ISOLATION OF OLIVE ROCKFISH, *SEBASTES SERRANOIDES*, POPULATIONS OFF SOUTHERN CALIFORNIA

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ABSTRACT

Movements of the olive rockfish, *Sebastes serranoides*, off Santa Barbara, California, were investigated, using mechanical and parasite tags. The movements were restricted over shallow reefs though somewhat less so around deeper oil platforms. Highly restricted movements may cause greater vulnerability of populations to overfishing—comparisons of olive rockfish size frequencies between two reefs indicated that fishing pressure had reduced olive rockfish populations to almost all prereproductive individuals on the more heavily fished site.

Rockfishes, genus *Sebastes* (Family Scorpaenidae), form a most diverse fish group along the California coast. Some 57 species are found in these waters (Miller and Lea 1972), inhabiting virtually every marine habitat from estuarine (occasionally) and intertidal waters to depths of more than 610 m (Miller and Lea). Rockfish are very important to both sport and commercial fishing industries; in California waters in 1974, rockfish ranked third in the commercial fishery (poundage landed) and first in the sport fishery (numbers landed) (McAllister 1976).

California species can be roughly divided into two bathymetric groups: shallow species that inhabit subtidal areas of reef and kelp, and those that live in relatively deep water (deeper than about 70 m). All species are ovoviviparous, producing pelagic larvae. There is some evidence that the shallow water species may remain within a relatively small area of reef or kelp (Miller and Geibel 1973).

A species that consists of relatively sedentary, reef-oriented aggregations would present potential problems in management, as certain management strategies presuppose movements of this fish (Harden Jones 1968; Cushing 1968). If the exploited species inhabits reefs, for example, it might soon be decimated at a heavily fished reef if individuals were parochial and did not move from an unexploited site to repopulate the depleted one. Obviously, a management strategy to protect this type of segregated reef species would differ from that for a species whose individuals move between sites. Many rockfish species grow very slowly (Phillips 1964; Chen 1971: Westrheim and Harling[2]). Thus, even if a depleted reef were densely settled by a successful year class, it would not harbor adults for a number of years. Before then, the subadults would probably be caught before the age of first maturity, so the reef would effectively be lost as a site of propagation for the species. If this process continued through all available reef sites, the fisheries would be endangered.

On the other hand, a rockfish species whose individuals move freely from reef to reef may be less vulnerable to such perturbations. Even a locally depleted reef could be sufficiently repopulated by adults during breeding season because of the typically high fecundity of females (Phillips 1964) and great dispersability of pelagic larvae. Thus the fishery might be effectively managed by conventional procedures of establishing catch limits, etc.

The olive rockfish, *Sebastes serranoides*, inhabits reefs and kelp beds from San Benito Island, Baja California, north to Redding Rock, Del Norte County, northern California, and from intertidal waters (juveniles) to 146 m (Miller and Lea 1972). The species is most common in southern and central California from surface waters to depths of about 75 m. It is a major sport fish throughout much of the state (Miller and Gotshall 1965), particularly in southern and central California. Objectives of the present study were to determine whether individuals move from reef to reef and if average size was smaller at heavily fished reefs.

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[2]Westrheim, S. J., and W. R. Harling. 1975. Age-length relationships for 26 scorpaenids in the northeast Pacific Ocean. Fish. Mar. Serv. (Can.), Res. Dev. Dir. Tech. Rep. 565, 12 p.

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METHODS

Artificial Tagging

Between 26 October 1973 and 17 October 1976, 1,847 olive rockfish (19-43 cm total length, TL) were tagged and released upon capture at 18 sites off southern California (Figure 1, Table 1). Generally, sites were selected either on the basis that they were reefs regularly fished by partyboats or private vessels, which maximized the opportunity to recapture tagged animals; or that sites had to be within 2 km of another regularly fished reef that harbored olive rockfish, which maximized the opportunity to recover fish that move short distances. The exception was Naples Reef, which had no other suitable site within 2 km. Naples Reef was included because its fish fauna was being studied intensively by other scientists. Only a few fish were tagged at some sites, such as Anacapa Island, Platform Holly, and Avila, either because olive rockfish were infrequent there or because the sites were relatively remote from Santa Barbara.

