most abundant, making up 53.2 percent. Only an occasional small one was discarded.

Stripetail rockfish were next in importance, amounting to 29.3 pounds in an average rockfish catch of 88.5 pounds. All were small and thus were discarded. This species alone made up 74.7 percent of the rockfish discard.

Shortspine channel rockfish and greenstriped rockfish made up another 8.4 percent of the catch. Since greenstriped rockfish were not of marketable size and shortspine channel rockfish were not desired, both were discarded.

The above four species comprised 94.8 percent of the rockfish catch. Another six species made up the remaining 5.2 percent. These six were potentially marketable species and only small specimens were discarded. Some greenspotted and chilipepper rockfish, and all splitnose and darkblotched rockfish were discarded because of size. The few cow and canary rockfish caught were marketed.

Flatfish

Flatfish were the objective of these tows and comprised 51.5 percent of the catch. Because of a relatively small discard, 77.3 percent of the marketed fish were of this group. Discard amounted to 14.6 percent of the 495.2 pounds of flatfish in an average tow.

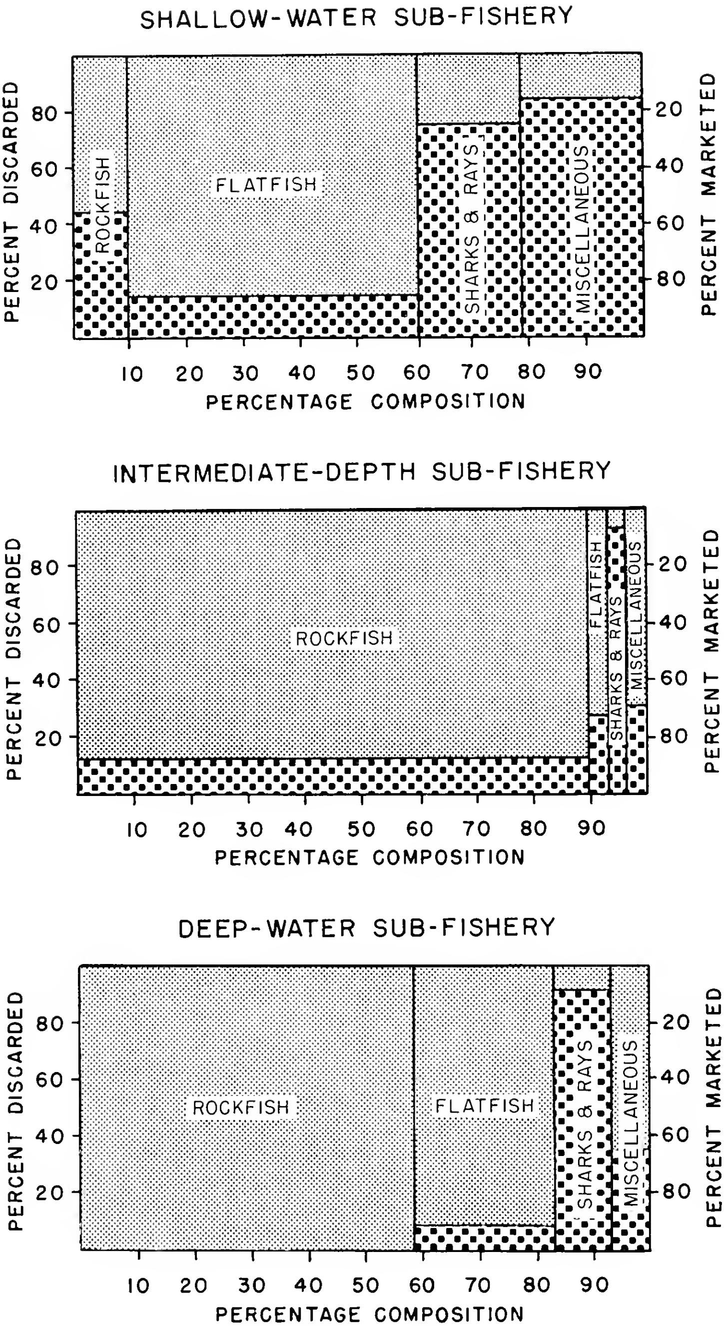

FIGURE 4. Composition of trawler catches from the shallow-water, intermediate-depth, and deep-water trawl sub-fisheries in the Monterey Bay area, based on sampling at sea during 1960. The smaller stipling represents marketed fish, the larger stipling discarded fish.

TABLE 2

Catch Composition of 10 Shallow-Water Sub-Fishery Tows Made Between Pigeon Point and Point Sur, California, March to November, 1960

Group and Species	Caught				Discarded			Number of occurrences (tows)
	Total pounds	Percent of group total	Percent of sub-fishery total	Average pounds per tow	Total pounds	Percent of species total	Average pounds per tow	
ROCKFISH	**885**	**100.0**	**9.2**	**88.5**	**392**	**44.3**	**39.2**	
Bocaccio	470	53.2	4.9	47.0	3	0.7	0.3	6
Stripetail rockfish	293	33.2	3.0	29.3	293	100.0	29.3	7
Shortspine channel rockfish	56	6.4	0.6	5.6	56	100.0	5.6	5
Greenstriped rockfish	18	2.0	0.2	1.8	18	100.0	1.8	5
Greenspotted rockfish	17	1.9	0.2	1.7	--	1.5	--	2
Chilipepper	11	1.2	0.1	1.1	7	62.8	0.7	6
Splitnose rockfish	8	0.9	0.1	0.8	8	100.0	0.8	4
Darkblotched rockfish	7	0.7	0.1	0.7	7	100.0	0.7	6
Canary rockfish	3	0.3	--	0.3	--	--	--	1
Cow rockfish	2	0.2	--	0.2	--	--	--	1
FLATFISH	**4,952**	**100.0**	**51.5**	**495.2**	**721**	**14.6**	**72.1**	
English sole	1,660	33.5	17.3	166.0	--	--	--	10
Petrale sole	1,534	30.9	16.0	153.4	--	--	--	9
Dover sole	828	16.7	8.6	82.8	266	32.1	26.6	9
Pacific sanddab	701	14.2	7.3	70.1	409	58.3	40.9	7
Rex sole	186	3.8	1.9	18.6	16	8.9	1.6	9
Slender sole	30	0.6	0.3	3.0	30	100.0	3.0	8
Curlfin turbot	13	0.3	0.1	1.3	--	--	--	4
SHARKS AND RAYS	**1,746**	**100.0**	**18.2**	**174.6**	**1,316**	**75.4**	**131.6**	
Longnose skate	1,134	65.0	11.8	113.4	764	67.4	76.4	10
Spiny dogfish	294	16.9	3.1	29.4	294	100.0	29.4	9
Ratfish	142	8.1	1.5	14.2	142	100.0	14.2	6
California skate	120	6.8	1.2	12.0	110	91.6	11.0	6
Big skate	50	2.9	0.5	5.0	--	--	--	2
Pacific electric ray	6	0.3	0.1	0.6	6	100.0	0.6	1
MISCELLANEOUS	**2,030**	**100.0**	**21.1**	**203.0**	**1,710**	**84.2**	**171.0**	
Pacific hake	1,477	72.8	15.4	147.7	1,477	100.0	147.7	10
Lingcod	180	8.9	1.9	18.0	15	8.3	1.5	5
Sablefish	135	6.6	1.4	13.5	44	32.5	4.4	8
Plainfin midshipman	114	5.6	1.2	11.4	114	100.0	11.4	9
Pile perch	62	3.0	0.6	6.2	--	--	--	2
Threadfin sculpin	24	1.2	0.2	2.4	24	100.0	2.4	6
Longspine combfish	19	0.9	0.2	1.9	19	100.0	1.9	6
White croaker	10	0.5	0.1	1.0	8	79.0	0.8	2
Wolf-eel	7	0.4	0.1	0.7	7	100.0	0.7	1
Poachers	1	0.1	--	0.1	1	100.0	0.1	1
Pink seaperch	1	--	--	0.1	1	100.0	0.1	2
Pacific herring	--	--	--	--	--	100.0	--	1
Eelpouts	--	--	--	--	--	100.0	--	1
GRAND TOTAL	**9,613**	--	**100.0**	**961.3**	**4,139**	**43.1**	**413.9**	

English and petrale sole were the most prized species and made up 64.4 percent of the flatfish caught. All sizes and amounts were marketed. Petrales brought the highest price for trawl-caught fish.

Dover soles made up 16.7 percent of the flatfish catch. Usually, large catches of Dover soles were accepted by the Monterey markets; however, only recently have they been willing to take relatively small amounts and then only if the fish were longer than 14 inches. Thus, smaller fish were discarded and this discard amounted to 32.1 percent.

Quantities of Pacific sanddabs were taken, but since the market for them was very limited, fishermen discarded 58.3 percent of the 70.1 pounds taken in an average drag.

Rex soles contributed only 3.8 percent to the flatfish take. Of these, 8.9 percent were discarded because they were shorter than the market requirement of 12 inches.

Two other flatfishes, slender soles and curlfin turbots, constituted 0.9 percent of the flatfish taken. Slender soles were discarded, but curlfin turbots were marketed.

Sharks and rays

Sharks and rays comprised 18.2 percent of the total catch of the shallow-water tows. Since they have little market demand, the 75.4 percent discard for the group reflected dealer limits.

Longnose skates made up 65.0 percent of the 174.6 pounds of sharks and rays taken in an average drag. These and the less-abundant California and big skates were occasionally marketed. The marketed catch amounted to 33.0 percent of the total catch and was composed of 86.1 percent longnose, 11.6 percent big, and 2.3 percent California skates.

Dogfish and ratfish together represented 25.0 percent of the shark and ray catch, contributing 43.6 pounds in an average tow. These and Pacific electric rays, which made up only 0.3 percent of the shark and ray catch, were discarded.

Miscellaneous

Thirteen species formed the miscellaneous group. Only four had any value, the remainder were discarded. This group made up 21.1 percent of the average shallow-water tow, with 84.2 percent of these discarded.

The most valuable miscellaneous species was lingcod, taken at the rate of 18.0 pounds per tow and making up 8.9 percent of the group. The lingcod discard, consisting of an occasional small specimen, amounted to 8.3 percent.

Sablefish, pile perch, and white croakers were the other miscellaneous species with market value. These three made up 10.1 percent of the group, averaging 20.7 pounds per tow. All pile perch, 67.5 percent of the sablefish, and 21.0 percent of the white croakers were marketed.

Pacific hake comprised 72.8 percent of the miscellaneous catch. Since they have very soft flesh and are not marketed as food; all were discarded. Pacific hake made up 15.4 percent of the total catch and 35.7 percent of the total discard.

Eight other species constituted 8.2 percent of the miscellaneous catch. These were plainfin midshipmen, threadfin sculpins, longspine combfish, wolf-eels, an unidentified poacher, pink seaperch, Pacific herring, and an unidentified eelpout.

Intermediate-Depth Sub-Fishery

The average total catch-per-tow for 19 drags in intermediate depths was 2,559.5 pounds (Table 3). Rockfish made up 89.6 percent of this catch, with flatfish, sharks and rays, and miscellaneous fishes contributing about equal parts of the remainder (Figure 4). Total discard for these tows was 15.7 percent.

TABLE 3

Catch Composition of 19 Intermediate-Depth Sub-Fishery Tows Made Between Pigeon Point and Point Sur, California, March to November, 1960

	Caught				Discarded			
Group and Species	Total pounds	Percent of group total	Percent of sub-fishery total	Average pounds per tow	Total pounds	Percent of species total	Average pounds per tow	Number of occurrences (tows)
ROCKFISH	**43,589**	**100.0**	**89.6**	**2,294.2**	**5,033**	**11.5**	**264.9**	
Chilipepper	21,572	49.5	44.4	1,135.3	77	0.4	4.0	19
Bocaccio	15,180	34.9	31.2	798.9	12	0.1	0.6	18
Shortbelly rockfish	3,412	7.8	7.0	179.6	3,410	99.9	179.5	16
Widow rockfish	1,696	3.9	3.5	89.3	--	--	--	6
Stripetail rockfish	1,138	2.6	2.3	59.9	1,138	100.0	59.9	15
Greenstriped rockfish	387	0.9	0.8	20.4	387	100.0	20.4	13
Canary rockfish	86	0.2	0.2	4.5	--	--	--	9
Blackgill rockfish	86	0.2	0.2	4.5	--	--	--	1
Greenspotted rockfish	14	--	--	0.7	2	14.9	0.1	5
Cow rockfish	6	--	--	0.3	--	--	--	1
Sharpchin rockfish	5	--	--	0.3	5	100.0	0.3	1
Vermilion rockfish	3	--	--	0.2	--	--	--	1
Yellowtail rockfish	2	--	--	0.1	--	--	--	1
Splitnose rockfish	1	--	--	0.1	1	57.2	--	2
Shortspine channel rockfish	1	--	--	0.1	1	100.0	0.1	1
FLATFISH	**1,630**	**100.0**	**3.4**	**85.8**	**435**	**26.7**	**22.9**	
Rex sole	619	38.0	1.3	32.6	205	33.2	10.8	18
English sole	419	25.7	0.9	22.1	25	5.9	1.3	18
Petrale sole	353	21.6	0.7	18.5	2	0.5	0.1	17
Dover sole	178	10.9	0.4	9.4	175	98.1	9.2	13
Pacific sanddab	27	1.7	0.1	1.4	16	59.4	0.9	9
Curlfin turbot	20	1.3	--	1.1	--	--	--	5
Slender sole	12	0.7	--	0.6	12	100.0	0.6	10
Rock sole	2	0.1	--	0.1	--	--	--	1
SHARKS AND RAYS	**1,781**	**100.0**	**3.7**	**93.7**	**1,656**	**93.0**	**87.1**	
Ratfish	600	33.7	1.2	31.5	600	100.0	31.5	11
Longnose skate	548	30.8	1.1	28.8	548	100.0	28.8	18
Spiny dogfish	251	14.1	0.5	13.2	251	100.0	13.2	17
Big skate	169	9.5	0.4	8.9	169	100.0	8.9	2
Soupfin shark	125	7.0	0.3	6.6	--	--	--	2
Pacific electric ray	51	2.8	0.1	2.7	51	100.0	2.7	7
Sandpaper skate	24	1.4	0.1	1.3	24	100.0	1.3	3
California skate	11	0.6	--	0.6	11	100.0	0.6	2
Starry skate	2	0.1	--	0.1	2	100.0	0.1	1
MISCELLANEOUS	**1,629**	**100.0**	**3.3**	**85.8**	**513**	**31.5**	**27.0**	
Lingcod	629	38.6	1.3	33.1	--	--	--	12
Sablefish	455	27.9	0.9	24.0	72	15.9	3.8	10
Plainfin midshipman	217	13.3	0.5	11.5	217	100.0	11.5	7
Jack mackerel	112	6.9	0.2	5.9	8	6.6	0.4	4
Pacific hake	103	6.3	0.2	5.4	103	100.0	5.4	5
Threadfin sculpin	63	3.9	0.1	3.3	63	100.0	3.3	18
American shad	33	2.0	0.1	1.7	33	100.0	1.7	6
Longspine combfish	11	0.7	--	0.6	11	100.0	0.6	8
Eelpouts	5	0.3	--	0.3	5	100.0	0.3	2
Pacific herring	1	0.1	--	--	1	100.0	--	1
Spotted cusk-eel	--	--	--	--	--	100.0	--	1
Pink seaperch	--	--	--	--	--	100.0	--	1
GRAND TOTAL	**48,629**	--	**100.0**	**2,559.5**	**7,637**	**15.7**	**401.9**	

Rockfish

Fifteen species of rockfish were taken; some frequently and in large amounts, others only rarely and in minute quantities. This group contained desirable as well as unmarketable species. As a group, 11.5 percent of the rockfish caught were discarded. Discards of individual species varied from zero to 100 percent.

Chilipeppers and bocaccio were the sought-after species in this sub-fishery. They made up 84.4 percent of the rockfish catch with 1,934.2 pounds in an average drag. They were caught and marketed together as "rockfish." Chilipeppers were dominant in the tows sampled, making up 58.7 percent of the combined total of these two species. Proportions in individual tows varied, however, from 100 percent chilipeppers to 95 percent bocaccio. Few individuals of unmarketable size were taken, with the result that only 0.4 percent of the chilipeppers and 0.1 percent of the bocaccio were discarded.

Widow rockfish appeared erratically in the catch and were marketed with the bocaccio-chilipepper complex. They were taken in 6 of 19 tows in amounts varying from 3.5 to 1,506.0 pounds and made up 3.9 percent of the rockfish catch. Only large specimens were caught so none was discarded.

Shortbelly, stripetail, and greenstriped rockfish together made up 11.3 percent of the rockfish group. These are all small species, attaining maximum lengths of 12, 13 and 15 inches respectively (Phillips, 1957). Often they were netted in considerable poundages; but because of their size they have no market value and were discarded. They made up 98.1 percent of the rockfish discard and 64.6 percent of all poundages discarded from intermediate-depth tows. On one occasion, 690 pounds of shortbelly rockfish were ground as animal food, rather than being discarded.

The above six species made up 99.6 percent of the rockfish catch in the intermediate-depth sub-fishery. Nine other rockfishes averaged only 10.8 pounds per drag. Five of these made up 9.6 pounds per drag and were valuable; none was discarded. These were the canary, blackgill, cow, vermilion and yellowtail rockfishes. Greenspotted rockfish generally were handled with these five, except for a few small specimens that were discarded. The remaining three species (sharpchin, splitnose and shortspine channel rockfish) contributed only 7 of over 43,500 pounds of rockfish caught.

Flatfish

The role of flatfishes in the intermediate-depth sub-fishery is variable, depending on whether the amounts and kinds caught justify bringing them to market. Thus, from zero to several hundred pounds of flatfish may be unloaded at the dock.

Flatfish as a group comprised but 3.4 percent of the total catch at intermediate depths. They were caught in comparatively small amounts, varying from 8.8 to 264.3 pounds. Eight species were taken, with an average catch of 85.8 pounds; 26.7 percent were discarded.

Rex soles, the principal flatfish in these drags, represented 38.0 percent of the flatfish catch. Markets do not utilize rex soles under 12 inches long or accept small landings. This resulted in a discard of 33.2 percent.

English sole comprised 25.7 percent of the flatfish catch. Most were marketed, although 5.9 percent, usually small fish or small catches, were discarded.

Petrale soles were almost always saved, even small amounts. They made up 21.6 percent of the flatfish catch, and only 0.5 percent were discarded.

Although valuable when caught in quantity, small amounts of Dover sole were not marketable in the Monterey area. The average catch per intermediate-depth tow was 9.4 pounds, 98.1 percent being discarded.

These four species constituted 96.2 percent of the flatfish catch. Of the remaining species, Pacific sanddabs averaged 1.4 pounds per drag and were generally discarded. Curlfin turbots and rock soles were taken occasionally and marketed. One other very small flatfish, the slender sole, was taken in very small quantities; it has no market value.

Sharks and rays

This group made up 3.7 percent of the catch from intermediate-depth tows. Only one of the nine species was saved for the markets. As a result, 93.0 percent of the shark and ray catch was discarded. As small as this group was in relation to total catch, high discard resulted in sharks and rays making up 21.6 percent of total discard.

The only valuable species, the soupfin shark, was always kept. Soupfins made up 7.0 percent of the shark and ray catch, but only 0.3 percent of the average take of an intermediate-depth tow.

Ratfish, longnose skates, and dogfish comprised 78.6 percent of the shark and ray catch. These were always discarded. Longnose skates were accepted in limited quantities by Monterey markets; however, the demand was usually filled by boats from the shallow-water sub-fishery.

Another five species of sharks and rays were taken infrequently and in small amounts. These five (Pacific electric rays, big skates, sandpaper skates, California skates and starry skates) averaged 13.6 pounds per drag and were always discarded.

Miscellaneous

Twelve species taken in the intermediate-depth tows were lumped under miscellaneous. This group made up 3.3 percent of the take and includes some valuable species, as well as a host of small or otherwise unmarketable ones.

Lingcod, the most important, averaged 33.1 pounds per drag and amounted to 38.6 percent of the group. This species is valuable even in small amounts and none was discarded.

