Juvenile Red Rockfish, *Sebastes* sp., Associations with Sponges in the Gulf of Alaska

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Introduction

Sponge–fish associations have been documented for a variety of species in both cold-water and tropical habitats. Eastman and Eakin (1999) found that fishes of the genus *Artedidraco* (Artedidraconidae) are associated with sponge beds in the Ross Sea of Antarctica. Likewise, Tokranov (1998) described the association of sponge sculpin, *Thyriscus anoplus* (Cottidae), with sponge beds in the northern Kuril Islands.

Konecki and Targett (1989) found that cod icefish, *Lepidonotothen larseni* (Nototheniidae), in waters adjacent to the Antarctic Peninsula utilize the spongocoel of the hexactinellid (glass) sponge *Rossella nuda* as a substrate on which to deposit their eggs. Notothenioid fishes known to utilize sponges as spawning and nesting sites include emerald rock-cod, *Notothenia bernacchii* (Moreno, 1980) and Antarctic spiny plunderfish, *Harpagifer antarcticus* (Daniels, 1978). Antarctic fishes that utilize sponges for predator avoidance include sharp-spined notothen, *Trematomus pennellii*, and spotted notothen, *T. nicolai*, as well as the crocodile icefish, *Pagetopsis macropterus*. Dayton et al. (1974) state that glass sponges provide almost all of the vertical structure on the sea floor in the Ross Sea of Antarctica.

Finally, Munehara (1991) established that the silverspotted sculpin, *Blepsias cirrhosus* (Cottidae), uses the sponge *Mycale adhaerens* as a spawning bed, stating that the eggs benefit from this association through predator avoidance, oxygen supply, and the natural antibacterial and antifungal properties of the sponge. Konecki and Targett (1989) note that glass sponges serve as important nesting and refuge sites for Antarctic fishes, and destruction of sponge communities by bottom trawling could have an impact on fish ecology in the region.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act require that increased emphasis be placed on "essential" fish habitat (USDOC, 1996). One type of marine habitat that fishery managers must consider during decision-making is living substrate. In Alaska waters, living substrate is often provided by a variety of epibenthic fauna, such as deepwater corals (e.g. *Primnoa* spp., *Paragoria* spp.), sea whips (Pennatulacea), and a number of large, erect sponges (Heifetz, 2002; Malecha et al., In press). These taxa form a high-relief, complex habitat that is generally thought to foster increased biological diversity and productivity by providing abundant cover and food aggregations for fish in various stages of their life history (Collie et al., 1997).

Studies conducted in the Gulf of Alaska (GOA) have shown that the aforementioned organisms are heavily impacted by even one pass of a commercial bottom trawl (Freese et al., 1999; Krieger, 2001). These findings generally agree with those of studies conducted in other parts of the world (Watling and Norse, 1998; Auster and Langton, 1999; Moran and Stephenson, 2000). Trawl impacts can result from direct removal or damage to the megabenthos as well as changes in species composition over time (Wassenberg et al., 2002). Research in the GOA and elsewhere has shown that sponge communities and gorgonian coral colonies in boreal waters may be very slow to recover from trawl damage (Freese, 2003; Krieger, 2001).

An association between large *Primnoa* spp. colonies and six species of adult rockfish has been documented by Krieger and Wing (2002) in the GOA. Although it has been assumed that sponges at northern latitudes provide important habitat for fish in early stages of their life cycle in the GOA, there has heretofore been only anecdotal information available to support this assumption. This paper describes in situ observations made from a research submersible of an association between juvenile red rockfish, *Sebastes* spp., and one species of sponge in the GOA.

Materials and Methods

In June 2001, researchers from the NMFS Alaska Fisheries Science Center's Auke Bay Laboratory conducted a series of biological surveys in the eastern GOA, using the research submersible *Delta*. The *Delta* is a 4.7 m long, battery-powered underwater vehicle able to dive to

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ABSTRACT—In 2001, a research submersible was used to survey seafloor habitat and associated benthos in the northeastern Gulf of Alaska. One inspected site had a uniform sand-silt substrate, punctuated by widely spaced (10–20 m apart) boulders. Two-thirds of the boulders had sponge, Aphrocallistes *sp., colonies. Eighty-two juvenile (5–10 cm) red rockfish (*Sebastes *sp.) were also observed during the dive, and all of these fish were closely associated with the sponges. No juvenile red rockfish were seen in proximity to boulders without sponges, nor were any observed on the sand-silt substrate between boulders.*