The tags (yellow Floy[3] anchor type FD-67c) consisted of a plastic tube 42 mm long with a 15 mm nylon stem and a 10 mm cross bar attached to the stem and were inserted with a Floy tagging gun, FDM 68, with a heavy-duty needle 2 cm long. My name, Department of Biology, UCSB, and a number were printed on each tag. The anchor was injected into the dorsal musculature between the second and third dorsal spines, leaving the brightly colored end free. Even though bryozoan growth completely obscured the legend within a few months, this growth was easily rubbed off by a person's finger when the tag was read.

Fish were caught by hook and line aboard research vessels and sportfishing partyboats, then measured, tagged, and returned to the water. Because of expanded gas in their swim bladders, fish taken at depths greater than about 20 m had to be deflated before they could return to depth. Perhaps 10% of all fish tagged required deflation, using a technique modified slightly from Gotshall (1964). A 3.8 cm, 18 gage hypodermic needle was inserted through the body wall into the swim bladder. However, instead of placing both fish and needle underwater, then waiting for the gas bubbles to stop emanating from the needle, gas was sucked from the bladders to speed the process, and if needed, the fish's everted stomach was pushed back into place. About 20% of the inflated fishes died either before or immediately after being returned to the water. Undoubtedly others that swam downward also died; of six fish placed in a tank after deflation, two died within 1 day and the rest survived for 2 wk, to the end of the test. Eliminated were all fish whose eyes were everted by gas expansion in the choroid plexa. Experience with *S. caurinus*, *S. paucispinis*, and *S. serranoides* indicates that this condition frequently leads to blindness and/or death, whether or not pressure is released.

TABLE 1.—Descriptions and locations of tagging sites for olive rockfish near Santa Barbara, Calif. For locations of sites see Figure 1 also.

Site and description
Diablo Canyon, Avila—11 km west of Avila Harbor, 9 m reef in 33 m, 0.3 km offshore
Naples Reef—24 km west of Santa Barbara, 1.6 km offshore, in 8-10 m, surrounded by 16-20 m deep sand flats
Oil Platform Holly—18 km southwest of Santa Barbara, in 60 m, about 3.2 km offshore
1 Mile Reef—2 km southeast of Santa Barbara, 2-6 m reef in 30-35 m
Horseshoe Reef—10 km east of Santa Barbara. Average depth 8-10 m, surrounded by 12-13 m
Oil Platform Hilda—8.7 km east of Santa Barbara, 3.1 km offshore in 34 m
4 Mile Reef—6.4 km southeast of Santa Barbara, 6-8 m pinnacle in 40 m
Oil Platform Hillhouse—10.4 km southeast of Santa Barbara, 8.9 km offshore in 58 m
Oil Platforms Houchin, Hogan, Hope—About 14.0 km southeast of Santa Barbara, about 7 km offshore in 50 m
Talcott Shoals, Santa Rosa Island—64.0 km southwest of Santa Barbara, 2-15 m pinnacles in 4-45 m
Fraser Pt., Santa Cruz Island—46 km south of Santa Barbara, 2-6 m reefs in 12-15 m
Smugglers Cove, Santa Cruz Island—40 km southeast of Santa Barbara
Anacapa Island—43 km southeast of Santa Barbara
Rincon Oil Island—19 km east of Santa Barbara (not figured)
Deephole Reef—68 km east of Santa Barbara, 2-6 m reefs in 24-28 m, about 1.8 km offshore (not figured)

Tagging mortality in fish that did not have to be deflated was probably low. Ten of 12 tagged olive rockfish lived for 2 mo in an aquarium, two dying after about 1 mo, apparently of a fungal infection. I saw none of the extensive hemorrhaging previously observed in Floy-tagged Pacific mackerel, *Scomber japonicus* (Gregory[4]).