Small catches of sablefish were marketed with bocaccio and chilipepper, but larger catches were sorted and sold separately. They contributed 27.9 percent of the miscellaneous catch, and had a discard of 15.9 percent.

Jack mackerel were caught during the summer and marketed when in quantity. They were taken in four tows, in amounts ranging from 7.5 to 47.0 pounds. The discard was 6.6 percent.

Nine species were valueless and were always discarded. These were plainfin midshipmen, Pacific hake, threadfin sculpins, American shad, longspine combfish, an unidentified eelpout, Pacific herring, spotted cusk-eels, and pink seaperch. Together the nine species made up 26.6 percent of the miscellaneous catch, but less than 1 percent of the total poundage taken in intermediate depths.

Deep-Water Sub-Fishery

Four tows were sampled from the deep-water sub-fishery where the average catch was 2,258.4 pounds. Rockfish made up 58.4 percent; flatfish, 25.1 percent; sharks and rays, 9.6 percent; and miscellaneous, 6.9 percent (Table 4, Figure 4). The overall discard for these tows was the least for the three sub-fisheries sampled, amounting to 14.0 percent.

Rockfish

Fifteen species of rockfish were taken in these tows. They made up 58.4 percent of the catch, averaging 1,318.2 pounds per haul. Discard amounted to 0.9 percent.

Splitnose rockfish were by far the most important, amounting to 75.9 percent of the rockfish catch. These became important at Monterey in 1959 and 1960; prior to then, they were not sought and were discarded when taken incidentally. Splitnose rockfish do not attain as large a size as other commercial rockfish; their maximum lengths are 18 inches compared to 36 inches for bocaccio and 22 inches for chilipeppers (Phillips, 1957). Although they bring a lower price than bocaccio and chilipeppers, they were the principal objective and represented 76.6 percent of the marketed rockfish and 51.5 percent of all marketed fish from the deep-water sub-fishery. They were seldom too small, hence few were discarded.

Chilipeppers and bocaccio, the only other important rockfishes, amounted to 21.0 percent of the group. None was discarded. They made up only 12.3 percent of the total deep-water catch, compared to 75.6 percent of the total intermediate-depth catch.

The remaining 12 species made up only 3.1 percent of the rockfish catch. Darkblotched rockfish amounted to 1.0 percent of the group; they reach an acceptable size in deep water and most were marketed. All widow, cow, greenspotted, blackgill, canary, and speckled rockfish were marketed, but all shortbelly, stripetail, shortspine channel, greenstriped, and aurora rockfish were discarded because of their small sizes.

Flatfish

Flatfishes made up 25.1 percent of the catch from deep-water tows, averaging 566.0 pounds per haul. This was over six times the average taken in intermediate-depth tows, and about 70 pounds more than was taken in the shallow-water tows. The comparatively large flatfish catches from deep water were of both migratory and resident species.

Petrale soles contributed the greatest amounts to the deep-water sub-fishery. These migrate to deep water in the winter to spawn. One October drag caught 720 pounds, which was 94.1 percent of the petrale sole taken in the four deep-water tows. Petrale soles are not as available to this sub-fishery during summer. Overall, they made up 33.8 percent of the flatfish taken.

English soles contributed 22.2 percent of the flatfish deep-water catch and all were marketed.

TABLE 4

Catch Composition of 4 Deep-Water Sub-Fishery Tows Made Between Pigeon Point and Point Sur, California, March to November, 1960

Group and Species	Caught				Discarded			Number of occurrences (tows)
	Total pounds	Percent of group total	Percent of sub-fishery total	Average pounds per tow	Total pounds	Percent of species total	Average pounds per tow	
ROCKFISH	**5,273**	**100.0**	**58.4**	**1,318.2**	**50**	**0.9**	**12.5**	
Splitnose rockfish	4,000	75.9	44.3	1,000.0	1	--	0.3	4
Chilipepper	764	14.5	8.5	191.0	--	--	--	3
Bocaccio	341	6.5	3.8	85.4	--	--	--	3
Darkblotched rockfish	53	1.0	0.6	13.2	1	1.9	0.2	2
Widow rockfish	33	0.6	0.4	8.2	--	--	--	3
Shortbelly rockfish	21	0.4	0.2	5.3	21	100.0	5.3	2
Stripetail rockfish	20	0.4	0.2	4.9	20	100.0	4.9	2
Cow rockfish	15	0.3	0.2	3.8	--	--	--	2
Greenspotted rockfish	10	0.2	0.1	2.4	--	--	--	2
Shortspine channel rockfish	6	0.1	0.1	1.6	6	100.0	1.6	2
Blackgill rockfish	4	0.1	--	1.0	--	--	--	1
Canary rockfish	3	--	--	0.6	--	--	--	1
Speckled rockfish	2	--	--	0.6	--	--	--	1
Greenstriped rockfish	1	--	--	0.1	1	100.0	0.1	1
Aurora rockfish	--	--	--	0.1	--	100.0	0.1	1
FLATFISH	**2,264**	**100.0**	**25.1**	**566.0**	**207**	**9.1**	**51.7**	
Petrale sole	765	33.8	8.5	191.2	--	--	--	4
Rex sole	756	33.4	8.4	189.1	55	7.2	13.6	4
English sole	503	22.2	5.6	125.8	--	--	--	4
Dover sole	238	10.5	2.6	59.4	150	63.4	37.6	4
Slender sole	2	0.1	--	0.5	2	100.0	0.5	3
SHARKS AND RAYS	**872**	**100.0**	**9.6**	**218.1**	**792**	**90.8**	**198.1**	
Ratfish	488	55.9	5.4	121.9	488	100.0	121.9	3
Longnose skate	169	19.4	1.9	42.2	169	100.0	42.2	4
Soupfin shark	80	9.2	0.9	20.0	--	--	--	1
Spiny dogfish	55	6.3	0.6	13.7	55	100.0	13.7	3
Pacific electric ray	41	4.7	0.4	10.3	41	100.0	10.3	2
Sandpaper skate	35	4.1	0.4	8.9	35	100.0	8.9	3
Filetail cat shark	3	0.3	--	0.8	3	100.0	0.8	2
Brown cat shark	1	0.1	--	0.3	1	100.0	0.3	1
MISCELLANEOUS	**625**	**100.0**	**6.9**	**156.1**	**220**	**35.2**	**54.9**	
Sablefish	372	59.7	4.1	93.1	--	--	--	3
Pacific hake	216	34.5	2.4	54.0	216	100.0	54.0	4
Lingcod	33	5.2	0.4	8.1	--	--	--	2
Eelpouts	3	0.4	--	0.6	3	100.0	0.6	1
Threadfin sculpin	1	0.2	--	0.3	1	100.0	0.3	1
Poachers	--	--	--	--	--	100.0	--	1
GRAND TOTAL	**9,034**	--	**100.0**	**2,258.4**	**1,269**	**14.0**	**317.2**	

Rex and Dover soles made up 33.4 and 10.5 percent of the flatfish catch respectively. These soles are of marginal value at Monterey and the amounts marketed and discarded depend on the relative amounts of other species in the catch, market demand, and fish sizes. The discard amounted to 7.2 percent for rex soles and 63.4 percent for Dovers.

Slender soles, the only other flatfish taken, made up just 0.1 percent of the group. All were discarded.

Sharks and rays

This group comprised 9.6 percent of the deep-water catch, averaging 218.1 pounds per drag. Scarcity of marketable species resulted in a discard of 90.8 percent, which was 62.4 percent of the discard from the entire deep-water sub-fishery.

Soupfin sharks made up 9.2 percent of the sharks and rays caught, and were the only members in this group not discarded. Ratfish and longnose skates were the largest contributors to the shark and ray group, amounting to 55.9 and 19.4 percent respectively. Dogfish, Pacific electric rays, and sandpaper skates made up 15.1 percent; filetail and brown cat sharks constituted the remaining 0.4 percent.

Miscellaneous

This group made up 6.9 percent of the deep-water catch and contributed 156.1 pounds to an average tow. Only six species comprised the deep-water miscellaneous group compared to the 12 and 13 species, respectively, from intermediate-depth and shallow-water tows. Discard for the group was 35.2 percent.

Sablefish and hake were 94.2 percent of this group. All sablefish, amounting to 93.1 pounds per drag, were marketed. The soft-fleshed hake averaged 54.0 pounds per tow and all were discarded.

All lingcod were marketed but contributed only 8.1 pounds per tow. Other than sablefish, lingcod was the only valuable miscellaneous species. Unidentified eelpouts, threadfin sculpins, and unidentified poachers made up just 0.9 pounds per tow. These small, valueless fishes were discarded.

Comparison of Sub-fisheries

A comparison of catches of the shallow-water, intermediate-depth and deep-water sub-fisheries revealed that fishermen can direct their efforts toward definite groups of fishes (Figure 5).

English sole, petrale sole, and Pacific hake were the leading species in the shallow-water sub-fishery, contributing 467.1 pounds (48.7 percent) of 961.3 pounds in an average drag. Longnose skates, Dover soles, and Pacific sanddabs were next in importance, comprising 266.3 pounds (27.7 percent). The last of the 10 top-ranking species were bocaccio, spiny dogfish, stripetail rockfish and rex sole. These 10 species averaged 857.7 pounds, or 89.3 percent of the catch from shallow-water tows.

The two leading species of the intermediate-depth sub-fishery were bocaccio and chilipepper. Together they made up 1,934.2 pounds (75.6 percent) of 2,559.5 pounds in an average tow. The next three species, shortbelly, widow, and stripetail rockfish, contributed 328.8 pounds (12.8 percent) of the total. The last five high-ranking species, in order of importance, were lingcod, rex sole, ratfish, longnose skate, and sablefish. These 10 contributed 2,413.0 pounds (94.2 percent) of an average tow.

Deep-water landings were dominated by splitnose rockfish which made up 44.3 percent of the 2,258.4 pounds in an average tow. The next three important species were petrale sole, chilipepper and rex sole, accounting for 571.3 pounds (25.4 percent). English sole, sablefish, and

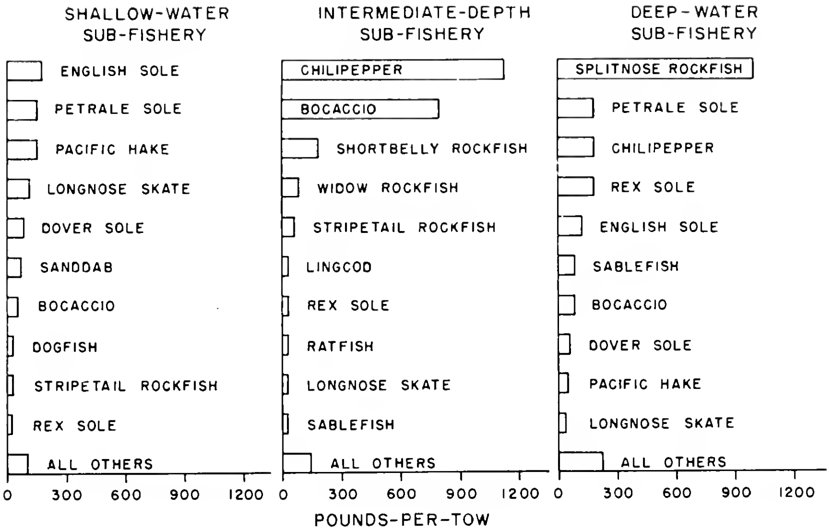

FIGURE 5. The average catch-per-tow of the 10 most important species in the shallow-water, intermediate-depth, and deep-water trawl sub-fisheries in the Monterey Bay area, based on sampling at sea during 1960.

bocaccio, amounting to 304.3 pounds, and Dover sole, Pacific hake, and longnose skate, contributing 155.6 pounds, complete the 10 most important species. These 10 contributed 2,031.2 pounds or 90.1 percent of an average deep-water drag.

Thus, the three sub-fisheries are characterized by different dominant species, and varying proportions of several other important species: (1) the shallow-water sub-fishery by English and petrale soles, with large amounts of valueless hake and longnose skates; (2) the intermediate-depth sub-fishery by large catches of bocaccio and chilipeppers, with smaller amounts of both valuable and worthless species; (3) the deep-water sub-fishery by splitnose rockfish, with petrale soles, chilipeppers and rex soles also fairly important contributors.

Implications to the Party-Boat Fishery

This survey revealed no important sources of competition between the trawl and party-boat fisheries. With few exceptions, none of the 10 most important species in any of the three trawl sub-fisheries were or are important sportfishes. Sportfishing and trawling take place in different depths and over different bottom types so that the areas fished and species caught by the two fisheries are separate.

Party boats fish in 50 fathoms (300 feet) or less, avoiding deeper water because of the time and effort required to reel in fish. Most trawling takes place in deeper water, effectively separating the two interests in many areas. Trawlers require a smooth bottom to prevent snagging their nets, while sportfishermen seek rocky banks and reefs where many species of fish congregate. Thus, even though some depths fished by trawlers and party boats are the same they fish over different types of bottom, and consequently catch different kinds of fish.

Additional areas of possible conflict are excluded by the law prohibiting trawling within 3 miles of shore. Most sportfishing activity occurs within this area closed to trawling.

These three factors separate the fisheries into areas where different species form the bulk of the catch. When a species is important to both fisheries, it is generally of much greater importance to one, or is wide-ranging. In either case, heavy pressure on such species by one fishery will have little effect on the combined take of the other. Therefore, since the areas fished and the species taken are different, competition is virtually impossible. This is the same conclusion Heimann and Miller (1960) reached in a similar study at Morro Bay.

Size of Fish

Various fish were measured whenever time and conditions permitted. Generally, emphasis was placed on measuring the species to be discarded. Marketable species were available for measuring after the catch was sorted. Total lengths to the nearest centimeter were recorded for each species in each sub-fishery (Figure 6).

Rockfish

Stripetail rockfish, the smallest rockfish taken, had about the same size distribution in both the intermediate-depth and deep-water sub-fisheries, thus the data were combined. Lengths ranged from 13 to 31 cm with 80 percent between 16.0 and 27.9. Their maximum reported size is 33.0 cm (Phillips, 1957).

Shortbelly rockfish also are too small to be marketable. In intermediate-depth tows, they ranged from 15 to 31 cm with 50 percent under 24.8. Somewhat larger fish were found in deep-water tows, where sizes ranged from 25 to 32 cm with the median at 28.5 cm. The largest, 32 cm, was longer than the previous 30.5 cm maximum size (Phillips, 1957).

Splitnose rockfish are somewhat of an anomaly. Although not much different in size range than shortbelly rockfish, they are much plumper and are fished for and marketed. Since they are readily available, the fishermen can catch them in quantity and the markets can buy them cheaply. Splitnose rockfish from deep water were 23 to 34 cm long with 50 percent over 29.3. Only 10 percent were over 31.3 cm.

Greenstriped rockfish are intermediate in size between splitnose rockfish and chilipeppers. Samples from intermediate depths were 19 to 37 cm long, with only 10 percent over 33.1. Their size would indicate marketability, however, their flesh is inferior to other rockfish and they are generally discarded. The maximum size recorded for this species is 38.1 cm (Phillips, 1957), not much more than the longest measured during this study.

In the intermediate-depth sub-fishery, marketable chilipeppers ranged from 32 to 50 cm, with 90 percent longer than 35.3. Discarded chilipeppers ranged from 19 to 35 cm with 90 percent under 28.6. Chilipeppers too small to be marketable were uncommon in the catch.

In the intermediate-depth sub-fishery bocaccio were larger than chilipeppers, ranging from 42 to 65 cm, with the median at 48.3. Bocaccio too small to be marketable were rare in the catch; in fact the whereabouts of those just under marketable size is somewhat of a mystery.

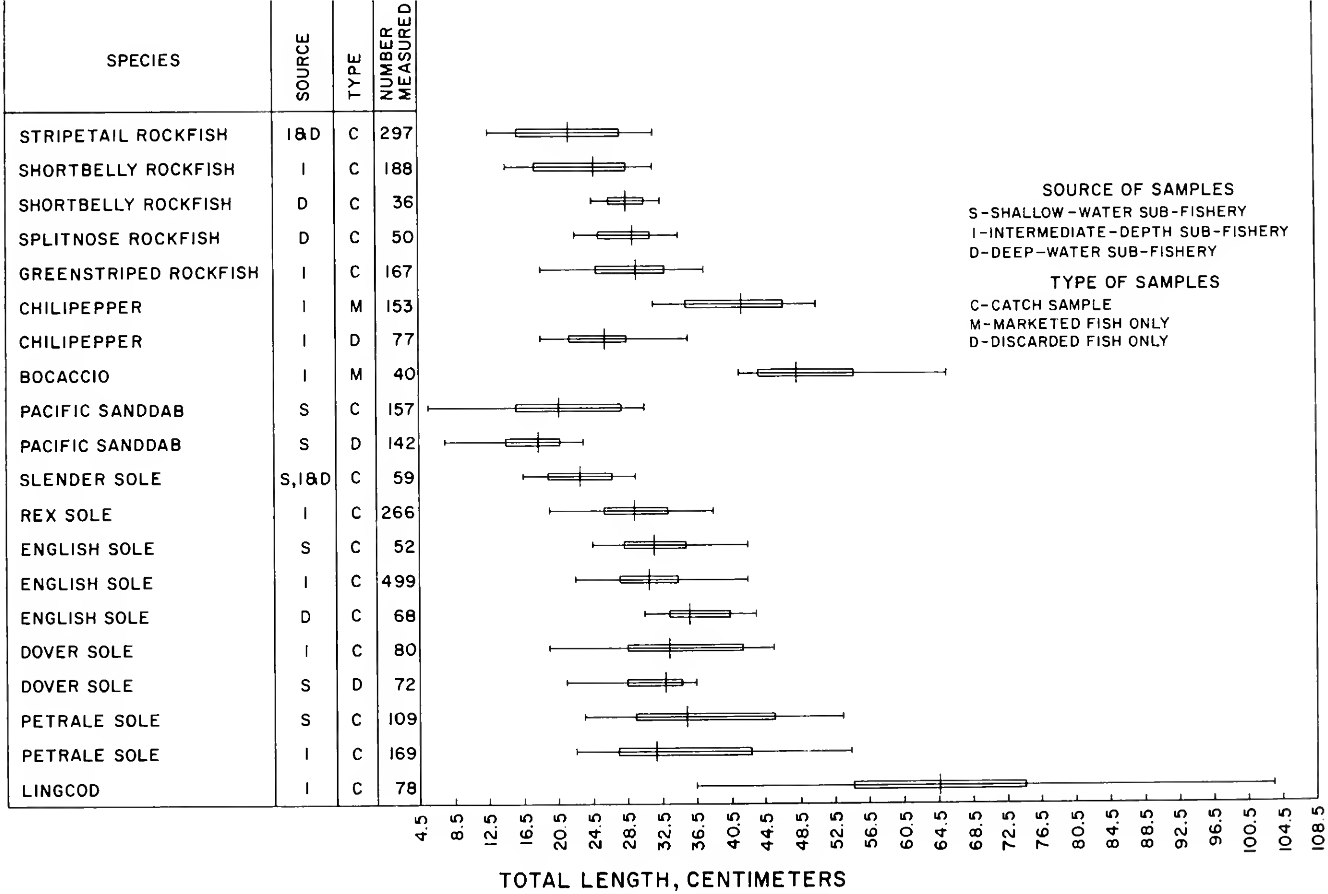

FIGURE 6. Lengths of some of the species taken by the trawl fishery during 1960 in the Monterey Bay area. The horizontal bar represents range in length, the vertical bar indicates the median length, and the hollow rectangle includes 80 percent of the measured fish: 40 percent above and 40 percent below the median.

Flatfish

Pacific sanddabs were the smallest flatfish taken. Although they ranged from 6 to 30 cm in the shallow-water sub-fishery, 90 percent were over 15.7 cm and 50 percent were over 20.8. Their small sizes accounted for the considerable discard. Of Pacific sanddabs discarded from the shallow-water sub-fishery, 90 percent were under 20.9 cm.

The size distribution of slender soles was similar to that of Pacific sanddabs except that no very small specimens were found. Sizes for all sub-fisheries combined ranged from 17 to 29 cm with the median at 23.2. Unlike Pacific sanddabs, this species has no value and all were discarded.