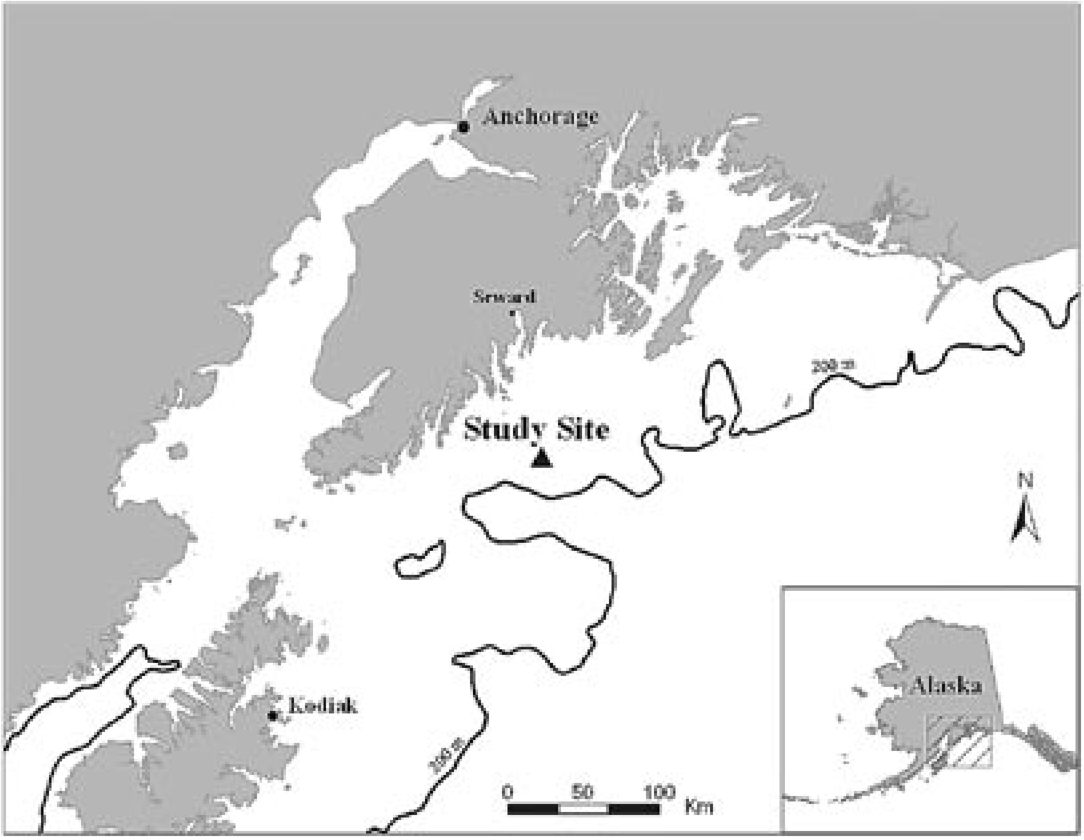

Figure 1.—Location of the study site in the Gulf of Alaska.

depths of 345 m with a pilot and an observer. It is outfitted with video cameras, halogen lights, a laser scaling device, gyro compass, voice communications equipment, and a transponder. The transponder allows tracking of the vehicle by the submersible's surface support vessel, which has GPS capability. During the survey dives, positional fixes were taken at 30-second intervals.

The video equipment consisted of an externally mounted Hi-8 video camera pointed downward at an angle of 45° and an internal video camera positioned parallel to the seafloor. The cameras were used to record images of the seafloor and associated benthos, while an audio track was used to record observer comments. A digital camera was used by the observer to take still photographs.

The primary purpose of the surveys was to collect information on red tree coral, *Primnoa* sp., abundance, distribution, and habitat associations at locations where past NMFS trawl surveys had brought up the species as bycatch. Survey sites ranged from waters along the southeast part of the Kenai Peninsula, southeastward to the Fairweather Grounds in the vicinity of Yakutat, Alaska.