Biological Tagging

I analyzed the parasite mix of olive rockfish to determine the feasibility of using parasites as "biological tags." Differences in parasite infection

[3]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

[4]Gregory, P. A. 1977. Results of tagging mortality experiments on Pacific mackerel, *Pneumatophorus japonicus*. Calif. Dep. Fish Game, Mar. Res. Tech. Rep. 40, 21 p.

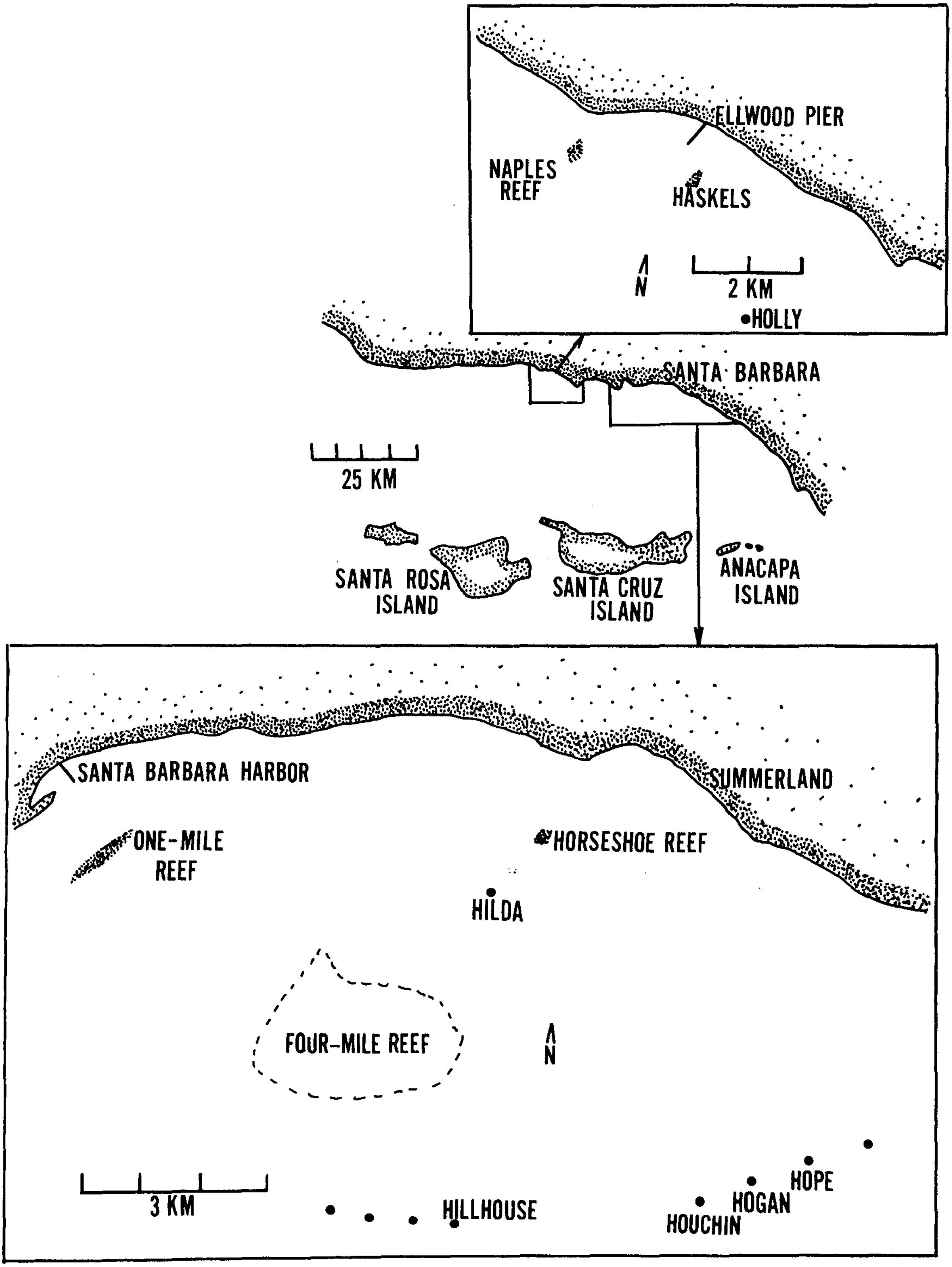

FIGURE 1.—Location of tagging and sampling sites for olive rockfish near Santa Barbara, Calif. Specific sites are described in Table 1. Deep Hole Reef (68.6 km east of Santa Barbara) and Rincon Oil Island (19 km east of Santa Barbara) are not included.