Rex soles in the intermediate-depth sub-fishery ranged from 20 to 38 cm with the median at 29.5. They are elongated compared to Pacific sanddabs, so their minimum marketable size was somewhat greater. Although 90 percent of the rex soles were over 25.9 cm long, a considerable portion of the catch was discarded.

In the intermediate-depth sub-fishery, English sole ranged from 23 to 42 cm, with the median at 31.1. Those from the shallow-water sub-fishery were 25 to 42 cm long, with the median at 31.8. In the deep-water catches they were 31 to 43 cm long, with the median at 36.3.

Since only the larger Dover soles were accepted by Monterey markets, their discard was relatively high. The discarded fish from the shallow-water tows ranged from 22 to 36 cm, with 90 percent under 34.8. The median size taken by the intermediate-depth sub-fishery was 33.9 cm.

Petrale soles were the largest flatfish taken during this study and virtually all were marketable. Those from shallow water ran larger than those from intermediate depths. Petrale soles from shallow water tows ranged from 24 to 53 cm, with 80 percent between 29.5 and 45.6. In intermediate depths the range was 23 to 54 cm, with 80 percent between 27.5 and 42.9.

Miscellaneous

Lingcod was the only species other than rockfish and flatfish for which we had a significant number of measurements. Those from intermediate depths ranged from 37 to 103 cm with the median at 64.6. Eighty percent were between 54.7 and 74.7 cm long.

SUMMARY

The Monterey Bay trawl fishery is centered between Pigeon Point and Point Sur. Eight trawlers operated from Monterey Bay ports in 1960, compared to 17 in 1956. During 1960, sixteen trips were made aboard these trawlers to obtain information on this fishery.

Landings from the fishery rose from 2.0 million pounds in 1951 to 7.3 million pounds in 1956, then declined to 3.4 million pounds in 1959 and 1960. This rise and decline was paralleled by similar fluctuations in effort, with catch-per-day exhibiting a slight rising trend.

The rockfish category, in which I have included all rockfish except splitnose, has dominated landings since 1951. In 1959 and 1960, splitnose rockfish replaced English sole in importance and became second-ranked. Change in proportions of English sole and splitnose rockfish

in the catch may have influenced catch-per-day without reflecting actual conditions of the stocks of fish.

The Monterey Bay trawl fishery consists of three sub-fisheries: a shallow-water sub-fishery (40 to 60 fathoms), an intermediate-depth sub-fishery (60 to 130 fathoms), and a deep-water sub-fishery (130 to 200 fathoms). The area available for trawling in each sub-fishery is limited by law and bottom topography. Sampling was proportional to the fishing effort of the three sub-fisheries.

An average shallow-water tow caught 961.3 pounds and was composed of 9.2 percent rockfish, 51.5 percent flatfish, 18.2 percent sharks and rays, and 21.1 percent miscellaneous. Discard amounted to 43.1 percent. The leading marketed species were English and petrale soles. Pacific hake and longnose skates were the principal constituents of the discard.

An average intermediate-depth tow caught 2,559.5 pounds and was composed of 89.6 percent rockfish, 3.4 percent flatfish, 3.7 percent sharks and rays, and 3.3 percent miscellaneous. Discard amounted to 15.7 percent. Bocaccio and chilipepper made up the bulk of the catch. Shortbelly and stripetail rockfish were the major species discarded.

An average deep-water tow caught 2,258.4 pounds and was composed of 58.4 percent rockfish, 25.1 percent flatfish, 9.6 percent sharks and rays, and 6.9 percent miscellaneous. Discard amounted to 14.0 percent. Splitnose rockfish was the principal species taken. Ratfish and Pacific hake were the principal species discarded.

No sources of competition with the party-boat fleet, in terms of species caught or areas fished, were revealed by this survey.

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Several department employees participated in this program. R. E. Jones accompanied me on most of the trips at sea and transcribed the initial data. Department marine biologists Julius B. Phillips, Daniel J. Miller, and C. E. Blunt, Jr., assisted in sampling at sea during the latter part of the study. D. W. Satterlee summarized much of the data necessary for this report. I am indebted to E. A. Best, H. G. Orcutt, and John L. Baxter for their suggestions and editorial assistance during the preparation of this report.

REFERENCES

Heimann, Richard F. G., and Daniel J. Miller
1960. The Morro Bay otter trawl and party boat fisheries August, 1957, to September, 1958. Calif. Fish and Game, vol. 46, no. 3, pp. 35-58.

Phillips, Julius B.
1957. A review of the rockfishes of California. Calif. Dept. Fish and Game, Fish Bull. no. 104, 158 pp.

Roedel, Phil M.
1962. The names of certain marine fishes of California. Calif. Fish and Game, vol. 48, no. 1, pp. 19-34.

DISTRIBUTION OF CALIFORNIA ANGLING EFFORT IN 1961 [1]

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ABSTRACT

The distribution of 1961 fishing effort by California's licensed anglers in fresh waters, ocean waters, and waters of San Francisco Bay and the Sacramento-San Joaquin Delta was estimated from a postal-card survey. Percentages of total angling days expended by licensed anglers in these waters, ordered as above, were 55.8, 29.4, and 14.8. Estimated percentages of licensed anglers who fished at least once in the different water types were 68.2, 47.0, and 20.3, while the percentages of licensees who fished only in a particular type of water were 31.1, 14.5, and 3.68, in the order mentioned above. An estimated 11.2 percent of licensees did not fish at all. Purchasers of about 124,000 3-day licenses good only in ocean waters were not included in the sampled population. The survey technique provided estimates corrected for nonresponse error but not for response error. Standard errors of the estimates were obtained.

INTRODUCTION

Sport fishermen, the fishing industry, and the Department of Fish and Game have indicated concern over the distribution of angling effort in California's ocean and inland waters. The department uses such information in planning future activities.

Within the past 15 years, several surveys produced estimates of the proportion of angling days expended in California ocean waters (Opinion Research Center, 1949; Skinner, 1955; Ryan, 1959) and one provided estimated proportions of fishing days spent in ocean waters, fresh waters, and San Francisco Bay and Sacramento-San Joaquin Delta waters (Clark, 1953).

This report gives the results of a mail survey designed to estimate the above proportions for 1961. In addition, estimated proportions and numbers of licensees fishing in each of the three types of waters, the proportion and numbers of licensees fishing exclusively in each of the three and the proportion and number who did not fish at all were obtained.

SURVEY ERRORS

Survey estimates are subject to many errors which can be fairly well classified into three general types: sampling error, response error and nonresponse error.

Sampling error includes those errors arising from sampling rather than censusing the population. It comprises statistical variability, bias of estimators, improper sample selection, and lack of correspondence between sampling frame and population, although the last could occur

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even if the entire frame were censused. Statistical methods are available for eliminating or estimating the magnitude of most sampling errors.

Response error reflects the difference between a characteristic's true value and that reported by a respondent. Difficulties in remembering events and interpreting questions, as well as a tendency by some persons to exaggerate catches and fishing activity, undoubtedly contribute to response error.

Nonresponse error occurs when the tendency to respond is correlated with the value being estimated. If fishermen who make many trips are more likely to return questionnaires than those who make few trips, nonresponse error results since the respondents do not represent the population.

The effects of response error, nonresponse error, or both on mail survey estimates were indicated by the results of a questionnaire designed to obtain various statistics on California sportfishing catch and effort for 1955. One question asked the respondent to give the number of days spent fishing on boats carrying passengers for hire. A simple expansion of mean days per licensee in this category yielded an estimate of over 1.4 million angler days (unpublished data, Marine Resources Operations), yet compulsory logbook records provided by boat captains showed that total angler days could not have exceeded 600,000. Data collected in the present survey also indicate nonresponse error was present.

Schemes developed for eliminating bias due to nonresponse generally involve field surveys of all, or a portion of, the nonrespondents. The method of nonresponse correction for this survey, while less satisfying statistically, requires no field survey and is easy to operate with a small staff and limited financial resources.

Eliminating response error would be quite difficult. Atwood (1956) studied this problem with respect to game kill on controlled hunting areas, but a similar investigation covering response characteristics of the many categories of anglers would be very expensive. The present survey makes no correction for response bias.

STATISTICAL DESIGN

General Estimation Procedure

For each of the 17 different estimates, the basic statistic is mean per licensee for the particular characteristic involved. To estimate these means, I used a procedure proposed by Chapman *et al.* (1959), for calculating dove kill. This scheme incorporates a correction for nonresponse error and provides for estimating sampling variability. Correcting for nonresponse involves mailing follow-ups to those not returning the original questionnaire and sending second follow-ups to persons not responding to either the first or second queries. A quadratic equation through the origin is fitted to the cumulative sums from the three response waves and the equation of the tangent to the curve at the point corresponding to the third response is derived. An estimated mean is obtained by extending the tangent out to the sample size and dividing the resulting value of the tangent by the sample size which is the number of questionnaires mailed less those undeliverable. Such estimates of the mean are obtained k times, each from a systematic sample with an independent random start. The average of the k sample values is used to estimate the mean. The variance of the mean is then estimated in a straightforward manner.

To define the estimation procedure in mathematical notation, let y_{ij} be the observed cumulative total for some characteristic from the ith response wave of the jth independent sample and let x_{ij} be the corresponding cumulative number of responses ($i = 1,2,3$; $j = 1,2, \ldots ,k$). The size of the jth sample is n_j. When a quadratic equation through the origin, $y = ax + bx^2$, is fitted by least squares, the formulas for the coefficients are

$$a_j = (\Sigma x_{ij}y_{ij}\, \Sigma x_{ij}^4 - \Sigma x_{ij}^3\, \Sigma x_{ij}^2 y_{ij})/D_j$$

$$b_j = (\Sigma x_{ij}^2\, \Sigma x_{ij}^2 y_{ij} - \Sigma x_{ij}y_{ij}\, \Sigma x_{ij}^3)/D_j$$

$$D_j = \Sigma x_{ij}^2\, \Sigma x_{ij}^4 - (\Sigma x_{ij}^3)^2$$

with all summations over i. The value of the required tangent at any x is $a_j x + b_j x_{3j}(2x - x_{3j})$ and at $x = n_j$ the estimate of the mean from the jth sample is $y_j^* = a_j + b_j x_{3j}(2n_j - x_{3j})/n_j$. Averaging these values over k samples, the estimated mean is $y.^* = \Sigma\, y_j^*/k$ and its estimated variance is $v(y.^*) = \Sigma\, (y_j^* - y.^*)^2/k(k-1)$.

Proportions of Angler Days in Different Waters

Mean days per licensee in each of the three waters is estimated from the jth sample with the formula for y_j^* and the combined estimate from k samples is obtained with the expression for $y.^*$. If we let s_j^*, f_j^*, and d_j^* correspond to y_j^* for ocean waters, fresh waters and San Francisco Bay and Delta waters, then $t_j^* = s_j^* + f_j^* + d_j^*$ is an estimate from the jth sample of mean days per licensee for all waters. Likewise, $s.^*$, $f.^*$, $d.^*$ and $t.^*$ are analogous to $y.^*$.

The ratio of two sample means is a biased estimator of the ratio of population means, even though the numerator and denominator of the sample ratio are unbiased estimators of their respective population means. In the present case the sample values cannot be assumed unbiased but it still seems desirable to reduce bias caused by the form of the ratio estimator; therefore, I used an almost unbiased ratio estimator described by Nieto de Pascual (1961).

To estimate the proportion of angling days spent in ocean waters, let $r_j = s_j^*/t_j^*$ and $r. = \Sigma r_j/k$. The estimated proportion is then $r^* = [k/(k-1)](s.^*/t.^*) - r./(k-1)$. An approximation to the variance of r^* is $v(r^*) = [C/(k-1)](s.^*/t.^*)^2 + (k-1)^{-2}[v(r.) - 3C(s.^*/t.^*)^2]$, where $C = \Sigma(s_j^* - s.^*)^2/[s.^{*2}(k-1)] + \Sigma(t_j^* - t.^*)^2/[t.^{*2}(k-1)] - 2\Sigma(s_j^* - s.^*)(t_j^* - t.^*)/[s.^* t.^*(k-1)]$ and $v(r.) = \Sigma(r_j - r.)/[k(k-1)]$.

Formulas for the proportions of angler days in fresh water or in San Francisco Bay and Delta are those above with f or d substituted for s.

Proportions and Numbers of Licensees Fishing in Different Waters

To estimate the proportion of licensees fishing in a particular water type, the formula for $y_{.}^{*}$ is used with y_{ij} the number of respondents in the ith response wave of the jth sample who reported fishing there. The number of persons fishing in the water type is estimated by $Ny_{.}^{*}$ where N is the number of licenses sold. An approximation to the variance of this estimate is $N^2v(y_{.}^{*})$.

Estimates and variances of the proportions and numbers of licensees fishing exclusively in the different areas are computed in a completely analogous manner, as are estimates of the proportions and numbers of licensees not fishing. In these cases y_{ij} is the number of anglers in response wave i of the jth sample who fished only in the water type of interest or, in estimating non-fishing licensees, the number of respondents who reported not fishing.

OPERATION OF THE SURVEY

Sample Selection

Carbon copies of 1,275,184 resident, non-resident, and 10-day 1961 angling licenses were available for sampling early in 1962. Almost 100,000 additional licenses were sold, but the copies could not be obtained soon enough to be sampled. Also, we omitted about 124,000 3-day Pacific Ocean licenses from the sampled population because they were good only in ocean waters. For this survey $k = 4$ was used.

To perform the sampling, four random numbers between 1 and 1,000 inclusive were drawn. The licenses were stacked in groups of 1,000, and from each group four licenses in the order corresponding to the random numbers were withdrawn without regard to legibility of name and address. This procedure supplied four systematic samples, each with an independent random start. Each sampled license was numbered to identify the recipient of the questionnaire as well as the sample to which he belonged.

Mailing Procedure

After deleting illegible licenses, a deck of IBM cards containing names, addresses and identification numbers was prepared. Questionnaires containing instructions and a request for cooperation were printed on continuous accounting machine forms divisible into double post cards. This allowed addressing and imprinting identification numbers by a 402 accounting machine. The forms for the original and follow-up mailings were identical except the portion requesting cooperation (Figure 1). The cards were mailed under a permit imprint and the reverse sides of the questionnaires were business reply cards. As returns were received their identifying numbers were punched into IBM cards for use in removing respondents' name and address cards from the addressing deck before the follow-up mailing. The original and follow-up mailings were spaced at 3-week intervals beginning February 1, 1962; responses postmarked more than 24 hours after a given mailing were considered returns from that mailing.

Please fill out and mail this card. You will help the California Department of Fish and Game improve fishing.

How many days in 1961 did you fish or gather shellfish in California?

Include days on which you caught nothing. If you did not fish, fill in zeros.

	Number of days
San Francisco Bay and Delta	☐
Fresh water	☐
Ocean and other bays	☐

To receive the results of this survey check here ☐

Dear Sportsman:

Will you take a minute to help us conduct a research study designed to improve the management of California's fisheries? We want to determine the number of angling days spent in the different kinds of California fishing waters in 1961. Good information can be had only with your assistance.

Please fill out the attached card as accurately as you can and mail it. Be sure to include days on which you caught nothing. If you did not fish during 1961 write zeros in all of the spaces.

We will be happy to send you the results of this study if you so indicate on the return card.

Thank you for your cooperation.

CALIFORNIA DEPARTMENT OF FISH AND GAME

Dear Sportsman:

About one month ago we wrote to you and asked your assistance in determining the amount of angling in California fishing waters. We are very anxious to receive your reply.

In case you misplaced our original communication, we are sending you the attached reply card. Please fill it out as accurately as you can and drop it in a mailbox.

Be sure to include days on which you caught nothing and if you did not fish in 1961, fill in the spaces with zeros.

Thank you.

CALIFORNIA DEPARTMENT OF FISH AND GAME

Dear Sportsman:

We have been anxiously awaiting word from you regarding the number of days you spent angling in the different types of California fishing waters during 1961. It is important that we receive your information because we cannot complete our survey without it.

Please fill out and mail the attached card (no postage stamp is necessary).

Be sure to include days on which you caught nothing. If you did not fish in 1961 fill in the spaces with zeros. Even if you did not fish, we need your reply telling us that.

Thank you for your help.

CALIFORNIA DEPARTMENT OF FISH AND GAME

FIGURE 1. Left to right, top to bottom. Questionnaire used on original and follow-up mailings, messages used for first, second and third mailings.

RESULTS

About 1.5 percent of the licenses selected had illegible names or addresses and about 8 percent had faulty addresses or lacked forwarding information resulting in effective sample sizes of 1,153, 1,147, 1,156, and 1,149. Of the initial samples, about 35, 23, and 9 percent of the questionnaires were returned in the first, second and third response waves respectively, for a total of about 67 percent (Table 1). The first follow-up obtained responses from about 35 percent of those who did not answer the original mailing and the second elicited replies from about 21 percent of those remaining after two mailings.

Distribution of Angler Effort

The estimated proportions of total angler effort spent in San Francisco Bay and Delta, fresh waters, and ocean waters are .148, .558, and .294, respectively. Coefficients of variation (standard error of the estimate divided by the estimate) are less than .015 (Table 2). Nonresponse bias, to the extent it is indicated by the fitted curves, $y = ax + bx^2$, would have been present in these estimates if the correction procedure had not been used. The curves are all concave downward (b's are negative), showing that licensees who fished fewer days were less likely to respond (Table 3). Estimates of total angler days are not presented because it is possible response bias was substantial. However, the estimated proportions will not be affected seriously if response bias is an approximately constant proportion of the true means for the three water types; this seems a rather reasonable assumption.

Proportion of Licensees Fishing Different Waters

Estimated proportions of licensees who fished at least one day in each of the three waters are .203, .682, and .470 for San Francisco Bay and Delta, fresh waters, and ocean waters, respectively. Accompanying coefficients of variation are below .045. The estimated numbers of licensees fishing in the three waters, ordered as above, are 277,410, 931,455, and 642,180. These were based on the sale of 1,365,410 licenses of the pertinent types. Again, the fitted curves are concave downward indicating a correction for nonresponse bias. Total numbers were estimated for the categories in this section because, intuitively, substantial response bias seems unlikely.

Some anglers fished in only one type of water. The estimated proportions of licensees who fished exclusively in each type are .0368, .311, and .145, listed in the previous order. Corresponding estimated numbers of anglers are 50,302, 424,711, and 198,435 and coefficients of variation range from .013 for fresh waters to .074 for San Francisco Bay and Delta. The fitted curves are concave downward in half of the samples and concave upward in the others, with curvatures less than for the other estimates. Thus, no clear evidence of nonresponse bias is present.

Apparently many persons who bought licenses did not fish. The proportion in this category is an estimated .112 or 152,598 licensees and the coefficient of variation is .073. The fitted curves are markedly concave upward (b's are positive), indicating that licensees who did not fish tended not to respond. This relates to the findings that licensees who fished fewer days were less likely to respond.