Twenty dives were made during the cruise. This report details the observations made during one dive at 59°14.88′N, 149°13.27′W, (about 100 km south of Seward, Alaska) on 26 June 2001 (Fig. 1). Although no red tree coral was observed during the dive, juvenile red rockfish were observed in close association with sponges.

The pilot headed the submersible in a general eastward direction maintaining close proximity between the vessel and the seafloor. When boulders were noted, the pilot slowly approached these habitat features for close-up observations, and the boulders were slowly circled. The volumes of the boulders were calculated by estimating length, width, and height using the onboard laser scaling device. Volume estimates were made for only the sections of the boulders protruding above the seafloor.

If sponges were attached, the volume of the sponge was calculated using length, width, and height estimates. Volumes of individual sponges were expressed as a percentage of the volume of the boulders. The sponges were then closely inspected for the presence of juvenile red rockfish, counts were made of the number of rockfish if present, and the laser scaling device was used to estimate their lengths. Epifaunal invertebrates other than sponges that were attached to the boulders or present on the surrounding seafloor were noted, as were any fish species present.

Results

The total length of the transect completed by the submersible was 865 m. Water depth at the site was 148 m with a temperature of 6.6°C. Underwater lateral visibility was about 10 m. The seafloor was flat, and the substrate consisted of a fine silt-sand mixture, with occasional boulders encountered at intervals of about 10 to 20 m. The only three-dimensional relief was that provided by boulders and sponges, and occasional seawhips.

Vertebrate fauna encountered were typical of fauna found on similar substrate in the GOA, and included arrowtooth flounder, *Atheresthes stomias*, and other unidentified flatfishes; spiny dogfish, *Squalus acanthias*; schools of adult Pacific ocean perch, *Sebastes alutus;* and rougheye rockfish, *Sebastes aleutianus,* (the two species could not be distinguished underwater); pricklebacks (Stichaeidae); eelpouts (Zoarcidae); and poachers (Agonidae). Macroinvertebrates present included squat lobster, *Munida quadrispina*; hermit crabs (Paguriidae); spot shrimp, *Pandalus platyceros;* bryozoans; hydroids; brachiopods; seawhips (Pennatulacea); seastars (Asteroidea); brittlestars (Ophiuridae); sea urchins (Echinoidea); sea cucumbers (Holothuridae); and gastropods, in addition to the sponges.

Eighty-two boulders ranged along the transect, from 0.1 to 2.0 m along their longest axis, and most were roughly spherical in shape. Sponges were present on 66% of the boulders. Although other epifaunal invertebrates such as hydroids, bryozoans, brachiopods, basketstars, and seastars were also present on the boulders, sponges contributed most of the invertebrate biomass. In addition to habitat structure provided by these taxa, a small amount of cover was provided by occasional small indentations or caves located between the base of the boulders and the surrounding seafloor, presumably formed by water currents.

Fifty-four sponges were seen on the transect; all were attached to boulders. *Aphrocallistes* sp. made up 87% (47) of the sponges. In addition, five glass sponges, *Rhabdocalyptus* sp., and two unidentified sponges were present. *Aphrocallistes* sponges were roughly spherical in shape and had many finger-like protuberances projecting from the sponge body. *Rhabdocalyptus* sponges were generally cylindrical in shape, and the walls of the sponge body were smooth. Estimated volumes for both types of sponge combined ranged from 0.1 m^3 to 8.4 m^3 ($\bar{x}$ = 1.1 m^3). Volumes of sponges expressed as a percentage of the volume of the boulders to which they were attached ranged from 10% to 700% ($\bar{x}$ = 195%).

Eighty-two juvenile red rockfish were noted in the immediate vicinity of sponges along the transect. These fish ranged in length from 5 to 10 cm, and were probably 2–3 years old. All appeared to be of the same species, although positive identification was not possible from visual observation from the submersible. Only those boulders with attached sponges harbored juvenile rockfish. Of the 82 rockfish observed, 79 (96% of total) were associated with *Aphrocallistes* sponges. The remaining three (4% of total) rockfish were associated with *Rhabdocalyptus* sponges. Numbers of juvenile red rockfish per sponge ranged from 1 to 10. These fish were usually first observed hovering as individuals or small schools a short distance (< 0.5 m) above the sponges attached to the boulders. They invariably darted into the body of the sponge for cover as the submersible approached (Fig. 2). If the submersible remained motionless next to the sponge they would emerge from the sponge after several minutes had elapsed. They did not appear to be frightened by the submersible's lighting system, disappearing into the sponge only when the submersible began to move. Statistical analyses showed no correlation ($P > 0.05$) between sponge volume and number of juvenile red rockfish present, or between the sponge volume/boulder volume ratio and number of rockfish.