rates between host groups within a species can indicate reduced movement of fish between populations (Kabata 1963). Twenty olive rockfish from each of six sites (Naples Reef, Ellwood Pier, Horseshoe Reef, 4 Mile Reef, and oil platforms Houchin and Hillhouse—Figure 1) were sampled quarterly by hook and line or spear, between June 1976 and March 1977, placed on ice and frozen for later dissection. After thawing, fish were measured and were examined for parasites on the external surfaces as well as the gills, gill cavities, mouth, mesentery, heart, gallbladder, stomach, intestine, and muscle. Initially, copepods and monogenetic and digenetic trematodes were fixed in an alcohol-formaldehyde-acetic acid (AFA) solution and the trematodes were stained with Harris' hematoxylin, cleared with xylene, and mounted. Protozoans were studied unpreserved after thawing. Because most of the parasites recurred frequently, only those not readily indentifiable were preserved in the latter parts of the study.

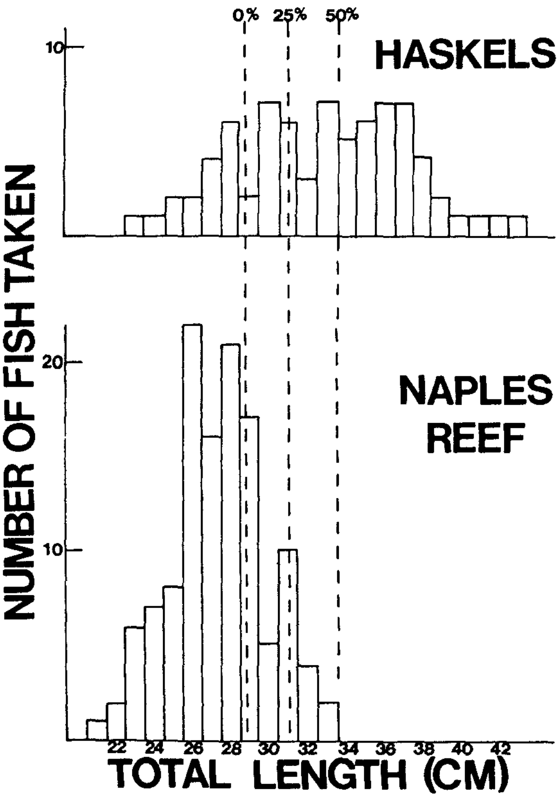

FIGURE 2.—Size frequencies of olive rockfish taken by partyboat at a heavily fished (Naples Reef) and lightly fished (Haskels) site (Naples Reef—$N = 121$, $\bar{x} = 27.3$, SD = 2.5; Haskels—$N = 76$, $\bar{x} = 32.8$, SD = 4.4). Dashed lines indicate size at which 0%, 25%, and 50% of the fish were mature.

After a year of sampling, it was apparent that the Ellwood Pier population was the only one not infected with the gill monogenean, *Microcotyle sebastis*. To test whether environmental conditions precluded *M. sebastis* from the site, 21 tagged, infected fish from the Horseshoe Reef were introduced into the Ellwood site. Specimens were collected after 1 and 6 mo.

Size Variation

To test whether heavy fishing pressure altered the size composition of olive rockfish on reefs, I compared size frequencies of fish taken by a sport fishing partyboat at Naples Reef (13 trips) and at a portion of the mainland bed called "Haskels" (four trips), which lies inshore and east of Naples Reef. A 4-yr study of partyboat operations indicated that Haskels had been fished by partyboats no more than four times in 5 yr.

Data on size and maturity of olive rockfish (Figure 2) was taken from Love (1978), who examined 365 individuals from off Santa Barbara. The gonads of mature olive rockfish undergo marked annual changes, similar to those in the Pacific ocean perch, *Sebastes alutus*, (Westrheim 1975) and mature individuals are readily distinguished from immature specimens, based on gonad size and color.