TABLE 1

Cumulative Sample Totals from 1961 Angling Effort Survey

	Sample 1			Sample 2			Sample 3			Sample 4		
Response wave	1	2	3	1	2	3	1	2	3	1	2	3
Days angled in:												
S. F. Bay and Delta	1390	2185	2399	1403	1930	2301	1126	1661	2073	1357	1877	2251
Fresh water	4947	7120	8216	4502	7205	8045	4230	6527	7756	4385	7545	8473
Ocean	2820	4181	4626	2195	3714	4109	2407	3866	4486	2712	3742	4325
Licensees fishing in:												
S. F. Bay and Delta	93	148	164	84	125	145	89	144	172	91	142	167
Fresh water	315	481	543	295	469	527	273	447	526	302	493	563
Ocean	214	337	381	214	344	384	195	307	357	228	341	392
Licensees fishing only in:												
S. F. Bay and Delta	15	28	31	17	24	29	11	22	25	14	22	26
Fresh water	137	214	243	125	206	231	116	195	233	126	218	248
Ocean	57	99	111	51	97	109	63	96	113	61	95	109
Licensees not fishing	28	51	67	27	57	65	28	70	84	20	44	67
Number of responses	424	674	769	401	665	750	388	652	769	408	669	785
Sample size	1153			1147			1156			1149		

TABLE 2

Estimates and Standard Errors

Estimates	S.F. Bay and Delta		Fresh water		Ocean	
	Proportion	S.E.	Proportion	S.E.	Proportion	S.E.
Angling days	0.14770	0.00188	0.55849	0.00506	0.29381	0.00408
Licensees fishing	0.20317	0.00880	0.68218	0.00757	0.47032	0.01359
Licensees fishing exclusively	0.03684	0.00272	0.31105	0.00410	0.14533	0.00686
	Number	S.E.	Number	S.E.	Number	S.E.
Licensees fishing	277,410	12,010	931,455	10,336	642,180	18,560
Licensees fishing exclusively	50,302	3,718	424,711	5,598	198,435	9,368

	Proportion	S.E.	Number	S.E.
Licensees not fishing	0.11176	0.00813	152,598	11,097

Discussion

Final estimates from this survey cannot be compared realistically with results of previous postal-card surveys for detecting small changes in the distribution of angling effort because prior surveys made no corrections for nonresponse bias and all but one differed substantially in questionnaire format. However, gross changes in the proportions of angling effort expended in the different waters should be revealed by a comparison between the 1951 results of Clark (1953) and simple ratios of angler days computed from only the first response wave of this

TABLE 3

Regression Coefficients of Fitted Curves, $y=ax+bx^2$

Estimate	Sample 1		Sample 2		Sample 3		Sample 4	
	a	*b*	*a*	*b*	*a*	*b*	*a*	*b*
Days angled in:								
S.F. Bay and Delta	3.51597	−0.00048	3.86682	−0.00120	2.94904	−0.00041	3.67295	−0.00111
Fresh water	12.66359	−0.00275	11.79521	−0.00143	11.48203	−0.00195	11.06427	−0.00015
Ocean	7.43867	−0.00184	5.51862	0.00000	6.56678	−0.00096	7.68242	−0.00287
Licensees fishing in:								
S.F. Bay and Delta	0.22933	−0.00002	0.22367	−0.00005	0.23168	−0.00001	0.23150	−0.00003
Fresh water	0.78675	−0.00011	0.77102	−0.00009	0.72014	−0.00005	0.77438	−0.00007
Ocean	0.51719	−0.00003	0.55857	−0.00006	0.53764	−0.00010	0.61733	−0.00015
Licensees fishing only in:								
S.F. Bay and Delta	0.03072	0.00001	0.04504	−0.00001	0.02605	0.00001	0.03516	0.00000
Fresh water	0.33162	−0.00002	0.31640	−0.00001	0.29281	0.00001	0.31005	0.00001
Ocean	0.12512	0.00003	0.10865	0.00005	0.17466	−0.00004	0.16095	−0.00003
Licensees not fishing	0.03705	0.00006	0.04688	0.00005	0.04175	0.00009	0.00352	0.00010

survey. The questionnaire formats were quite similar. Examination of the estimates shows a small increase in the proportion of angling effort spent in San Francisco Bay and the Delta and accompanying small decreases in the fresh water and ocean proportions (Table 4). No major change in the distribution of angling effort can be inferred from the comparison.

It should be noted that certain classes of anglers and the fishing effort they generated are not included in the survey estimates. These classes include purchasers of the previously mentioned 3-day Pacific Ocean licenses, public pier fishermen who do not need licenses in ocean waters, and anglers under age 16 who may fish without licenses. At the time of Clark's survey, the 3-day ocean license was not sold and pier fishermen needed licenses.

TABLE 4

Simple Ratios of Angling Days from First Response and Similar Estimates for 1951

Source of estimate	S.F. Bay and Delta	Fresh water	Ocean
Proportion of angling days from first response	0.158	0.540	0.303
Proportion of angling days for 1951 from Clark	0.121	0.561	0.318

ACKNOWLEDGMENTS

Most of the difficult work connected with this survey was performed by others. Betty Wright supervised and participated in the tedious jobs of drawing the sample, logging in responses, and maintaining the necessary records. Other personnel of the Biostatistical Section, Marine Resources Operations gave valuable help in these operations and, in addition, the staff of the Data Processing Unit carried through the essential machine processing of outgoing questionnaires and incoming responses.

Survey results were calculated on the 7090 computer of Western Data Processing Center, University of California at Los Angeles.

REFERENCES

Atwood, Earl L.
1956. Validity of mail survey data on bagged waterfowl. Jour. Wild. Mgmt., vol. 20, no. 1, pp. 1-16.

Chapman, D. G., W. S. Overton and A. L. Finkner
1959. Methods of estimating dove kill. North Carolina State Coll., Inst. Stat. Mimeo Ser., no. 264, pp. 1-48.

Clark, Frances N.
1953. California marine and fresh water sport fishing intensity in 1951. Calif. Fish and Game, vol. 39, no. 1, pp. 115-125.

Nieto de Pascual, Jose
1961. Unbiased ratio estimators in stratified sampling. Amer. Stat. Assoc., Jour., vol. 56, no. 293, pp. 70-87.

Opinion Research Center
1949. Angling in California—1948. Univ. of Denver, 144 pp. (Conducted for Calif. Div. Fish and Game).

Ryan, James H.
1959. California inland angling estimates for 1954, 1956, and 1957. Calif. Fish and Game, vol. 45, no. 2, pp. 93-109.

Skinner, John E.
1955. California statewide angling estimates for 1953. Calif. Fish and Game, vol. 41, no. 1, pp. 19-32.

CALIFORNIA INLAND ANGLING SURVEYS FOR 1959 AND 1960[1]

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Periodic state-wide surveys of California's inland sport fisheries have been conducted since 1935 to provide information on trends in sport fish catches, angling pressures, and changes in major game fish populations. Previous surveys have been described by Curtis (1940), Calhoun (1950, 1951, 1953), Clark (1953), Skinner (1955), and Ryan (1959).

State-wide angling surveys in California were originally conducted by means of questionnaires attached to fishing license applications. Postal card questionnaires, initiated in 1939, were more efficient and have been used since then.

The present report is based primarily on postal card questionnaire returns from anglers who fished successfully in 1959 and 1960. Information about unsuccessful anglers could not be evaluated accurately from the questionnaire used.

METHODS

Postal card questionnaires were mailed to a 0.7 percent random sample[2] of licensed California anglers. About 33 percent of these cards were returned, giving a sample of about 0.2 percent of all licensed anglers. Though the percentage of nonresponse is large (67 percent), its influence on the validity of these surveys is considered unimportant (Calhoun, 1950).

We assumed that anglers who returned questionnaires were representative of all anglers. Estimates of total catch, total number of anglers, and total days fished were calculated by means of a projection factor determined by dividing the total number of licenses sold by the total number of usable questionnaires returned.

Estimates of days fished are based on successful anglers only and are not quite comparable to those of previous reports (Skinner, 1955; Ryan, 1959), which included days fished by unsuccessful anglers.

Estimates pertaining to ocean salmon, river salmon, and steelhead fisheries were made but not included. More precise figures than are possible with these surveys are being obtained by extensive creel checking, use counts and, in the case of ocean salmon, party boat records. (Jensen, M. S.).

Evidence from California (Wendler, 1960) and elsewhere (Bjornn, 1961) demonstrates that postal card reports may grossly exaggerate

[1] Submitted for publication March 1963.
[2] Anglers were selected from carbon copies of their fishing licenses by taking one copy from each group of 125.

true catch figures. Some factors contributing to exaggerations in postal card surveys are: complete dependence upon the accuracy of a respondent's memory, his ability to distinguish different fish species, confusion in correctly filling out the questionnaire, reporting fish of sub-legal size (striped bass), deliberate exaggeration, and would-be attempts at humor. These exaggerations are partially offset by omitting anglers under 16 years of age, who are not required to buy a license, and those qualified for free licenses.

Although these factors affect validity of these surveys to an unknown degree, suspected exaggerations are probably proportional to those in previous surveys, making the data valuable, especially regarding trends. Standard errors (included) place confidence limits on the data presented (Tables 2 and 3). However, these are confidence limits for trend figures only, rather than for true estimates.

Various species are grouped, since many anglers do not recognize specific differences. Thus, trout includes kokanee salmon and trout; black bass includes largemouth and smallmouth bass; catfish includes catfish and bullheads; and panfish includes sunfishes and crappies.

Anglers who fished in inland waters for any kind of fish except trout, but including steelhead trout, were required to purchase a $1 license stamp in addition to their license. Those who fished for trout were required to purchase two $1 stamps.

In order to ascertain numbers of license buyers who bought two extra stamps and the numbers who actually fished (successfully or unsuccessfully) for trout, two questions were asked in the 1960 survey:

Did you purchase two license stamps in 1960?
Did you fish for trout in 1960?

In all other respects the questionnaire used in the 1960 survey was identical to the one used in 1959 and those reported by Ryan (1959).

RETURNS

In answer to the question, "Did you purchase two license stamps in 1960?," 2,477 (70 percent) respondents answered yes (Table 1). Of these, 17 percent purchased two stamps, but did not fish for trout.

In answer to the question, "Did you fish for trout in 1960?," 2,050 (58 percent) answered yes. Of these, 82 percent were successful.

Of the 18 percent who were unsuccessful, 65 percent gave no detailed information regarding their trout fishing (e.g., county fished or days fished). Assuming this is representative of responses for other species as well, it follows that most unsuccessful anglers give incomplete, or no information about their fishing; therefore, data from them are unusable, especially when compared to data from successful anglers, which are essentially complete. This supports our long-standing contention that data obtained by these questionnaires from unsuccessful anglers are not usable.

Of all successful anglers in 1959 and 1960, approximately 58 percent fished only in inland waters, 17 percent fished only in the ocean, and 25 percent fished in both inland and ocean waters.

TABLE 1

Characteristics of the Two Surveys

	1959		1960	
	Number	Percentage	Number	Percentage
a. Sport fishing licenses sold	1,465,440	--	1,475,691	--
b. Questionnaires mailed	10,030	0.7	10,480	0.7 (of a)
c. Questionnaires returned	3,304	32.9	3,553	33.9 (of b)
d. Usable returns	3,259	98.6	3,515	98.9 (of c)
e. Respondents who did not fish	132	4.1	141	4.0 (of d)
f. Successful respondents	2,655	81.5	2,935	83.5 (of d)
g. Unsuccessful respondents	472	14.5	439	12.5 (of d)
h. Projection factor*	449.66	--	419.83	--
i. Mean days fished	16	--	18	--
j. Bought two stamps†	--	--	2,477	70.5 (of d)
k. Did not buy two stamps†	--	--	863	24.6 (of d)
l. Did not answer question about two stamps†	--	--	175	5.0 (of d)
m. Fished for trout†	--	--	2,050	58.3 (of d)
n. Successful for trout†	--	--	1,690	82.4 (of m)

* Total sport fishing license sales divided by usable returned questionnaires.
† j. through n. pertain to questions asked only in the 1960 survey.

In 1960, the mean number of days fished in inland waters by successful anglers was 16, while successful ocean anglers fished 10. Overall, successful anglers fished 18 days, an increase over previous surveys. This increase is further reflected in the data for each species group.

State-wide estimates for successful anglers in 1959 and 1960 are given (Tables 2 and 3), and trends in the California sport fish catch since 1949 are shown (Figure 1). The following account discusses the most important features of the data.

Trout

Trout angling continues as the favorite type of fishing in California. Of all successful anglers, nearly 50 percent caught trout. In comparison with other recent surveys (Ryan, 1959; Skinner, 1955) no important changes are evident. The catch stability probably reflects the department's stocking program, which has varied little since 1957.

Striped Bass

This fishery occurs primarily in the lower portions of the Sacramento and San Joaquin rivers, the Sacramento-San Joaquin Delta, and the San Francisco Bay area. The total catch increased considerably over catches reported in earlier years. This may be partially attributed to the increased harvest in upper San Francisco Bay, and to an apparent increase in the size of the entire striped bass population (Chadwick, 1962).

The validity of these trend figures may be affected by changes in regulations. In 1956, the minimum size limit was increased from 12 to 16 inches and the daily bag limit was reduced from five to three fish. Subsequently, the 1956 total catch was less than that of the 1954 survey. Despite regulation changes, the median annual catch of about five fish per angler has remained stable since 1949.

TABLE 2

State-wide Estimates for Successful Anglers in 1959

	Trout	Striped bass	Black bass	Catfish	Panfish	Ocean fish and shellfish*
Postal card reports	1,467	499	485	517	625	1,206
Successful anglers	660,000	224,000	218,000	232,000	281,000	542,000
Standard error	12,800	9,200	9,100	9,400	10,100	12,393
Percentage of all licensees	45.0	15.3	14.9	15.8	19.2	37.0
Mean annual catch	41	10	20	32	56	--
Standard error	1.7	0.7	1.6	0.9	5.9	--
Median annual catch	21	5	9	10	22	--
Total annual catch	27,480,000	2,260,000	4,493,000	7,674,000	16,114,000	--
Standard error	1,284,000	183,000	354,000	369,000	1,750,000	--
Mean annual days	9	12	9	9	8	7
Standard error	0.35	0.80	0.71	0.78	0.55	0.22
Median annual days	6	7	5	5	5	5
Total annual days	5,966,000	2,677,000	1,802,000	1,775,000	1,933,000	3,459,000
Standard error	248,500	208,700	160,600	160,500	171,400	229,600
Percentage of total days	42.2†	18.9†	12.7†	12.5†	13.7†	19.6‡
Mean catch per angler day	4.4	0.9	2.2	3.4	1.0	--

* Does not include ocean salmon data.
† Percentage of the total inland days for these five groups.
‡ Percentage of inland and ocean fishing days combined.

TABLE 3

State-wide Estimates for Successful Anglers in 1960

	Trout	Striped bass	Black bass	Catfish	Panfish	Ocean fish and shellfish*
Postal card reports	1,690	551	559	656	705	1,110
Successful anglers	709,000	231,000	235,000	275,000	296,000	466,000
Standard error	12,400	9,000	9,100	9,700	10,000	11,600
Percentage of all licensees	48.1	15.7	15.9	18.7	20.1	31.6
Mean annual catch	39	12	22	37	50	--
Standard error	1.3	0.9	1.9	3.0	4.3	--
Median annual catch	21	5	9	15	22	--
Total annual catch	28,000,000	2,770,000	5,150,000	10,100,000	14,740,000	--
Standard error	1,048,000	241,000	485,000	902,000	1,375,000	--
Mean annual days	10	13	10	10	8	10
Standard error	0.30	0.75	0.90	0.69	1.54	0.54
Median annual days	6	7	5	5	4	4
Total annual days	6,776,000	2,949,000	2,438,000	2,809,000	2,214,000	4,562,000
Standard error	243,000	208,000	232,000	214,000	414,000	276,000
Percentage of total days	39.3†	17.2†	14.2†	16.1†	12.9†	21.0‡
Mean catch per angler day	4.1	0.9	2.1	3.6	6.7	--

* Does not include ocean salmon data.
† Percentage of the total inland days for these five groups.
‡ Percentage of inland and ocean fishing days combined.

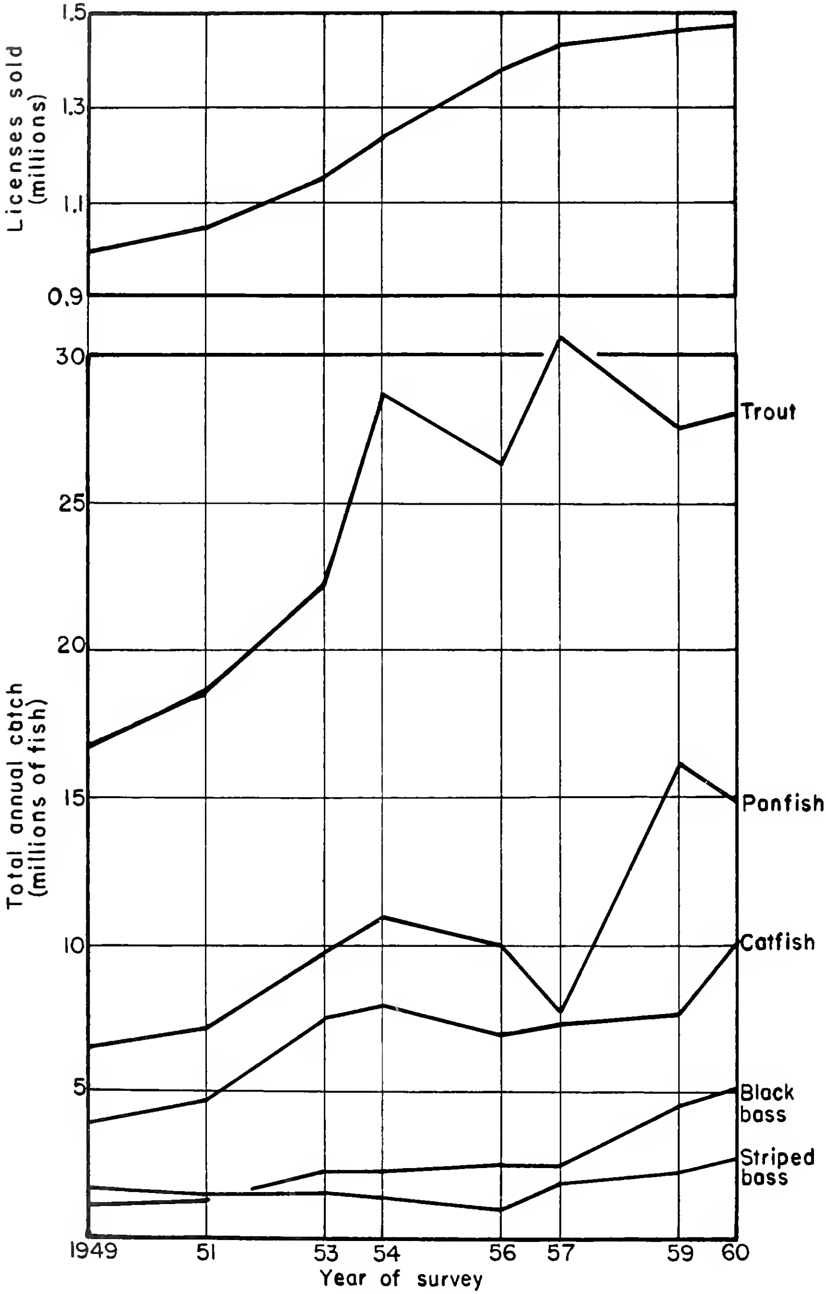

FIGURE 1. Trends in California sport fishing.

Black Bass

The most striking change in catch records concerns black bass. The number of black bass anglers and total catch were the highest since these surveys began. The number of successful anglers increased about 26 percent over 1957 and the proportion of these anglers increased from 12 percent of all licensed anglers in 1949 to 16 percent in 1960. Days expended in 1960 exceeded the 1957 figure by nearly 80 percent. The mean annual catch rose to 22 fish in 1960 (the highest since 1938). The median annual catch rose from five to six in 1949 and 1951, respectively, to nine fish per angler in the present surveys.

These increases are related primarily to the construction of several new reservoirs and subsequent introductions of bass.

Catfish

Catfish, like other warmwater fish, show rather large increases in angler numbers, catch, and days fished.

Panfish

Panfish catch data fluctuate considerably with each survey. However, the total catch, as with the other warmwater species, shows a rising trend.

SUMMARY

Periodic angling surveys have been conducted in California since 1935 to assess state-wide trends in angling success and pressure and to detect major changes in game fish populations. A survey of 1959 and 1960 angling was made by postal-card questionnaires sent to a sample of angling license buyers.

Trout fishing is the most popular form of angling. Over half the licensed anglers in the State fish for trout each year.

The estimated total catches of striped bass, black bass, and panfish in 1959 and 1960 were greater than in any previous survey. These increases accompanied greater angling effort, as shown by increases in mean days fished for these groups. Increased catch and angling effort for warmwater species are indicative of their greater availability because of continuing warmwater reservoir construction in California.

Angling quality, as indicated by the median annual catch per angler, has remained quite stable since 1949 for all species groups except black bass. This figure for black bass has increased from five in 1949 to nine in 1959 and 1960.

REFERENCES

Bjornn, Ted C.
1961. Statewide fishing harvest survey, 1960. Idaho Dept. of Fish and Game, Annual Progress Report for Investigations Project F-18-R-7, 19 pp.