Discussion

This survey shows that sponges of the genus *Aphrocallistes* can provide important habitat for juvenile red rockfish. Although several species of sponge were present along the transect, almost all juvenile red rockfish were associated with *Aphrocallistes*. Furthermore, the rockfish showed a clear preference for epifanual cover as all rockfish were associated with sponges rather than the small caves and crevices present at the base of many of the boulders.

Tyler and Bohlke (1972) listed 39 species of fish in the Caribbean known to have some association with sponges, and categorized sponge-dwelling fish as either 1) morphologically specialized obligate sponge dwellers, 2) morphologically unspecialized obligate sponge dwellers, 3) facultative sponge dwellers, or 4) fortuitous sponge dwellers. They stated that fishes in category 1 were likely to spend their entire lives, with the possible exception of the larval stage, within the bodies of the sponges they inhabit. Fishes in category 2 may leave the host sponge to feed nocturnally. Facultative sponge dwellers (category 3) spend part of their lives on or in sponges, but have been observed in other types of habitat. Finally, fortuitous sponge dwellers (category 4) comprised a variety of families, all of which are known to occupy a wide variety of habitat types. These families include gobies, clinids, pomocentrids, gobiescoids, apogonids (Tyler and Bohlke, 1972), a xenogongrid (Bohlke, 1957), and two scorpaenids: *Scorpaenodes tredecimspinosus* (Eschmeyer, 1969) and an unidentified scorpaenid species (Metzelaar, 1922). In addition to the aforementioned families, juvenile creole wrasse, *Clepticus parrae,* have been observed fortuitously associated with sponges in the Bahamas (Colin, 1975).

The juvenile red rockfish that were observed during this study probably can be classified in category 4, fortuitous sponge-dwellers. Personal observations made by the authors during other investigations (unpubl. observ.) in the GOA indicate that juvenile red rockfish of the size encountered in 2001 can occupy a wide variety of habitat types, including other species of sponge, gorgonian coral colonies, and interstices between cobbles and boulders. The fact that the juvenile rockfish observed in this study were associated only with *Aphrocallistes* sponges can likely be attributed to the paucity of other available habitat types along the transect.