RESULTS

Of the 1,847 fish artificially tagged, 216 were recovered, an 11.2% return (Table 2), and 9 were recaptured twice. Recaptured fish were at large 1-514 days. Highest return rates were from Horseshoe Reef (34.6%), Naples Reef (23.7%), and the

TABLE 2.—Percentage recapture of tagged olive rockfish at the study sites off Santa Barbara, Calif.

Site	Number tagged	Median time at large (days)	Percentage recovered
Horseshoe Reef	75	309	34.6
Naples Reef	177	156	23.7
Platforms Houchin, Hogan, Hope	513	172	15.2
Talcott Shoals, Santa Rosa Island	159	371	9.4
Fraser Pt., Santa Cruz Island	81	302	7.4
Deephole Reef	369	42	6.5
Rincon Oil Island	17	18	5.8
1 Mile Reef	240	291	5.0
4 Mile Reef	99	112	3.0
Other sites[1]	117	—	0.0
Total	1,847		11.2

[1]Platform Hilda, Platform Holly, Anacapa Island, Smuggler's Cove.

three oil platforms off Summerland (15.2%), all of which were heavily fished by partyboats. Eighty-one percent of all returns were made by partyboat fishermen.

Only the fish tagged around the Summerland oil platforms showed any movements; here nine moved from one platform to another (about 0.8 km).

Regarding biological tags, only the incidence of infection of *Microcotyle sebastis* (Table 3) differed significantly among study sites. Naples Reef and Ellwood Pier differed significantly from the other four sites: a *G*-test of independence (Sokal and Rohlf 1969) was significant when all six sites were included ($G = 186.45$, $P<0.005$), but not significant when only the oil platforms, 4 Mile Reef, and Horseshoe Reef were included ($G = 1.14$, $0.9>P>0.5$). Naples Reef also differed significantly from Ellwood Pier ($G = 16.8, P<0.005$).

There was no seasonality in incidence of infection, as *G*-tests of independence among four seasons were not significant for any site (Table 3).

To test whether environmental conditions at Ellwood Pier were suitable for the monogenetic trematodes, tagged fish from Horseshoe Reef infected with *M. sebastis* were introduced into the site. Untagged fish were collected 1 and 6 mo later. After 1 mo 2 of 20 untagged fish (10%) were infected and after 6 mo 7 of 20 (35%) were infected (not a significant difference, $G = 3.6$, $0.1>P>0.05$). The presence of *M. sebastis* in the population seems to indicate that conditions were suitable for the trematode.

Fish lengths averaged significantly shorter ($t = 9.3$, $P<0.001$) at the heavily fished Naples Reef than at the lightly fished Haskels site (Figure 2). Most fish taken from Naples Reef were prereproductive, while mature individuals made up about 45% of the Haskels catch.

DISCUSSION

Kabata (1963) lists five criteria which should ideally be met if a parasite is to be useful as a tag: 1) the parasite should be common in one population and rare or absent in another; 2) the parasite should have a direct life cycle, infecting only one host species during its life; 3) the parasitic infection should be of fairly long duration; 4) the incidence of infection should stay relatively stable; 5) environmental conditions throughout the study site(s) must be within the physiological tolerance of the parasite.

Compared with artificial tags, biological tags have both advantages and disadvantages. Artificial tags may alter the normal behavior of the tagged animal, whereas, in most cases, parasites do not. Moreover, the parasite mix of a population is usually the result of long-term processes, and may be a more accurate indicator of movements than short-term tagging studies. On the other hand, parasite tags will not indicate individual movements. Over the past 20 yr, studies using parasites as tags have delineated nursery grounds (Olson and Pratt 1973), spawning grounds (Margolis 1963; Hare and Burt 1976), and discrete or semidiscrete populations (Sindermann 1961; Kabata 1963).