Calhoun, A. J.
1950. California angling catch records from postal card surveys: 1936-1948; with an evaluation of postal card nonresponse. Calif. Fish and Game, vol. 36, no. 3, pp. 177-234.
1951. California state-wide angling catch estimates for 1949. Calif. Fish and Game, vol. 37, no. 1, pp. 69-75.
1953. State-wide California angling estimates for 1951. Calif. Fish and Game, vol. 39, no. 1, pp. 103-113.

Chadwick, Harold K.
1962. Catch records from the striped bass sportfishery in California. Calif. Fish and Game, vol. 48, no. 3, pp. 153-177.

Clark, Frances N.
1953. California marine and fresh water sport fishing intensity in 1951. Calif. Fish and Game, vol. 39, no. 1, pp. 115-125.

Curtis, Brian
1940. Anglers' catch records in California. Amer. Fish. Soc., Trans., 1939, vol. 69, pp. 125-131.

Jensen, Paul T.
M.S. Landings estimates of California's marine recreational salmon fishery.

Ryan, James H.
1959. California inland angling estimates for 1954, 1956, and 1957. Calif. Fish and Game, vol. 45, no. 2, pp. 93-109.

Skinner, John E.
1955. California state-wide angling estimates for 1953. Calif. Fish and Game, vol. 41, no. 1, pp. 19-32.

Wendler, Henry O.
1960. The importance of the ocean sport fishery to the ocean catch of salmon in the states of Washington, Oregon and California. Calif. Fish and Game, vol. 46, no. 3, pp. 291-300.

EFFECT OF OCEAN TEMPERATURE ON THE SEAWARD MOVEMENTS OF STRIPED BASS, *ROCCUS SAXATILIS*, ON THE PACIFIC COAST[1]

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INTRODUCTION

It all began during the surge of exotic fish introductions following Seth Green's remarkable transplantation of American shad, *Alosa sapidissima*, into the Sacramento River on June 27, 1871 (Smith, 1896). Multitudes of fish and fish eggs, of various kinds, were transported across continents and oceans, and from one hemisphere to the other. Many did not become established; unfortunately some did. Others proved welcome additions to their new habitat; the striped bass is generally considered one of these.

In July 1879, Livingston Stone, of the United States Fish Commission, dumped about 135 small striped bass into Carquinez Strait at Martinez. The entire Pacific coast striped bass population has descended from these fish, collected from the Navesink River, New Jersey, and 300 additional fish transplanted to Suisun Bay (Figure 1) from Shrewsbury River, New Jersey in 1882; although by then, the original fish had already gained a foothold (Smith, 1896).

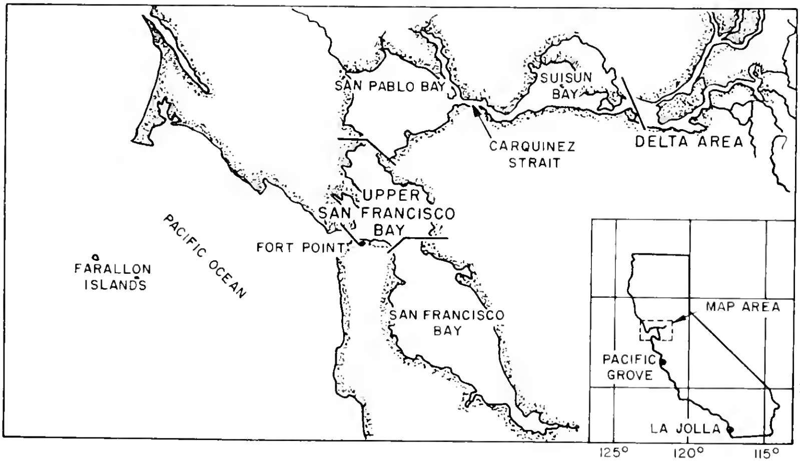

FIGURE 1. Reference chart of the San Francisco Bay area.

[1] Submitted for publication March 1963.

Despite their common origin, striped bass are caught primarily in inland waters on the Pacific coast of the United States, while they are considered surf fish by anglers on the Atlantic coast. A possible explanation for this apparent difference in the fisheries of the two coasts is that the magnitude of the striper's seaward migration might be a function of ocean temperatures. Cold water off San Francisco may tend to keep them from running to sea and dispersing along the coast, except during warm-water years. Their establishment in Coos Bay, Oregon during 1925 and 1926, and the exceptional surf catches around San Francisco during 1957, 1958, and 1959, could have been the result of warm coastal waters (Radovich, 1961).

This paper presents evidence pertaining to this phenemenon and concludes there is a relationship between ocean temperatures and the seaward migration of striped bass. This study is especially pertinent to biological problems that may arise from the salt-water barrier that has been proposed between San Francisco Bay and the Sacramento and San Joaquin Rivers.

EARLY OCEAN OCCURRENCES

During the wave of exhilaration following the successful introduction of striped bass, reports were sometimes more enthusiastic than accurate. Although the California Commissioners of Fisheries (1884) reported that a striped bass weighing nearly 17 pounds was taken in Monterey Bay in September 1883, they also stated, "Bass have been taken as far north as British Columbia." The Monterey Bay capture was the first ocean record on the Pacific Coast, but the reference to catches off British Columbia may have been overly optimistic. Regarding this, and another report in 1887, of catches as far south as San Diego, Smith (1896) reported that inquiries by the United States Fish Commission between 1888 and 1894 found no authentic reports of striped bass either as far south as San Diego or north of California. Meanwhile, in the Russian River a 6-pound specimen was caught in 1890, and in 1891, salmon gill-netters began catching them there. In 1893, one was reported from Santa Cruz and two, 6-pounders were caught at Redondo Beach in 1894 (Smith, 1896).

The California Board of Fish Commissioners (1907) stated that three or four specimens weighing up to 20 pounds were taken in the Eel River in 1905. They implied that these may have survived from less than a dozen liberated in Humboldt Bay in 1899. The Humboldt Bay transplant was an attempt to extend the range of striped bass north of the Russian River.

Smith (1908) wrote: "Up to 1896 the fish had not been reported outside of California, but several years thereafter it began to run in some of the coast rivers of Oregon, and in the fall of 1906, half a dozen fine specimens were caught in traps at the mouth of the Columbia River, the first recorded from that stream." Since Smith did not pinpoint the time of their first occurrence off Oregon closer than "several years after 1896," we can only surmise it took place within a "few years" of the turn of the century.

Additional attempts were made to extend the range of striped bass south of Monterey Bay. In December 1903, about 75 bass were planted in the mouth of the Santa Ana River, Orange County (Calif. Board of Fish Commissioners, 1904). In 1909, a "carload" was planted in "suitable waters of limited area in Orange County," according to the California Board of Fish and Game Commissioners (1910) who also stated this was "the third shipment made into these waters in the past eight years." I was unable to find the third record for Orange County prior to 1910. Scofield and Bryant (1926) wrote of another plant in 1904; however, no such record appears on their table of California plantings. Their table showed additional plants at North San Diego River, and at Morro Bay in 1916, and at Bolsa Chica, Orange County, and Morro Bay in 1919.

Morgan and Gerlach (1950) stated, "It has been reported that the first striped bass caught in Coos Bay was taken by a gill-netter in 1914." They also stated, "From the information available, it appears that striped bass were first taken in commercial quantities on Coos Bay in 1922." However, in neither case do they give the source of their information.

Also referring to striped bass in Coos Bay, Scofield (1931) wrote, "It was not until 1918 that the bass were noticed there in any great numbers. Since that time a good market has been established for them and the catch is increasing annually." Scofield did not indicate the source of his information regarding the 1918 occurrences. The "good market" probably developed in 1925.

In 1925, striped bass were being caught in commercial quantities in the Coos Bay region (Scofield and Bryant, 1926). Hubbs and Schultz (1929) noted that striped bass occurred in commercial abundance both in and near Coos Bay, during the summer of 1926. Since that time, Coos Bay has had a resident striped bass population.

Despite the many plantings, only a few striped bass have been caught south of Monterey Bay. In 1959, their southern limit was extended to about 25 miles south of the Mexican Border (Radovich, 1961). An attempt to establish them in the lower Colorado River was made in 1959, when 938 were introduced near Blythe, Riverside County (St. Amant, 1959).

Apparently striped bass were confined mainly between Monterey and the Russian River until about 1900. They began to appear north of California after 1905. Some may have been caught in Coos Bay as early as 1914 and fair numbers may have appeared in 1918 and 1922; however, they definitely became established in 1925.

The appearance of striped bass in Coos Bay during the high ocean temperature period 1925 to 1926, and their appearance in the surf near San Francisco during 1957-1959, stimulated speculation that ocean temperatures affect their seaward migrations (Radovich, 1961). Although the historical record is compatible with this idea, it is far from convincing. The Coos Bay striped bass population could have descended from a few fish which arrived prior to 1925, instead of moving there *en masse* during 1925-1926.

Unfortunately, early records of striped bass occurrences are obscure and sea temperature data are non-existent. Therefore, I have relied on more recent records to study catch and temperature relationships.

CENTRAL CALIFORNIA OCEAN TEMPERATURE HISTORY

Fort Point is just inside the mouth of San Francisco Bay, where anadromous fish must pass (Figure 1). Water temperatures have been recorded here since 1922; however, the data are incomplete for 1942, 1946 through 1949, and 1959. Unfortunately, both tide and river flow influence these temperatures. Cool ocean water entering the bay on incoming tides and warm bay water flowing into the ocean on outgoing tides cause the temperatures to vary with the state of the tide. A lack of complete records and the influence of tidal and river flow makes Fort Point temperatures valueless for my purposes.

Farallon Island temperatures have been collected intermittently since 1925. The records are complete from 1926 through 1942, not available from 1943 to 1955 and incomplete for 1955, 1956, and 1959. Although their use is limited they show that monotonously cool conditions persist off San Francisco throughout the year. Average monthly mean temperatures from 1926 through 1955 ranged from 52.3°F. (11.3°C.) in April and May, to 56.0°F. (13.4°C.) in September, an average mean range of only 3.7°F. (2.1°C.).

Other California coastal stations, where long-term records have been kept include Blunts Reef Lightship, Pacific Grove, Port Hueneme, Los Angeles (Outer Harbor), Balboa, and La Jolla. Records begin in 1923 for Blunts Reef Lightship, located about 180 miles north of San Francisco. However, they are incomplete in 1941 and 1959, and absent between 1941 and 1955. The most complete California records are from La Jolla (about 450 miles south of San Francisco) beginning in 1917 and from Pacific Grove (about 80 miles south of San Francisco) dating from 1919. These are regarded as key stations, each typical of its nearby area. In general there is good agreement between temperature variations at all the coastal stations (Robinson, 1961).

Average monthly surface temperatures from 1921 through 1938 for the 5-degree (longitude and latitude) square encompassing central California (lat. 35-40°N., long. 120-125°W.) were obtained from Gunnar I. Roden, Scripps Institution of Oceanography. These data were originally compiled by the Imperial Marine Observatory, Kobe, Japan,

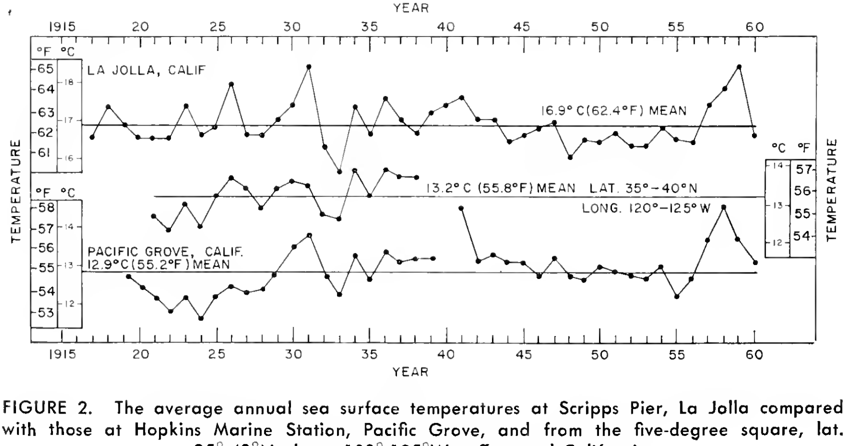

FIGURE 2. The average annual sea surface temperatures at Scripps Pier, La Jolla compared with those at Hopkins Marine Station, Pacific Grove, and from the five-degree square, lat. 35°-40°N., long. 120°-125°W., off central California.

and are the only data available for reflecting surface temperatures over a broad area off San Francisco during these years. It is not known how many temperature observations were made and how they were distributed over time and area from year to year. They are averages of all water temperatures recorded by Japanese merchant and fishing vessels, and would be affected by where and when the observations were made within a given month. When compared with records from La Jolla and Pacific Grove, strong similarities and some differences were revealed (Table 1, Figure 2). The peaks and troughs coincide quite well, but the warm year 1931 was not as prominent in the 5-degree square as at La Jolla or Pacific Grove. A major discrepancy occurred prior to 1928. This period was relatively colder at Pacific Grove than at the other areas. The ocean climate as reflected by temperature in the 5-degree square was intermediate between that at La Jolla and Pacific Grove.

Thus it appears that although some discrepancies occur, temperature variations at Pacific Grove and La Jolla broadly reflect variations in ocean waters off San Francisco and may be used as indicators of ocean conditions which may affect striped bass behavior.

Other indices of ocean climate could be developed by using a correlation between air temperature and ocean temperature at certain locations. In this manner the history of the ocean environment might be pushed back a number of years since records of air temperature are more complete than those of sea temperature.

TABLE 1

Average Annual Sea Surface Temperatures at Scripps Pier, La Jolla; at Hopkins Marine Station, Pacific Grove; and from the Five-Degree Square, lat. 35°-40°N., long. 120°-125°W.

	Temperatures ° C.		
Year	*La Jolla*	*Pacific Grove*	*Five-Degree Square*
1917	16.6		
1918	17.4		
1919	16.9	12.8	
1920	16.5	12.5	
1921	16.5	12.2	12.6
1922	16.5	11.8	12.3
1923	17.4	12.2	13.0
1924	16.6	11.6	12.4
1925	16.8	12.2	13.2
1926	18.0	12.5	13.7
1927	16.6	12.3	13.4
1928	16.6	12.4	12.9
1929	17.0	12.9	13.4
1930	17.4	13.5	13.6
1931	18.4	13.8	13.5
1932	16.3	12.8	12.7
1933	15.6	12.2	12.6
1934	17.4	13.3	13.9
1935	16.6	12.7	13.2

TABLE 1—Continued

Average Annual Sea Surface Temperatures at Scripps Pier, La Jolla; at Hopkins Marine Station, Pacific Grove; and from the Five-Degree Square, lat. 35°-40°N., long. 120°-125°W.

	Temperature ° C.		
Year	*La Jolla*	*Pacific Grove*	*Five-Degree Square*
1936	17.6	13.4	13.9
1937	17.0	13.1	13.7
1938	16.6	13.2	13.7
1939	17.2	13.2	
1940	17.4		
1941	17.6	14.5	
1942	17.0	13.1	
1943	17.0	13.3	
1944	16.4	13.1	
1945	16.6	13.1	
1946	16.8	12.8	
1947	16.9	13.2	
1948	16.0	12.8	
1949	16.5	12.7	
1950	16.4	13.0	
1951	16.6	12.9	
1952	16.3	12.8	
1953	16.3	12.7	
1954	16.8	13.0	
1955	16.5	12.2	
1956	16.4	12.7	
1957	17.4	13.7	
1958	17.8	14.6	
1959	18.4	13.7	
1960	16.6	13.1	
Mean	16.9	12.9	13.2

ANNUAL MIGRATIONS

An examination of the literature leaves one with a confused notion of the annual migrations of striped bass. Scofield (1931) states: "Throughout the winter they are inactive and the commercial catch is light. During the spring the catch increases, and in May just before the commercial season is closed, some of the best net catches are made. During this time the bass are caught periodically. For several days fishermen make fine catches; then gradually the total catch drops. For the next few days fishing is poor until a few fishermen report excellent catches in lower Suisun Bay again. As these periodical catches subside the fishermen will attempt to follow the run, or what they believe to be an 'ocean run', up to the upper Suisun Bay and into the rivers. Movements such as these occur each spring. When the season reopens in August and spawning is over, the fishermen go to lower Suisun Bay to net, for there they make their best catches. Offhand this action would indicate that many bass move back to salt water after spawning."

Scofield further indicated that striped bass were absent in sportsmen's catches in Monterey Bay during May, June, and July. This suggests that the fish migrated from the ocean to spawn in the spring and returned to the ocean during mid-summer after spawning.

Clark (1936) reported that results of tagging 1,544 small fish between 1932 and 1935 revealed, "no definite migrations, simply a diffusion from the locality in which bass were tagged."

Recoveries during a more extensive tagging program from 1947 through 1951 demonstrated a mass movement of adult striped bass up into the fresh-water Sacramento-San Joaquin Delta during the fall, where they remained during the winter. In the spring they dispersed out over the delta and into tributary rivers to spawn, after which they returned to San Francisco Bay and adjacent salt and brackish waters for the summer (Calhoun, 1952).

Skinner (1962) states: "The adults begin to enter Carquinez Strait from the bay and ocean about August; the run usually peaks in October, and tapers off rather abruptly. They spread out over the entire Delta for the winter season. . . . Potential spawners move up into the fresh water of the sloughs and rivers of the Delta system and begin to spawn in March or April."

It is apparent that interpretations of striped bass movements are contradictory. To recapitulate, Scofield indicates striped bass leave the ocean and spawn upstream during May, June, and July. Calhoun and Skinner feel that spawners move into the streams from the delta area and begin spawning in March or April. All three believe there is a movement back into salt water after spawning. However, Scofield feels the oceanward run extends into August, while Skinner feels they are beginning to return from the ocean in August. Calhoun and Skinner each state that a mass movement from salt water to the delta area occurs during fall and that the fish winter in the delta, while Scofield infers that many striped bass winter in the ocean.

In Coos Bay, Morgan and Gerlach (1950) indicated there are two migrations of striped bass—an upstream spawning migration in the spring followed by a return to the sea during summer, and a second migration into the sloughs in the fall.

If we assume all the workers to be conscientious and capable, we must conclude either that variation in movements between periods exists, or that at any given time different portions of the striped bass population may behave differently, or both. In reality, some striped bass probably winter in the ocean and some in the delta. They spawn upstream, although the beginning of the spawning period may vary from year to year and may differ between fish wintering in the delta and in the ocean. It is also probable that a few fish may move oceanward during winter or early spring. In any event, we would expect variations in striped bass movements to be reflected in a commercial fishery in lower Suisun Bay between the Delta and the sea.

THE COMMERCIAL FISHERY

Within 5 years after introduction, striped bass were offered for sale in San Francisco. In 1887, 3,000 to 4,000 small fish were sold, and by 1889, a commercial fishery was inaugurated (Smith, 1896). The greatest catch was recorded in 1915, when 1,784,448 pounds were delivered to markets, but during the economic slump following World War I, the catch fluctuated between 500,000 and 1,000,000 pounds annually (Scofield, 1931).

A catch analysis study of the striped bass gill-net fishery, ranging primarily from the delta to San Pablo Bay, was begun in 1920 (Craig, 1930) and continued until August 14, 1931, when it became unlawful in California to fish for striped bass with nets (Clark, 1933). As a result of this study, catch-per-effort values are available from 1920 through 1931 (Table 2).

TABLE 2

Average Daily Boat Catch of Striped Bass (in pounds)[1]

Year	*Pounds*	*Year*	*Pounds*
1920	66	1926	74
1921	58	1927	52
1922	63	1928	47
1923	82	1929	67
1924	65	1930	85
1925	68	1931	109

[1] After Clark (1933).

If we compare the striped bass catch-per-effort with average annual sea surface temperatures of the 5-degree square of latitude and longitude off central California, we see that fishing success varies directly with temperatures (Figure 3).