Results of both artificial and biological tagging indicated that olive rockfish rarely moved between shallow water reefs. A good example of this was the apparent lack of movement between Naples Reef and Ellwood Pier. Though only about 2 km apart, no tagged Naples Reef fish were taken at Ellwood Pier or anyplace else, nor were any of the *M. sebastis* found to be infecting Ellwood Pier fish before I introduced it, though they infect Naples Reef fish.

Like other monogeneans, *M. sebastis* has a direct (one host) life cycle. The maximum distance the infective oncomiricidium larval stage can travel before finding a host is not known, though it is probably limited to a few meters (Llewellyn 1972). Apparently, Ellwood fish were not parasitized because they were sufficiently isolated

TABLE 3.—Incidence of parasite *Microcotyle sebastis* in 80 olive rockfish sampled 20/mo from each of six sites off Santa Barbara, Calif. *P* values reflect *G*-tests of independence (Sokal and Rohlf 1969) for incidence of infections among four seasons.

Site	Number infected (1976-77) June-Aug.	Sept.-Nov.	Dec.-Feb.	Mar.-May	Total	*P*	Percent
Ellwood Pier	0	0	0	0	0	—	0.0
Naples Reef	4	3	3	4	14	0.9>*P*>0.5	17.5
Platform Houchin	12	12	14	15	51	0.5>*P*>0.1	63.8
Platform Hillhouse	10	14	13	15	52	0.9>*P*>0.5	65.0
Horseshoe Reef	14	11	15	15	55	0.9>*P*>0.5	68.8
4 Mile Reef	17	13	15	12	57	0.9>*P*>0.5	71.2

from others to escape exposure to infected fish, even pelagic larvae.

Yet, neither tagging nor parasite data indicated whether fish move offshore from the Ellwood area to Naples Reef. However, size-frequency data of fish taken on Naples Reef and at Haskels (adjacent to the Ellwood Pier) (Figure 2), are evidence that there was probably little movement from Ellwood to Naples. Naples Reef harbors primarily juvenile and preadult olive rockfish (Love and Ebeling 1978) and adults are rarely observed (Ebeling[5]). Apparently, fishing pressure removes fish before they can mature. However, adults were abundant at the lightly fished Ellwood Pier, and limited sampling along a 16 km stretch of kelp inshore of Naples Reef indicated that mature fish were common throughout the bed. Apparently, few of these fish move across the sandy stretch between Naples Reef and the inshore bed.

Though inshore movements seem to be inhibited by stretches of sandy bottom, movement from one oil platform to another obviously is not: tagged fish must traverse at least 0.8 km over sandy bottom with a depth of about 50 m to reach the adjacent site. Miller and Geibel (1973) observed a similar greater mobility in deep waters for blue rockfish, *S. mystinus*.

Olive rockfish off Santa Barbara feed primarily on midwater organisms (nekton and plankton) rather than substrate-oriented prey (Love and Ebeling 1978). It is not known whether these prey are less abundant at the platforms compared with inshore waters. However, if they are less abundant, olive rockfish might be more likely to leave the platform to follow prey. I have noted olive rockfish feeding on anchovies as much as 300 m away from the platforms. Perhaps in these instances some fish may not return to the original platform.

This study emphasized movements of fish that inhabit isolated reefs. Little work was done on fish from the extensive area of continuous kelp forest which grows mostly on sandy bottom and parallels most of the Santa Barbara coast, because sampling is more time consuming in such areas of low rockfish densities. Moreover, much of the tagging was done aboard partyboats which rarely fish these extensive beds. It is quite possible that olive rockfish in kelp beds move about considerably more than those on isolated reefs. I suspect that the limited movements observed may be due to the lack of cover on the relatively barren bottom surrounding the reeflike study sites. Olive rockfish have been rarely taken over sand, either in otter trawls (Ebeling et al.[6]), or seen in underwater transects in kelp beds over a sand bottom (Quast 1968), and seem to be strongly attracted to high-relief substrate, such as that of platforms and rocky reefs. Kelp beds may provide "bridges" from one reef to another.

Previous studies (Table 4) indicate that many other shallow water rockfish exhibit limited movements. The two most extensively investigated benthic species, *S. carnatus* and *S. chrysomelas*, defend small feeding territories and shelter holes (Larson 1977; Hallacher 1977). Also, agonistic displays by *S. serriceps* (Feder et al. 1974; Haaker 1978) and long-term residence in particular crevices by *S. nebulosus* (McElderry[7]) indicate that these benthic species may also be territorial. Thus, it seems likely that most or all benthic reef rockfish may move relatively little.

Similarly, some midwater rockfishes that live over these shallow reefs, seem to stay within a fairly small area. In particular, tagging of *S. mystinus* (Miller and Geibel 1973) indicated restricted movements, and tagging of *S. flavidus* (Carlson and Haight 1972) showed that this species has a strong homing tendency. However, movements of tagged *S. melanops* (Coombs 1979), along with pelagic capture (Dunn and Hitz 1969) indicate that it probably moves about extensively.

Relatively parochial midwater rockfish, such as *S. mystinus*, *S. serranoides*, and *S. flavidus*, do not appear to be territorial, in the sense that a territory is a "defended" (Noble 1939) or "exclusive" (Schoener 1968) area. Indeed, these species often form single or multispecies aggregations of thousands of individuals, which show little or no agonistic behavior. The sizes of rockfish home ranges have not been estimated, though Miller and Houk[8] believed that *S. mystinus* aggrega-

[5]Ebeling, Alfred W. Department of Biological Sciences, University of California, Santa Barbara, CA 93106, pers. commun. February 1978.

[6]Ebeling, A. W., W. Werner, F. A. Dewitt, Jr., and G. M. Cailliet. 1971. Santa Barbara oil spill: short-term analysis of macroplankton and fish. EPA, Water Qual. Off. Doc. no. 15080EA02/71, 68 p.

[7]H. McElderry Department of Biology, University of Victoria, Victoria, B.C. pers. commun. January 1978.

[8]D. Miller and J. Houk, California Department of Fish and Game, 2201 Garden Road, Monterey, CA 93940, pers. commun. January 1978.

TABLE 4.—Summary of published observations on rockfish, *Sebastes* spp., movements in the northeast Pacific.

Species	Location	Method	Results	Source
S. alutus	Northeast Pacific Ocean	Analysis of fish catch data	Seasonal bathymetric movements of many kilometers and 100 m in depth	Review in Gunderson (1977)
S. atrovirens	Monterey, Calif.	Tagging	No movement	Miller and Geibel (1973)
S. auriculatus	Monterey	Tagging	No movement	Miller and Geibel (1973)
	Humboldt Bay, Calif.	Tagging	No movement	DeWees and Gotshall (1974)
S. carnatus	Santa Barbara Channel, Calif.	Underwater observation, tagging	Has home range; no evidence of extensive movement	Larson (1977)
	Monterey region, Calif.	Underwater observation, tagging	No movement	Hallacher (1977)
S. caurinus	Monterey Bay, Calif.	Tagging, underwater observation	Limited movement, farthest 2.4 km	Miller and Geibel (1973)
	Monterey region	Tagging	No movement	Hallacher (1977)
	Humboldt Bay	Tagging	No movement	Dewees and Gotshall (1974)
	Puget Sound, Wash.	Underwater observation	Fewer individuals seen in shallow water during summer	Dewees and Gotshall (1974) Patten (1973)
	Puget Sound	Underwater observation	Very limited bathymetric and onshore-offshore movement, a few meters vertical movement between summer and winter	Moulton (1977)
S. chrysomelas	Santa Barbara Channel	Underwater observation, tagging	Species has home range, no evidence of extensive movement	Larson (1977)
	Monterey region	Underwater observation, tagging	No movement	Hallacher (1977)
	Monterey Bay	Tagging	No movement	Miller and Geibel (1973)
S. flavidus	Puget Sound	Underwater observation	Very limited bathymetric and onshore-offshore movement, a few meters vertical movement between summer and winter	Moulton (1977)
	Alaska	Tagging	Homing study, species homed up to 22.5 km	Carlson and Haight (1972)
S. melanops	Monterey	Tagging	No movement	Miller and Geibel (1973)
	Humboldt Bay	Tagging	No movement	DeWees and Gotshall (1974)
	Oregon	Tagging	Limited number of recoveries, 2 of the 10 recovered fish moved, one 619 km, other 24 km	Coombs (1979)
	Puget Sound	Underwater observation	Very limited bathymetric and onshore-offshore movement, a few meters vertical movement between summer and winter	Moulton (1977)
	Gulf of Alaska	Capture	Review of pelagic captures	Dunn and Hitz (1969)
S. miniatus (Juv.)	Redondo Beach, Calif.	Tagging	Movement of 8-9.6 km	Turner et al. (1969)
(Juv.?)	Monterey	Tagging	No movement	Miller and Geibel (1973)
S. mystinus	Southern to northern Calif.	Tagging	Generally little or no movement; slight movement in deeper water	Miller and Geibel (1973)
	Monterey Bay	Tagging	Restricted movement	
S. pinniger	Monterey Bay	Tagging	No movement	Miller and Geibel (1973)
S. rosaceus	Monterey region	Underwater observation	No movement	Hallacher (1977)
S. ruberrimus	Oregon	Tagging	No movement	Coombs (1979)
S. serranoides	Santa Monica Bay Calif.	Tagging	No movement	Turner et al. (1969)
	Santa Barbara Channel	Tagging	No movement in shallow water, limited movement in deeper water	Present paper