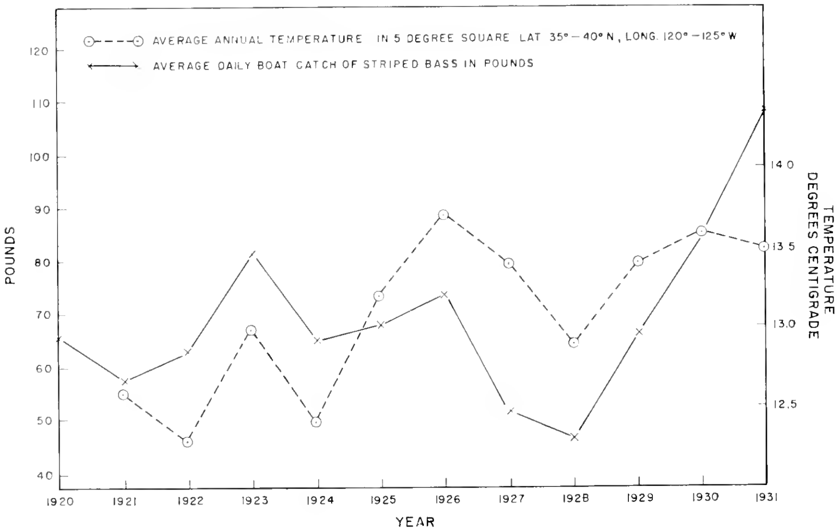

FIGURE 3. The average commercial daily boat catch of striped bass from 1920 through 1931, and average annual sea surface temperatures in the five-degree square, lat. 35°-40°N., long. 120°-125°W.

An even better correlation exists by using average annual sea surface temperatures at La Jolla (Figure 4). The latter correlation is remarkable, particularly when we consider that the temperatures are from about 450 miles south of the commercial fishing area. We would not expect sea surface temperatures at La Jolla to affect striped bass fish-

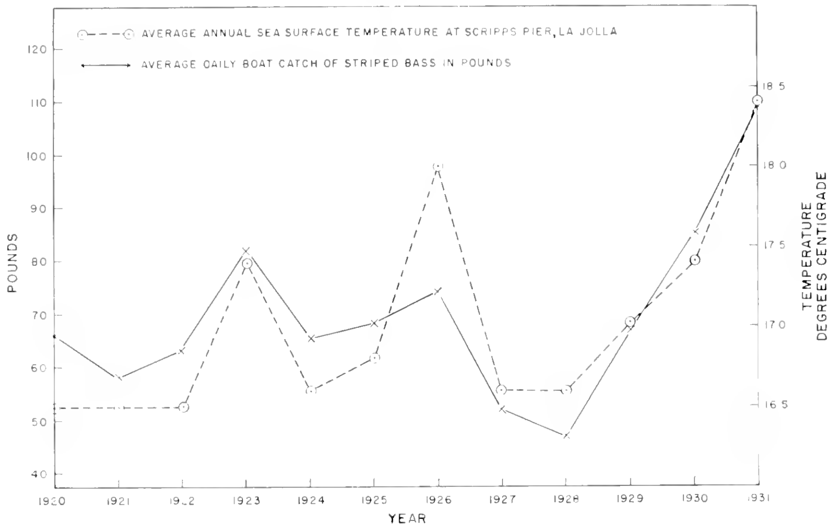

FIGURE 4. The average commercial daily boat catch of striped bass and average annual sea surface temperatures at La Jolla from 1920 through 1931.

ing in San Francisco Bay, but because of the temperature coherence between stations along the coast we may regard the La Jolla temperature variations as indicators of the oceanic environment off central California.

Since the efficiency of a gill-net is dependent on fish swimming into it, fishing success is higher when nets are placed across the paths of well-defined runs. This principle is well-known to fishermen who carefully place their gill-nets in specific areas and facing predetermined directions. It is also well-known that some anadromous fish migrate within narrow well-defined paths, and towers have been erected in strategic locations in the Kvichak River System of western Alaska from which to count upstream salmon migrants (Becker, 1962).

Therefore, catch-per-effort in a gill-net fishery is influenced by the nature and magnitude of fish movements. It is apparent that variations in catch-per-effort of striped bass were a result of the fishery, centered in lower Suisun Bay, responding to the volume of fish flowing through Carquinez Strait; hence, the positive correlation resulted from an increased vulnerability when temperatures were higher.

THE SPORT FISHERY

Radovich (1960 and 1961) used the ratio of catch-per-effort off central California, to catch-per-effort off southern California to obtain an index of latitudinal distribution for the Pacific sardine (*Sardinops caerulea*), independent of population size. Similarly, we may construct an index of seaward migration for striped bass.

A record of partyboat angler's catch-per-effort of striped bass for different regions of the Bay area is available for each year from 1938 through 1959 (Calhoun, 1949; Chadwick, 1962). While Calhoun and

Chadwick each felt that high variability in catch-per-effort values at the extreme edges of the San Francisco party boat fishing area precluded their use as reliable population indices, it is this variability that allows us to develop a migration index. An annual index of seaward migration is obtained by dividing the average daily catch of party boat anglers fishing in upper San Francisco Bay by the average catch of those fishing in the Delta (Figure 1, Table 3). Higher values indicate a greater downstream displacement, while lower values show a tendency to remain upstream. Catch-per-effort ratios are independent of population size, except to the extent that population size influences distribution.

Several other factors, however, that influence the catch-per-angler,

TABLE 3

Index of Seaward Migration

	Average daily catch per angler		*Index of seaward migration*
Year	*(A) Upper San Francisco Bay*	*(B) Delta area*	*A÷B*
1938	1.557	1.623	0.959
1939	1.134	0.566	2.004
1940	2.114	1.408	1.501
1941	2.214	1.209	1.831
1942	1.864	1.312	1.421
1943	2.187	2.267	0.965
1944	1.064	2.304	0.462
1945	1.113	1.547	0.719
1946	1.046	1.266	0.826
1947	0.862	1.221	0.706
1948	1.247	1.552	0.803
1949	0.036	1.359	0.026
1950	0.000	1.106	0.000
1951	1.345	1.528	0.880
1952	0.867	1.438	0.603
1953	1.208	0.934	1.293
1954	1.153	0.702	1.642
1955	0.407	1.025	0.400
1956	1.492	0.644	2.317
1957	1.838	0.614	2.993
1958	2.105	0.864	2.436
1959	2.274	0.849	2.678

also may affect this index. The five-fish bag limit was reduced to four in 1955 and to three in 1956. The 12-inch minimum size limit was increased to 16 inches in 1956. Chadwick (1962) felt that new fishing methods contributed to the increase in fishing success and effort in upper San Francisco Bay, beginning in 1956. In addition, effort was so low in upper San Francisco Bay in 1948 (166 angler days recorded), in 1949 (84 angler days recorded) and in 1950 (14 angler days recorded) that fishing success may not be measured adequately in those years, although poor fishing in this area must have been a primary reason for the low effort.

A comparison of average annual sea temperatures at La Jolla with the index of downstream migration shows a strong relationship (Figure 5). The discrepancies in 1948, 1949 and 1950 may be due, in part, to

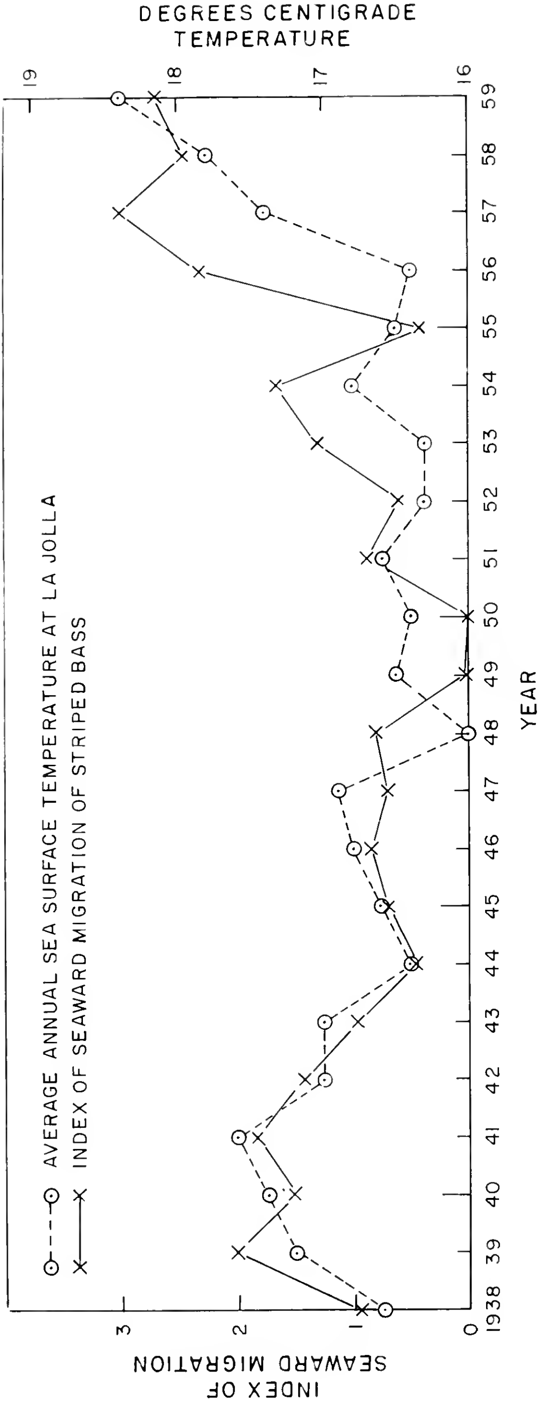

FIGURE 5. Average annual sea surface temperatures at La Jolla, and the index of seaward migration (Table 3) from 1938 through 1959.

the variability caused by the low effort, and after 1956 the indices may have been affected by new fishing methods, as Chadwick suggested. However, even with the inclusion of these years, the correlation is striking (Figure 6).

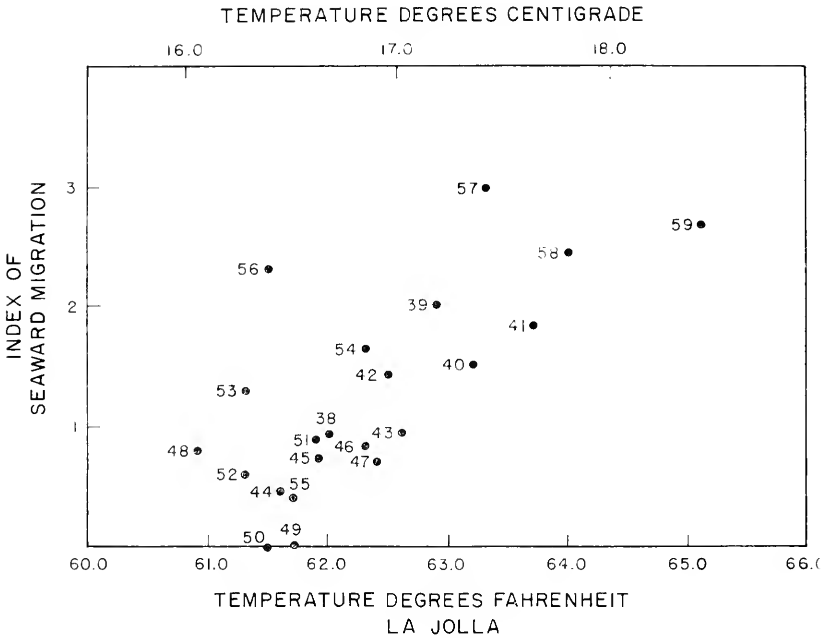

FIGURE 6. The index of seaward migration compared with average annual sea surface temperatures at La Jolla from 1938 through 1959. The least squares line of regression is $Y = 1.036X - 16.218$; the correlation coefficient is $r = .7119$.

The least squares regression line is

$$Y = 1.036\,X - 16.218,$$

where Y is the index of downstream migration and X, the sea surface temperature at La Jolla. The 22 pairs of observations have a high correlation coefficient ($r = .7119$) indicating a strong relationship.

A similar relationship also is found when the index of seaward migration is plotted against the average annual sea surface temperatures at Pacific Grove (Figure 7).

The least squares regression line is

$$Y = .816\,X - 9.500$$

and the correlation coefficient with 21 pairs of observations is $r = .6925$.

Considering the large number of contributing factors, these correlations are even more remarkable. There are variables influencing catch-per-effort; factors influencing distribution, such as population abundance and size and age composition; and errors introduced by using remote temperature data for an index of local oceanic conditions.

The highly significant correlations between ocean temperatures and the downstream displacement of striped bass for 22 years (1938 through 1959) and the fishing success of the commercial gill-net fishery for 12

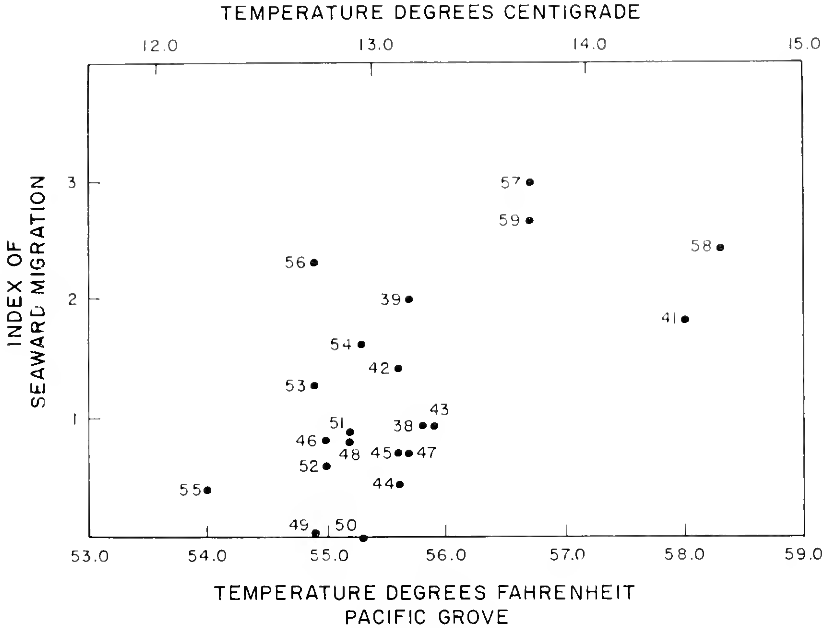

FIGURE 7. The index of seaward migration compared with average annual sea surface temperatures at Pacific Grove from 1938 through 1959. The least squares line of regression is $Y = .816X - 9.500$; the correlation coefficient is $r = .6925$.

years (1920 through 1931) leads me to conclude that there is a positive relationship between coastal sea temperatures and the seaward migration of striped bass.

DISCUSSION

Apparently striped bass angling success is influenced primarily by local abundance, although other factors such as feeding behavior must also affect it. By contrast, variations in intensity of the seaward migration were probably responsible for most of the variations in fishing success of the commercial gill-netters from 1920 through 1931, although local abundance and other factors also were involved.

Monotonous cool water conditions normally existing off San Francisco Bay seem to act as a barrier to the ocean migration. However, during warm years the Pacific coast striped bass make a definite ocean migration as do their Atlantic relatives.

Despite the apparent aversion of striped bass to cool ocean waters, the species can stand very cold water. Merriman (1941) states that on the Atlantic coast, the striped bass may winter under ice in estuaries, rivers and bays. However, in the spring, migrations do not begin until the water warms up. He also points out that up-coast migrations cease during cold snaps and resume when the snap ends. In addition, he shows that large year classes seem to be associated with cold years, although cold water does not guarantee one.

The conclusion that the seaward migration is a function of coastal temperature is consistent with the available information on striped bass. In fact, it helps explain certain irregularities. Calhoun (1949) felt that the sharp tapering off of the catch-per-angler in upper San Francisco Bay after 1944, resulted from causes unrelated to over-all abundance of striped bass. He indicated the decline probably was due to a change in conditions in San Francisco Bay. Apparently, fluctuations in ocean temperatures caused most of the variations he described (Figure 5).

Chadwick (1962) stated that information from tag returns indicates substantial changes in bass migration have taken place between 1953 and 1958. He maintained that bass tended to move farther downstream during recent years. This is consistent with my conclusions since the index of seaward migration also shows that bass were distributed farther downstream after 1956 (Figure 5)—probably because coastal waters began warming that fall.

Occasionally striped bass fishing is spectacular in the surf near the Golden Gate for brief periods during the summer. This happened in 1948 (Calhoun, 1952); yet the annual average ocean temperature was low (Figure 5). In this year, sea surface temperatures recorded at Pacific Grove during July and August were exceptionally high. By using annual average temperatures, short term temperature anomalies are lost and do not explain single season short-term catch anomalies. If better indices of local water temperatures and fish movements can be developed they would facilitate examining this phenomenon in much greater detail.

SUMMARY AND CONCLUSIONS

Despite a common ancestry, Pacific coast striped bass do not appear to make extensive coastal migrations as do their relatives on the Atlantic coast. Although a fishery had developed in San Francisco Bay by 1890, bass ranged mainly from Monterey to the Russian River until the early 1900's.

The striped bass in its native environment is an anadromous fish that moves into the ocean after spawning and occasionally at other times during the year. A cold-water barrier off the Golden Gate retards the seaward run, which develops when water temperatures become warm. Variations in the seaward run had a pronounced effect on commercial gill-netting success. The correlations for catch-per-effort and ocean temperatures between 1920 and 1931 were highly significant.

An index of seaward migration was developed by using the ratio of an average daily catch-per-angler from a downstream region to that from an upstream area. This index reflects downstream distribution and is somewhat independent of total population size. A high correlation was found between the index and ocean temperatures from 1938 through 1959. As a result of these correlations, I conclude a positive relationship exists between coastal sea temperatures and the seaward migration of striped bass. This conclusion is consistent with the available information on striped bass and, in fact, helps explain some irregularities that have been observed.

ACKNOWLEDGMENTS

In the preparation of this paper I received advice and counsel from many people. Among the Department of Fish and Game biologists to whom I am especially grateful are: Arnold Albrecht, John Baxter, Harold Chadwick, Harold Clemens, Donald Fry, Jr., Doyle Gates, Richard Heimann, Donald Kelley, Leo Pinkas, and James Thomas. Richard Croker, Pacific Marine Fisheries Commission, and John Isaacs, Scripps Institution of Oceanography, also gave valuable comments on the first draft of the manuscript. Gertrude Cutler, Department of Fish and Game, assisted with the computations and with the preparation of tables and figures.

REFERENCES

Becker, Clarence D.
1962. Estimating red salmon escapements by sample counts from observation towers. U. S. Fish and Wild. Sur., Fish. Bull. 192, vol. 61, pp. 355-369.

Calhoun, A. J.
1949. California striped bass catch records from the party boat fishery: 1938-1949. Calif. Fish and Game, vol. 35, no. 4, pp. 211-253.
1952. Annual migrations of California striped bass. Calif. Fish and Game, vol. 38, no. 3, pp. 391-403.

California. Commissioners of Fisheries
1879. Report of the Commissioners of Fisheries for the years 1878 and 1879. Sacramento, State Printer, 63 pp.
1884. Report of the Commissioners of Fisheries for the years 1883-4. Sacramento, State Printer, 33 pp.

California. Board of Fish Commissioners
1904. Eighteenth biennial report of the State Board of Fish Commissioners for the years 1903-1904. Sacramento, State Printer, 112 pp.
1907. Nineteenth biennial report of the State Board of Fish Commissioners for the years 1905-1906. Sacramento, State Printer, 112 pp.

California. Board of Fish and Game Commissioners
1910. Twenty-first biennial report of the Board of Fish and Game Commissioners for the years 1909-1910. Sacramento, State Printer, 72 pp.

Chadwick, Harold K.
1962. Catch records from the striped bass sportfishery in California. Calif. Fish and Game, vol. 48, no. 3, pp. 153-177.

Clark, G. H.
1933. Fluctuations in the abundance of striped bass (*Roccus lineatus*) in California. Calif. Div. Fish and Game, Fish Bull. 39, 20 pp.
1936. A second report on striped bass tagging. Calif. Fish and Game, vol. 22, no. 4, pp. 272-283.

Craig, J. A.
1930. An analysis of catch statistics of the striped bass (*Roccus lineatus*) fishery of California. Calif. Div. Fish and Game, Fish Bull. 24, 43 pp.

Hubbs, Carl L., and Leonard P. Schultz
1929. The northward occurrence of southern forms of marine life along the Pacific Coast in 1926. Calif. Fish and Game, vol. 15, no. 3, pp. 234-240.

Merriman, Daniel
1941. Studies on the striped bass (*Roccus saxatilis*) on the Atlantic Coast. U.S. Fish and Wild. Surv., Fish. Bull., vol. 50, no. 35, 77 pp.