tions are quite patchy within a kelp bed and some fish may remain within a very limited area for extended periods. In kelp beds, individuals of *S. serranoides* may move about more than those of *S. mystinus*. Miller and Houk noted that *S. serranoides* individuals were not seen as consistently as those of *S. mystinus* in kelp-bed transects in Monterey Bay. As *S. mystinus* preys primarily on plankton and animals on plant surfaces (Gotshall et al. 1965; Hallacher 1977; Love and Ebeling 1978), it seems likely that this species spends much of its time waiting for prey to drift by. *Sebastes serranoides* feeds somewhat more on moving prey (Love and Ebeling 1978) and so may forage more widely.

Some seasonal movement of rockfish may also occur, at least north of Pt. Conception. A number of studies report that rockfish numbers on shallow water reefs seem to decrease during winter (Miller and Geibel 1973; Moulton 1977; Burge and Schultz[9]). Increased turbulence may drive the fish into deeper water or into reef shelters where they are less visible. Ebeling (see footnote 5) observed no winter decrease in rockfish abundance at Naples Reef. The waters of the Santa Barbara Channel are considerably less turbulent

[9]Burge, R. T., and S. A. Schultz. 1973. The marine environment in the vicinity of Diablo Cove with special reference to abalones and bony fishes. Calif. Dep. Fish Game, Mar. Res. Tech. Rep. 19, 433 p.

than those above Pt. Conception; perhaps here fish can remain on the reefs despite winter storms. Miller and Geibel (1973) noted a sharp winter decrease in *S. mystinus* numbers on a reef in Monterey Bay. Yet despite extensive tagging at this site and intensive sampling and underwater observation of surrounding reefs during winter, no tagged individuals were found at other reefs (Miller and Houk see footnote 8). Factors other than turbulence may account for a winter exodus. Some rockfish species may leave inshore reefs to spawn. If fish do leave the reef, the extent of their movement is, in general, not known. Moulton (1977) found that during winter rockfish on Puget Sound reefs retreated only short distances, into slightly deeper water.

The between site difference in mean fish length found between Naples Reef and Haskels probably reflects a difference in fishing pressure. The more heavily fished site averaged smaller fish and fewer mature ones because larger fish were selectively angled, or have been subjected to fishing effort for a longer period and are thus more likely to be caught.

As heavily fished sites contain primarily prereproductive individuals (as, in general, does Naples Reef), reproduction of mature fish at lightly fished sites could account for much of the recruitment for all areas.

Based on data from mechanical and parasite tags, olive rockfish off Santa Barbara exhibit very restricted movements on shallow water reefs, but may be somewhat more mobile around deeper water oil platforms. The species' parochialism in shallow water makes it susceptible to overexploitation as interchange of individuals from other reefs is rare.

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