Morgan, Alfred R., and Arthur R. Gerlach
1950. Striped bass studies on Coos Bay, Oregon, in 1949 and 1950. Oregon Fish Comm., Contrib., no. 14, 31 pp.

Radovich, John
1960. Some causes of fluctuations in catches of the Pacific sardine *Sardinops caerulea* (Girard). FAO World Sci. Meet. Biol. Sardines and Related Species, Proc., vol. 3, Exp. pap., no. 14, pp. 1081-1093.
1961. Relationships of some marine organisms of the northeast Pacific to water temperatures particularly during 1957 through 1959. Calif. Dept. Fish and Game, Fish Bull. 112, 62 pp.

Robinson, Margaret K.
1961. The use of a common reference period for evaluating climatic coherence in temperature and salinity records from Alaska to California. Mar. Res. Comm., Calif. Coop. Fish. Invest., Rept., vol. 8, pp. 121-130.

Scofield, Eugene C.
1931. The striped bass of California (*Roccus lineatus*). Calif. Div. Fish and Game, Fish Bull. 29, 84 pp.

Scofield, N. B., and H. C. Bryant
1926. The striped bass in California. Calif. Fish and Game, vol. 12, no. 2, pp. 55-74.

Skinner, John E.
1962. An historical review of the fish and wildlife resources of the San Francisco Bay area. Calif. Dept. Fish and Game, Water Proj. Br. Rept. 1, 226 pp.

Smith, Hugh M.
1896. A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific states. U.S. Fish Comm., Bull., vol. 15, pp. 379-472.
1908. The United States Bureau of Fisheries, its establishment, functions, organization, resources, operations and achievements. U.S. Bur. Fish., Bull. 28, pp. 1367-1411.

St. Amant, J. A.
1959. Striped bass introduced into the Colorado River. Calif. Fish and Game, vol. 45, no. 4, p. 353.

U.S. Coast and Geodetic Survey
1956. Surface water temperature at tide stations, Pacific Coast, North and South America and Pacific Islands. *Its* Spec. Pub., no. 280, 74 pp.

NOTES

GRAIN PREFERENCE OF CAPTIVE WATERFOWL

Examining gizzard contents is the usual method of determining waterfowl food habits; however, this technique does not necessarily reflect their innate preference toward various grains. Based on gizzard analyses, the monograph of Martin and Uhler (1951) represents the most comprehensive study of food habits of game ducks throughout the United States. Using the same technique, Yokum and Keller (1961) reported on waterfowl food habits at Humboldt Bay, California.

Our study was undertaken to gain some knowledge about their actual preference for a limited variety of grains independent of availability.

MATERIALS AND METHODS

An experimental group of 27 waterfowl consisting of five lesser Canada geese (*Branta canadensis parvipes*), one cackling goose (*Branta canadensis minima*), one snow goose (*Chen hyperborea*), one Ross's goose (*Chen rossii*), five pintails (*Anas acuta*), four mallards (*Anas platyrhynchos*), four cinnamon teal (*Anas cyanoptera*), three green-winged teal (*Anas carolinensis*) and five coots (*Fulica americana*) were maintained in an enclosed pen from January 22, 1962 to March 5, 1962. These birds were fed *ad libidum*, a choice of seven grains placed in identical stainless steel pans, which were randomly distributed daily. The seven grains tested were watergrass or barnyard grass (*Echinochloa crusgalli*), Purina hen chow (a mixture of cracked corn, wheat, Kaffir corn and milo), sudan grass (*Sorghum sudunense*), reed canary grass (*Phalaris arundinacea*), whole barley (*Hordeum vulgare*), alkali bulrush (*Scirpus robustus*), and smartweed (*Polygonum pennsylvanicum*).

Every two days the amount of grain consumed was determined by the weight loss from each pan. Spillage was minimal.

RESULTS

The amount of grain consumed varied from 1,182 to 2,274 grams per day with an average of 1,728 ± 108 grams per day (mean ± standard error), or 64 grams per bird per day. Watergrass was always preferred over the other six grains, and it comprised 47 to 78.3 percent of the total grain consumed (Table 1). Purina hen chow was the second choice followed by sudan grass, reed canary grass, barley, alkali bulrush, and smartweed (Table 1).

TABLE 1

Grain Preference of Captive Waterfowl

Grain	*Percent of total grain consumed*	*Average Preference Value*
Watergrass (barnyard grass)	47.0-78.3	100.0
Purina hen chow	15.4-35.9	42.8
Sudan grass	13.4-21.9	21.7
Reed canary grass	6.5-10.2	14.8
Whole barley	4.0- 8.4	7.6
Alkali bulrush	0.0- 5.7	4.2
Smartweed	0.0- 4.9	3.9

To relate the preference of the various grains tested, an **average preference value** was calculated by assigning the value of 100 to the watergrass consumed and relating the percentage of other grains consumed to that of watergrass as follows:

$$\text{Average preference value} = \frac{\text{percent of grain eaten}}{\text{percent of watergrass eaten}} \times 100$$

Based on this calculation, watergrass is preferred about 2 to 1 over Purina hen chow, 5 to 1 over sudan grass, and 12 to 1 over barley (Table 1).

DISCUSSION

This study is apparently the first attempt to evaluate grain preference independent of availability in captive waterfowl. It is therefore important to determine whether the results are realistic based on the experiences of others.

The average consumption of 64 grams per bird per day appears to be acceptable, at least for the larger ducks. Wise (1960) reported that during 1960, 50 captive mallards consumed 30.3 to 84.8 grams per duck per day, while 50 captive pintails consumed 28.6 to 82.3 grams per duck per day. We assumed that the relatively greater consumption of grain by the geese in our experiment was balanced by the relatively lower consumption by the small waterfowl.

With respect to preference, the data of Martin and Uhler (1951) rank the grains in decreasing recovery as follows: *Scirpus* sp., *Polyganum* sp., *Echinochloa crusgalli*, *Sorghum vulgare*, *Hordeum vulgare*. Probably the high frequency of recovering *Scripus* and *Polyganum* reflects the numerous species of these grains available for waterfowl to eat. Yokum and Keller (1961) ranked these grains as follows: *Hordeum vulgare*, *Scirpus* sp., *Polyganum* sp.; *Echinochloa* and *Sorghum* were not found. Since the preference ranking of our investigation agrees in part with both of the above reports, we assume the preference observations for the various grains are valid and the differences in ranking reflect grain availability. Obviously, much additional work is needed in order clearly to rank waterfowl grain preference.

SUMMARY

Twenty-seven captive ducks and geese provided grains *ad libidum*, preferred watergrass to all others tested. Their second choice was Purina hen chow, followed by sudan grass, reed canary grass, whole barley, alkali bulrush, and smartweed.

This study was supported in part by U. S. Public Health Service Grant, Research Grant RG 8538 and Federal Aid to Wildlife Restoration project W-30-R.

REFERENCES

Martin, A. C., and F. M. Uhler
1951. Food of game ducks in the United States and Canada. Res. Rept. 30, U.S. Govt. Print. Off., Washington. 308 pp. (Reprint of U.S.D.A. Tech. Bull. 634)

Wise, R. W.
1960. Food consumption and nutritive requirements of mallard and pintail ducks in captivity. Masters Thesis. Univ. Calif., Davis, 40 pp.

Yokum, Charles F., and Methew Keller
1961. Correlation of food habits and abundance of waterfowl, Humboldt Bay, California. Calif. Fish and Game, vol. 47, no. 1, pp. 41-53.

—*Larry Z. McFarland, Department of Anatomy, School of Veterinary Medicine, University of California, Davis, California, and Harry George and Harold McKinnie, Game Management Branch, Department of Fish and Game, December 1962.*

A FANTAIL SOLE, *XYSTREURYS LIOLEPIS*, IN MONTEREY BAY

On July 24, 1962, a $13\frac{3}{4}$ inch fantail sole was taken in an otter trawl in 45 fathoms off the Salinas River by the vessel *Three Sisters*. When the catch, chiefly English sole, *Parophrys vetulus*, was unloaded at Regal Seafoods, Monterey, marketman Jim Esaki noticed the unfamiliar specimen and saved it for identification. Fantail sole distribution seems to be from Abreojos, Baja California to Central California; however, they are also found in the northern part of the Gulf of California. The Monterey Bay fish establishes a definite northern boundary, about nine miles above Monterey and extends the bathymetric range from 30 fathoms (Miller, 1960).

The fantail sole (family Bothidae) is the only flatfish along our coast with both an anterior high abrupt arch in the lateral line and a pectoral fin on the eyed-side nearly as long or a little longer than the head. The pectoral fin on the blind side is noticeably shorter. Individuals may be either left-eyed, as in this case, or right-eyed. Maximum recorded size for the species is 20 inches (Miller, 1960).

REFERENCE

Miller, Daniel J.
1960. (Rev. Ed.) A field guide to some common ocean sport fishes of California. Part I. Calif. Dept. Fish and Game, 40 p.

—*J. B. Phillips, Marine Resources Operations, California Department of Fish and Game, September 1962.*

MORE GIANT SQUIDS FROM CALIFORNIA

Through the courtesy of Tom Jow, Marine Biologist, California Department of Fish and Game, the Department of Invertebrate Zoology of the California Academy of Sciences has received three fine, complete examples of the Pacific giant squid *Moroteuthis robusta* Verrill, the largest known Pacific Coast invertebrate. The first (Figure 1) was taken in 300 fathoms west of Trinidad Head (approximately lat. 41° 03′ N; long. 124° 28′ W) on 28 July 1962, by the trawler *City of Eureka*, Capt. Glen Alley. It was deepfrozen and when subsequently thawed, measured 9 feet 1 inch from the tip of the tail to the ends of the long tentacular arms. Its total length was stated as "around 11 feet" when fresh.

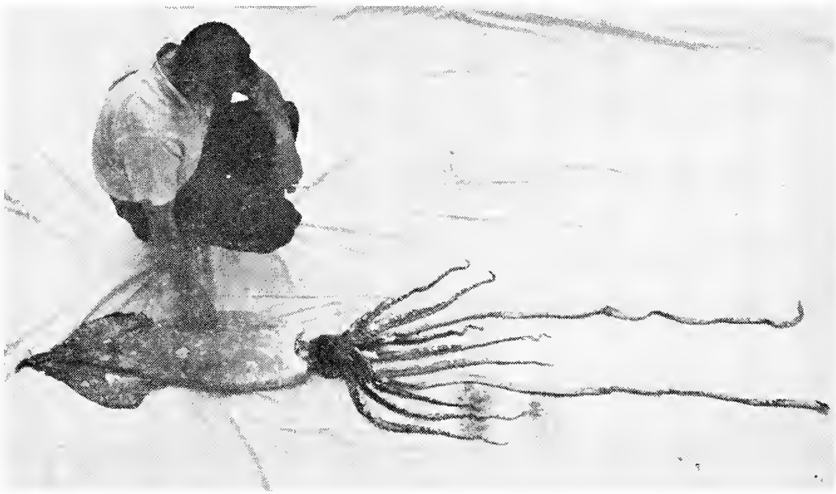

FIGURE 1. View of extended giant squid after thawing. Photo by Toshio Asaeda, California Academy of Sciences.

The second specimen, 9 feet 7 inches long, was trawled in 200 fathoms west of Trinidad Head by the *City of Eureka*, between 17 and 22 October 1962. The third squid, a juvenile about 34 inches long, came from the same haul. A previously unreported specimen was trawled in 220 fathoms west of Trinidad Head on 11 July 1950. All are preserved entire in the Academy's collection, and represent the 6th, 7th, 8th, and 9th *Moroteuthis robusta* recorded from California, and the 10th, 11th, 12th, and 13th from the Pacific Coast (Table 1).

It is now evident that this species is more prevalent than earlier records indicate. Dr. Cadet Hand, University of California (pers. comm.), says giant squids were taken in fair numbers by trawl fishermen in Monterey Bay in the summer of 1947, but no commercial use for them could be developed; attempts to prepare them as food produced unpalatable results. John E. Fitch (pers. comm.) also informs me that 15 or 20, 1- to 3-foot giant squids were seen or reported at the California State Fisheries Laboratory during 1961, and two large ones were trawled by the *N. B. Scofield* during an October-November 1962 cruise.

Little is known of the life history, food habits, or extent of the Pacific giant squid population. The species undoubtedly is pelagic and occurs at considerable depths. Adults from Californian waters have ranged from 8 to 11 feet long, with tentacular arms from 5 to 6 feet

TABLE 1

Pacific Giant Squids Reported in the Literature and Data on Four Recent Specimens

No.	Date	Location	Length (inches) Over-all	Length (inches) Tentacular Arms	Authority
1*	1872 (Apr.-May)	Beach at Unalaska Is., Alaska	80	30+	W. H. Dall
2*	1872 (Apr.-May)	Beach at Unalaska Is., Alaska	110	43+	W. H. Dall
3*	1872 (Apr.-May)	Beach at Unalaska Is., Alaska	167	61+	W. H. Dall
4	1896	Beach at Unalaska Is., Alaska	ca. 96	?	D. Thompson
5	1932 (Aug. 23)	Beach at Monterey, Calif.	100	60	J. B. Phillips
6	1934 (Apr. 14)	Beach at Laguna Beach, Calif.	112.5	65.5	R. S. Croker
7	ca. 1935	Fish Market, Monterey, Calif.	?	?	R. L. Bolin
8	1950 (July 11)	200 fms. W. of Trinidad Head, Humboldt Co., Calif., (trawled)	55.5	42.8	A. G. Smith
9	1954 (Nov.)	200 fms. off Santa Rosa Is., Calif. (trawled)	116	?	J. B. Phillips
10	1960 (June 19)	Carmel, Calif. (taken by SCUBA divers)	105	?	J. B. Phillips
11	1962 (July 28)	300 fms. off Trinidad Head, Calif. (trawled)	109	70	A. G. Smith
12	1962 (Oct. 12-22)	200 fms. off Trinidad Head, Calif. (trawled)	115	75	A. G. Smith
13	1962 (Oct. 12-22)	200 fms. off Trinidad Head, Calif. (trawled)	34.3	17.8	A. G. Smith

* Dall's three Alaskan specimens were mutiliated and lacked the ends of the tentacular arms.

long. One Alaskan specimen was probably well over 14 feet long when alive. The mouthparts of the three Trinidad Head specimens seem small for so large an animal. Specimen 11 (Table 1) had a chewed up pelagic siphonophore (*Velella lata*) in its beak and specimen 13 had the broken test of a small mud-dwelling heart-urchin (*Brisaster townsendi*) in its stomach, indicating *Moroteuthis* may seek its food from the top of the ocean to the bottom.

Phillips (1933) gave a good description of *Moroteuthis robusta* along with a discussion of other Californian squids. Thomson (1900) described the fourth Alaskan specimen in considerable detail, the two largest *Moroteuthis* I examined agree closely with his description.

REFERENCES

Croker, R. S.
1934. Giant squid taken at Laguna Beach, Calif. Fish and Game, vol. 20, no. 3, p. 297.

Dall, William Healey
1873. Aleutian cephalopods. Amer. Nat., vol. 7, pp. 484-485.

Phillips, J. B.
1933. Description of a giant squid taken at Monterey, with notes on other squid taken off the California coast. Calif. Fish and Game. vol. 19, no. 2, pp. 128-136, figs. 47-49.
1961. Two unusual cephalopods taken near Monterey. Calif. Fish and Game, vol. 47, no. 4, pp. 416-417, fig. 1.

Thompson, D'Arcy W.
1901. On a rare cuttlefish, *Ancistroteuthis robusta* (Dall) Steenstrup. Proc. Zool. Soc. London, for 1900, pp. 992-998, figs. 1-2.

Verrill, A. E.
1876. Note on gigantic cephalopods,—a correction. Amer. Jour. Sci. and Arts, 3rd ser., vol. 12, no. 69, pp. 236-237.

—Allyn G. Smith, Department of Invertebrate Zoology, California Academy of Sciences, San Francisco 18, California. November 1962.

A SECOND LARGE CATCH OF PACIFIC ROUND HERRING

On November 28, 1962 another large and unusual catch of Pacific round herring (*Etrumeus acuminatus* Gilbert), totaling 4,250 pounds, was made with a lampara net near the west end of Santa Catalina Island, lat. 33° 28′ 44″ N. long. 118° 36′ 17″ W. by Michael Di Meglio on the boat *Riptide*. In this instance the fish were not mixed with other species. The first large catch was made November 9, 1961 near Long Beach when a purse seiner took about 2 tons of round herring mixed with 8 tons of jack mackerel and Pacific mackerel (Carlisle 1962).

This note gives me an opportunity to correct an oversight in my previous paper where two references to Californian occurrences were overlooked. Jackson (1927) reported round herring were observed in San Pedro fish markets in 1919, 1920, 1921, and 1927; Clark (1934) reported three individuals in mackerel catches in 1934.

Sexes, total lengths (in millimeters) and weights (in grams) of a three-fish sample from the *Riptide* catch are:

Sex	*Length*	*Weight*
M	277	187
M	285	213
F	290	212

REFERENCES

Carlisle, John G., Jr.
1962. An unusual catch of a large number of Pacific round herring off Long Beach, California. Calif. Fish and Game, vol. 48, no. 3, p. 209.

Clark, Frances N.
1934. Uncommon fish taken at San Pedro. Calif. Fish and Game, vol. 20, no. 4, pp. 393-394.

Jackson, Carl R.
1927. The occurrence of the Japanese herring. Calif. Fish and Game, vol. 13, no. 2, p. 141.

—*John G. Carlisle, Jr., Marine Resources Operations, California Department of Fish and Game, December 1962.*

NEW NORTHERN RECORDS FOR OCEAN WHITEFISH *CAULOLATILUS PRINCEPS* (JENYNS)

An 11-ounce ocean whitefish, 258 mm standard length, was taken September 27, 1962 by Chester Hall of the trawler *Sunset* off Redding Rock, Humboldt County, California. It was taken in an otter-type shrimp net trawled between lat. 41° 23′ N., long. 124° 21′ W. and lat. 41° 19′ N., long. 124° 20′ W. at 55 to 57 fathoms. This location is over 220 miles north of the previously recorded range for the species.

Another ocean whitefish was received from A. Paladini Co. at Fort Bragg on December 10, 1962. The origin of this fish is unknown but it doubtlessly came from a trawl vessel operating from Fort Bragg. Both were deposited at California Academy of Sciences.

Ocean whitefish are uncommon north of Point Conception but have been known previously to range to the Farallon Islands off central California (Radovich, 1961, Roedel, 1953).

REFERENCES

Radovich, John
1961. Relationships of some marine organisms of the northeast Pacific to water temperature, particularly during 1957 through 1959. Calif. Dept. Fish and Game, Fish Bull. 112, 61 pp.

Roedel, Phil M.
1953. Common ocean fishes of the California coast. Calif. Dept. Fish and Game, Fish Bull. 91, 184 pp.

—Tom Jow, Marine Resources Operations, California Department of Fish and Game, January 1963.

GREENLAND HALIBUT, *REINHARDTIUS HIPPOGLOSSOIDES* (WALBAUM), ADDED TO CALIFORNIAN FAUNA

During the last week of August 1962, Mr. Bruno Mattuzzio, of the A. Paladini Fish Co., Fort Bragg, California, observed a large pleuronectid that was strange to him. The fish, a Greenland halibut (Figure 1), was frozen until presented to me for identification.

The Greenland halibut's taxonomic position in the Pacific has not been worked out satisfactorily as yet. Nikol'skii (1961, p. 439) considered it a subspecies of the Atlantic form, but Hubbs and Wilimovsky (pers. comm.) have in preparation a detailed study of eastern Pacific Ocean and Bering Sea *Reinhardtius* and find no acceptable support for a Pacific subspecies. Nikol'skii (1961, p. 441) gave the Pacific range as, "the western part of the Pacific from the Barents Sea to the shores of Japan." Andriashev (1937, p. 41) reported its occurrence in the Okhotsk Sea and the northern part of the Bering Sea.

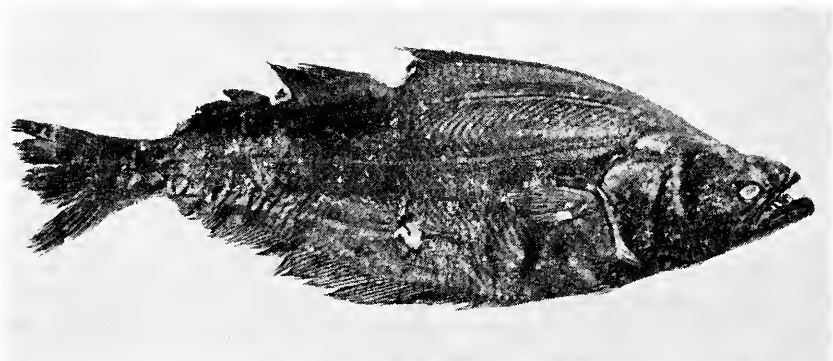

FIGURE 1. Male Greenland halibut 625 mm total length from Californian waters. *Photograph by Maurice C. Giles, January 1960.*

The exact capture location of the Californian specimen could not be determined. It was first observed at the processing plant in a box containing English sole, *Parophrys vetulus* Girard. A check of the fishing logs of otter trawlers delivering to A. Paladini Fish Co. at that time indicated the fish had to have been taken in the Gulf of the Farallons (approximately lat. 38° N., long. 123° W.), where all fishing had been in 50-fathom depths or less.

The specimen was an adult male 625 mm total length (562 mm standard length) and weighed 4 pounds. Scale examination indicated it was at least 5 years old. Although the dorsal fin was mutilated, 96 rays were distinguished and the anal fin ray count was 70. The specimen was deposited in the collection of the California Academy of Sciences (CAS 26921).

LITERATURE CITED

Andriashev, Anatoly P.

1937. A contribution to the knowledge of the fishes from the Bering and Chukchi Seas. Inst. Hydro., Leningrad, Explor. Mers URSS, fasc. 25, p. 295-355. (Translated by Lisa Lanz and N. J. Wilimovsky, U. S. Fish and Wildl. Serv., Spec. Sci. Rept.: Fish., no. 145, 81 p., 1955.)

Nikol'skii, G. V.

1961. Special ichthyology (*chastnaya ikhtiologiya*). 2nd rev. ed. Translated from Russian by J. I. Lengy and Z. Krauthamer. Jerusalem, Israel Program for Scientific Translations, 538 p.

—*E. A. Best, Marine Resources Operations, California Department of Fish and Game, January 1963.*

A SECOND PINTO LOBSTER FROM CALIFORNIA

On January 17, 1961, Mr. Carl A. Magers, Jr., caught a pinto lobster, *Panulirus inflatus* (Bouvier), in a trap set near the San Diego harbor breakwater and turned it over to the Department of Fish and Game (Fitch, 1962). Twenty-one months later, on October 16, 1962, Mr. Magers trapped a second pinto lobster in 12 feet of water off Hotel del Coronado, a few miles downcoast from where the first was taken.

I had assigned the scientific name *P. gracilis* to the first specimen, based upon the best information available at the time. Subsequently, however, a publication by Holthuis and Villalobos (1961) was received which reviews the taxonomy and distribution of eastern Pacific lobsters, genus *Panulirus*, and presents detailed information distinguishing *P. gracilis* from *P. inflatus*. Based upon a critical examination of numerous specimens, they give the range for *P. gracilis* as Paita, Peru north to Acapulco, Mexico (one record from Mazatlan) and for *P. inflatus* as Gulf of Tehuantepec north to Magdalena Bay, Baja California. My recent paper (Fitch, 1962) extended the range of *P. inflatus* northward to San Diego and discussed records for intermediate areas. Thus, the ranges of *P. gracilis* and *P. inflatus* overlap only between Mazatlan and the Gulf of Tehuantepec. Holthuis and Villalobos assign the name *P. penicillatus* to the species found at the offshore islands of Revillagigedos, Clipperton, Cocos, and Galapagos.

The most recent San Diego specimen, a male, 79 mm in carapace length (205 mm total length) agrees in all respects with the characters Holthuis and Villalobos ascribe to *P. inflatus*. Since it was nearly identical in size to the 1961 specimen, yet it was caught 21 months later, it seems reasonable and safe to assume that larval pinto lobsters drifted north into our waters during at least 2 of the 4 recent warm-water years, 1957-1961.

This specimen has been deposited in the Allan Hancock Foundation collection, Los Angeles.

REFERENCES

Fitch, John E.
1962. A sea urchin, a lobster and a fish, new to the marine fauna of California. Calif. Fish and Game, vol. 48, no. 4, pp. 216-221.

Holthuis, L. B., and Alejandro Villalobos F.
1961. *Panulirus gracilis* Streets y *Panulirus inflatus* (Bouvier), dos especies de langosta (Crustacea, Decapoda) de la costa del Pacifico de America. An. Inst. Biol. Univ. Mex., vol. 32, nos. 1 & 2, pp. 251-276.

—John E. Fitch, Marine Resources Operations, California Department of Fish and Game, January 1963.

A RECORD-SIZE DAGGERTOOTH TAKEN OFF NORTHERN CALIFORNIA

The most bizarre of the fishes received at the Eureka Marine Resources Laboratory during the past year was a daggertooth *Anotopterus pharao* Zugmayer. This was a male, 1,017 mm standard length (Figure 1), caught on April 16, 1962 by G. M. Lindstrom and D. A. Dettinger aboard the troller *Christine*. It was taken on a salmon spoon trolled at 20 fathoms in water 1,400 fathoms deep, 25 miles west of Cape Mendocino, Humboldt County, California. The surface water temperature was 54°F.

Records of daggertooths are sparse. They are known from the north Pacific, the Atlantic off Greenland, and Antarctica, and the temperate northeastern Atlantic.

Hubbs *et al.* (1953) listed five, 112.5 to 861 mm s.l., from the Pacific. All were taken between 1935 and 1952. One specimen, 299 mm s.l., came from the stomach of an albacore (*Thunnus alalunga*) caught in 1952 off central California at lat. 35° 35′ N., long. 122° 25′ W. Welander *et al.* (1957) reported specimens 759 and 867 mm s.l. taken in 1953 off Adak Island, Alaska. Neave (1959) recorded without mention of size, "several" taken during 1947 and 1948 and 15 taken between 1955 and 1958 from the Gulf of Alaska. Clemens and Wilby (1961) recorded another taken from the Gulf of Alaska in 1958.

W. I. Follett (pers. comm.) informed me of a 651 mm s.l. daggertooth in the California Academy of Sciences collection (CAS No. 26068) which was taken on June 2, 1954 by Walter Sunblad, aboard the troller *Harold J.* It was hooked on a salmon spoon trolled at 35 fathoms in water 200 fathoms deep at lat. 40° 05′ N., long. 124° 09′ W., 2 miles off Buck Creek, Humboldt County, California. A shortbelly rockfish, *Sebastodes jordani*, and a blue rockfish, *Sebastodes mystinus*, were found in its stomach.

John E. Fitch (pers. comm.) has records of some 36 individuals at the California State Fisheries Laboratory. All were from stomachs of albacore or lancetfish (*Alepisaurus richardsoni*). One, 630 mm s.l., was found in the stomach of a 35-pound albacore taken September 30, 1957 on Davidson Seamount, at approximately lat. 35° 43′ N., long. 122° 43′ W., by Homer Moore aboard the troller *GM*.

The 1,017 mm daggertooth caught by Messrs. Lindstrom and Dettinger weighed 1,300 grams (2.9 pounds) and is the largest on record. John E. Fitch interpreted six rings on its otoliths, which would indicate an age of 6 years if these marks are annuli. Scales found embedded beneath the integument on the sides of this fish did not appear to have rings. The specimen, in excellent condition, was deposited at the California Academy of Sciences (CAS No. 26911).

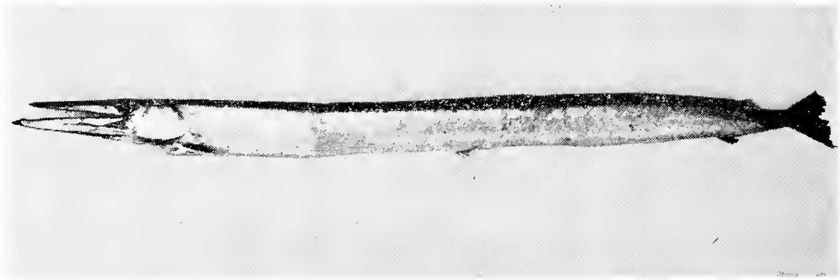

FIGURE 1. Daggertooth, *Anotopterus pharao*, 1,017 mm standard length taken April 16, 1962, 25 miles west of Cape Mendocino, Humboldt County, California. *Photograph by Jack W. Schott.*

The records available to Hubbs *et al.* (1953) suggested that *Anotopterus* occurs chiefly as young to small adults in the warmer temperate waters and as large adults only in cooler subpolar waters. Recent California records of 630, 651, and 1,017 mm *Anotopterus* reported herein show that large adults also occur in subsurface depths of the temperate eastern Pacific Ocean.

LITERATURE CITED

Clemens, W. A., and G. V. Wilby
1961. Fishes of the Pacific coast of Canada. 2nd ed. Fish. Res. Bd. Canada Bull. 68, 443 pp.

Hubbs, C. L., G. W. Mead, and N. J. Wilimovsky
1953. The widespread, probably antitropical distribution and the relationship of the bathypelagic iniomous fish *Anotopterus pharao*. Scripps Inst. Oceanogr., Bull., vol. 6, pp. 173-189.

Neave, Ferris
1959. Records of fishes from waters off the British Columbia coast. Fish. Res. Bd. Canada, Jour., vol. 16, no. 3, pp. 383-384.

Welander, A. D., D. L. Alverson and P. Bergman
1957. Rare fishes from eastern north Pacific ocean. Wash. Dept. Fish. Res. Pap., vol. 2, no. 1, pp. 60-72.

—*Tom Jow, Marine Resources Operations, California Department of Fish and Game, January 1963.*

BOOK REVIEWS

A Guide to the Study of Fresh-water Biology

By James G. Needham and Paul R. Needham, Holden-Day, Inc., San Francisco, 1962; x + 107 pp. profusely illustrated with text drawings, etc.; $2.25 (paperbound).

This is the fifth revision of a basic field guide originally published in 1938 as an outgrowth of material developed by the two Needhams (father and son) at Cornell University. It differs from previous printings primarily through the added keys of the common fishes, updated classification, and improved format. The stated purpose is to facilitate recognition of freshwater organisms commonly found in the field throughout the United States.

As previously, the manual is divided into two parts: keys and line drawings for identification, and information on collecting methods and equipment needs.

A few minor criticisms are in order. One of the best references for identifying western aquatic insect forms, Usinger *et al., Aquatic Insects of California* is only casually mentioned under Hemiptera. The reason generic names were listed in duplicate under each plate is not clear to me. References for algae were begun on page 11 and resumed on page 16 for no apparent reason. One serious omission from the section on mollusks is the Asiatic clam, *Corbicula*, which is now nationwide in distribution and a real problem in many areas.

With our ever-expanding knowledge, it becomes increasingly difficult to organize a manual which will undertake identification of such a broad, diverse field as invertebrate life of inland waters. Despite its breadth, this guide is still the best compact field manual students and biologists will find for nationwide general classification of aquatic organisms. Those wishing to delve into detailed studies of specific groups or regional faunas will want to consult the reference works noted.—*Willis A. Evans. California Department of Fish and Game.*

A Treasury of Birdlore

Edited by Joseph Wood Krutch and Paul S. Eriksson, Doubleday & Company, Inc., New York, 1962; xviii + 390 pp., 52 figures; $7.50.

Strictly speaking, a concise review of this anthology could be accomplished by simply using the title alone, *A Treasury of Birdlore*, for a treasury it is indeed.

Acknowledgments of copyrighted material from which the various selections were taken are first presented. A four-page introduction sets the stage, and a list of authors and titles of selections are placed under five broad headings as follow: "Flight," "Family Matters," "Birds of a Feather," "Birds and Men," and "Extinction and Conservation." Some 84 articles, from brief one-page accounts to those several pages long, comprise the "meat" of the book. The subject matter is quite broad, including in part: fossil history, flight, migration, capacity and intelligence, courtship, social behavior, hibernation, voice and song, bird banding, bird anting, extinct species, and conservation.

The stories selected are written in the popular vein for the most part and are arranged to make easy and very enjoyable reading. The tenor of the various subjects runs from the humorous to the downright tragic, and covers a wide range between.

Very few typographical errors were observed and the continuity is very good. The editors did a fine job of selecting the articles from publications covering a period of several hundred years.

Several pages of figures supplement the text, which is unfortunate, as they serve very little purpose that I can see. Their general arrangement is poor, there is much repetition of species illustrated, and the captions are not completely correct (figures 12 and 13 have captions reversed; in figure 37 a "Water Thrush or Water Ouzel" is depicted, presumably to illustrate John Muir's story "The Water Ouzel." The bird shown is a water thrush but can hardly be considered an ouzel as Mr. Muir so vividly describes). If illustrations were deemed necessary, it would seem a better selection could have been made.

While I cannot help feeling critical of many of the figures, I unhesitatingly recommend this book to anyone interested in ornithology either as a field of study or as a casual bird watcher or "dickey birder." This work compiles a vast amount of history and other birdlore information into one volume that otherwise would require much library research to obtain. As previously stated, this is indeed *A Treasury of Birdlore.—William D. Hawes, California Department of Fish and Game.*

Fish Capture

By Ronnie Balls, Edward Arnold (Publ.) Ltd., London (American agents, St. Martin's Press, Inc., New York), 1961; 144 pp., 2 black and white plates, 14 text figures; $1.75.

This is another in the Buckland lecture series. Captain Balls has spent his life in the pursuit of sea fishes and here reports many of his observations and experiences in the capture of fishes.

He begins with a simple discussion of the various fishing methods in use all over the world and follows with a rather complete description of English trawling and herring drifting. The final section is devoted to observations of fish behavior, primarily herring; reaction of fish to fishing gear; locating fish by echo-sounding; and future developments in fishing gear and techniques.

The sections on fish behavior and reaction are very timely and thought-provoking. Anyone interested in the pursuit of fish will find this stimulating as well as interesting reading.—*E. A. Best, California Department of Fish and Game.*

Fish Culture

By C. F. Hickling, Faber & Faber Publ., London, 1962; 295 pp., 66 figures; 45/.

At a time when worldwide emphasis is being placed on increasing production of freshwater food fishes to fill protein needs of an expanding human population, Mr. Hickling's *Fish Culture* should well serve administrators, biologists, fish culturists, and students concerned with pond-fish culture. The book compiles works and findings of researchers in many lands and is probably the most extensive English-language reference available today.

Rearing of several species of food fishes in many parts of the world, both as principal enterprises or in conjunction with land crops, is reviewed. Chapters deal with fertilization, supplemental feeding, stocking rates, species composition, production trends and problems, as well as water and pond soil requirements. Water and soil chemistry is well covered, particularly the interaction of pond water and pond mud in releasing and adsorbing nutrients. Genetics, hybridization, and diseases of pond fishes are touched upon.

As Mr. Hickling states, his book is not concerned with producing ornamental and aquarium fish, nor with producing trout and other game fishes. Aside from general information, this book would be of little value to operators of large, government or commercial trout hatcheries since the brief coverage of methods and results is hardly applicable to techniques presently employed in this country. Warmwater game fish culturists and biologists managing lake and pond fisheries will, however, find some provoking information.

If the author were to revise this book, I would suggest addition, in parentheses, of weight and area conversions to a common factor when, within the same paragraph comparing production from different ponds, results are given in metric, English, and American units of measure. In a single sentence, kilograms per hectare may be compared with tons per acre. Readability is impaired for the person not in daily contact with these terms, for the thought train is interrupted while he mentally converts grams to ounces or English hundredweight to tons. Portions of the book seem repetitive, which may represent an intentional effort by the author to place emphasis on certain points. It more probably is an unavoidable product of assembling and citing, with proper credit, the results obtained by so many other workers.

The book is well illustrated and the many photos, along with Mr. Hickling's word pictures of, to me, strange and often ingenious methods in distant lands, added interest to the text.—*William M. Richardson, California Department of Fish and Game.*

Fishing Secrets of the Experts

Edited by Vlad Evanoff; Doubleday & Co., Inc., Garden City, New York, 1962; 288 pp., 106 illustrations; $4.95.

This book contains 20 chapters by 18 authors which deal with a vast array of fishing subjects ranging from fly fishing for trout to fishing for swordfish and giant tuna. Nine chapters discuss angling in salt water while the remainder deal with freshwater. For a book of this size, the coverage is exceptional. Freshwater angling topics include fishing for trout, bass, carp, salmon, and many others. Salt-water angling sections are equally broad and discuss angling on both Atlantic and Pacific coasts.

The expectional coverage of this book suggests it is intended primarily for the novice angler. Herein lies one of its basic weaknesses. The authors generally did not have sufficient space to deal with fundamentals. Fly fishing for trout, a subject on which legends have been written, is treated in just 13 pages. While the author, Ray Ovington, has done a creditable job, it is worth noting that space did not permit including basic material on casting, rod and reel selection, knots, or lines and leaders. This criticism is not directed at the authors; many of them have done a difficult job extremely well. There is no question but that the value of this book would have been greatly increased if a list of supplementary reading material had been provided at the end of each chapter.

Unfortunately, this book may be of limited value to most anglers. The novice will certainly require much more in the way of fundamentals, while the seasoned angler will be interested in only a few of the many chapters.—*Charles E. von Geldern, Jr., California Department of Fish and Game.*

These We Inherit, the Parklands of America

By Ansel Adams, Sierra Club, San Francisco, 1962; 103 pp., 42 black and white plates (photographs); $15.

Ansel Adams, in the preface, writes, "This book may be considered as a photographic introduction to the national parks and scenic monuments. It relates more to photography *in* than *of* the areas so designated. Fortunate he is who may see Mount McKinley against the summer midnight sky, the lush fern forests of Kilauea, the white jubilance of Yosemite's waters, and the somber rock and surf of Acadia National Park. To record and interpret these qualities for others, to brighten the drab moods of cities, and build high horizons of the spirit on the edge of plain and desert—these are some of the many obligations of art. The grandeurs and intimacies of nature as presented here will, I hope, encourage the spectator to seek for himself the inexhaustable sources of beauty in the natural world about him."

Thus Mr. Adams expresses what he and The Sierra Club intend to do with this book; to encourage people to seek sources of beauty and realize that these areas of natural beauty must be preserved for future generations.

This book, which Mr. Adams uses as a vehicle for transporting his philosophy to the world, is more than just a book; it is a work of art. Seldom are readers able to obtain photographs of the natural scene with such superb quality and beauty. The photographs move the viewer from coast to coast and across the sea to the lush fern forests of Hawaii. The photographs are accompanied by a short, well-written text which discusses the concepts and ideals of the National Parks. This book makes a valuable addition to the library of those who have an interest in the beauty and wonder of our natural areas.—*Michael L. Johnson, California Department of Fish and Game.*

Grawing Wings

By Sarita VanVleck, Doubleday and Co., Inc., New York, 1963; xiv + 128 p., illus.; $3.95.

In reading *Growing Wings*, one is immediately aware of the author's keen sense of observation and the ease in which she gives examples that tend to put the reader in the role of the observer.

The scope of the book is basically the perennial cycle of birds. In remarkably few pages, the author enlightens the reader with an interesting account of bird behavior and habits in chapters devoted to migration, courtship, mating, incubation and flocking, among others.

Since birds and men are both vertebrate animals the similarities in basic anatomical, behavorial, and physiological patterns are presented. This distinctive treatment and the other subject matter is a fresh approach to birdwatching.

This book should appeal to all nature lovers and is recommended for interesting and instructive entertainment.—*William F. Hart, California Department of Fish and Game.*

Land, People, and History

By Elizabeth S. Helfman, David McKay Co., Inc., New York, 1962; xiv + 271 pp., 24 illustrations; $4.95.

The story of careless land use over the centuries holds an urgent message for children growing up in our urban society, insulated on all sides from farms and wild land. This book conveys that message well through illustrations drawn from the history of land use in various parts of the world. The author also draws heavily on pressing land use and problems throughout the world today to emphasize that a culture's attitude toward the soil is all important and that irreparable damage to its productivity often results from ignorance or indifference.—*Alex Calhoun, California Department of Fish and Game.*

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