The lack of a clear relationship between sponge size and number of juvenile

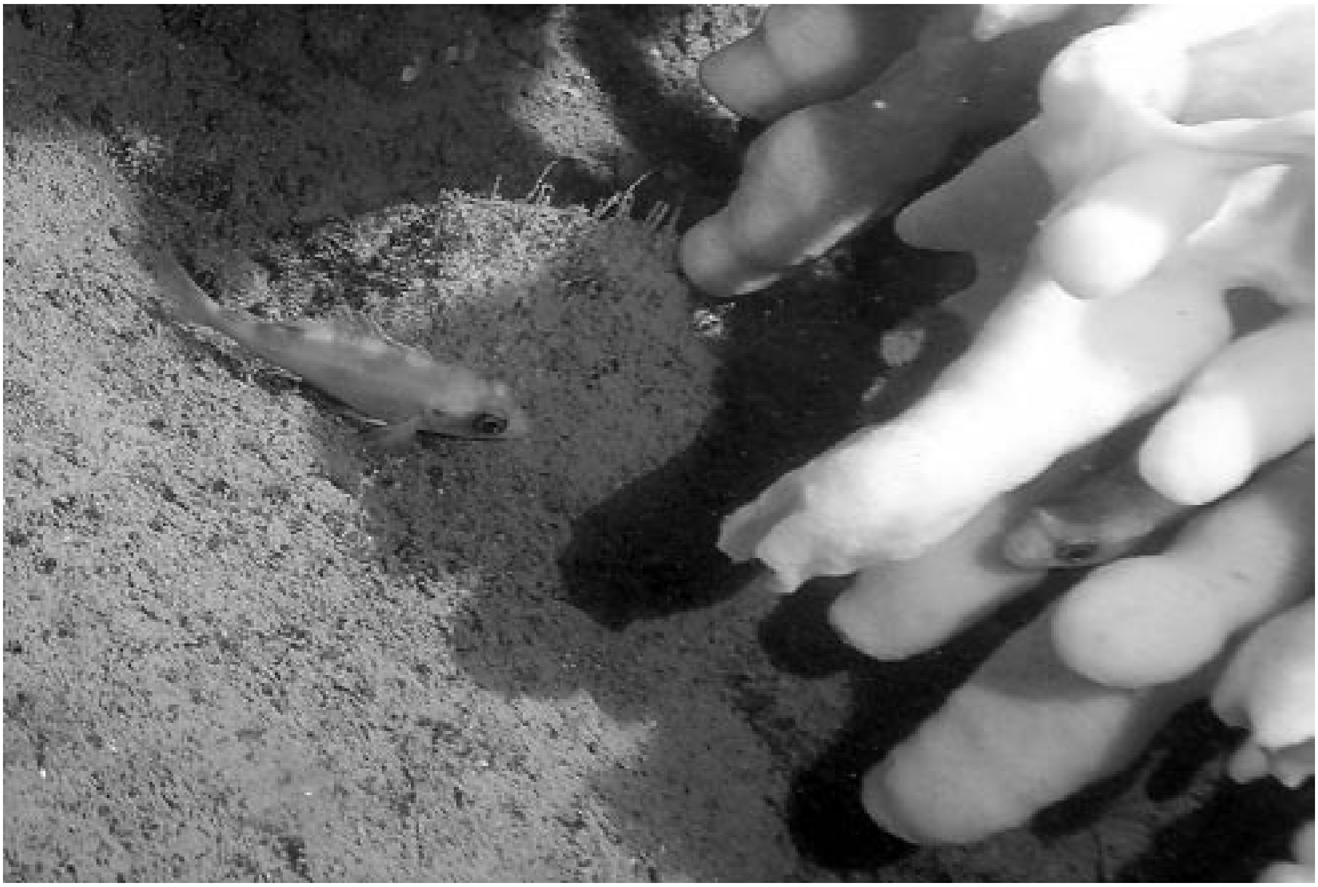

Figure 2.—Juvenile red rockfish, *Sebastes* sp., associated with *Aphrocallistes* sp. sponge in the Gulf of Alaska.

red rockfish harbored was surprising, but can most likely be attributed to the fact that the fish preferred those sponges with many finger-like protuberances in which to seek cover. Sponges in general are highly polymorphic, and there was no clear relationship between sponge size and number of protuberances present on the body of the sponge. Likewise, the fact that only 4% of the rockfish were associated with *Rhabdocalyptus* sponges can likely be attributed to the fact that this species is cylindrical in shape with a smooth texture, and affords minimal cover.

The locations of nursery grounds for many *Sebastes* spp. in the northeastern Pacific are generally not well known. Based on the fact that juvenile rockfish are lacking in offshore trawl catches but are often caught at nearshore trawl sites, Carlson and Haight (1976) hypothesized that nearshore hard-bottom coastal areas and adjacent fiords serve as nursery grounds for Pacific ocean perch, the most abundant rockfish in Alaskan waters. Their hypothesis was supported by observations made from a submersible (Carlson and Straty, 1981), during which thousands of juvenile red rockfish (6–8 cm length), believed by the authors to be Pacific ocean perch, were observed over just such habitat. The observations made during our investigation suggest that juvenile red rockfish may not exclusively use nearshore sites as nursery areas. The location at which we observed juvenile red rockfish of a size similar to those observed by Carlson and Straty (1981) was about 50 km offshore in the GOA; furthermore, the substrate at our study site was mostly a sand and silt mixture rather than rocky.

In conclusion, our observations show that *Aphrocallistes* sponges provide habitat for juvenile red rockfish. The association is fortuitous, in that many juvenile red rockfish have been noted in a wide variety of other habitat types in the GOA (personal observ.), including other types of emergent epifauna, as well as in cover provided by nonliving substrates such as boulders and cobbles. The fish observed in this study probably benefited from their association with the sponges through predator avoidance. The sponges provided most of the vertical relief on the seafloor at this site, with the exception of the boulders to which they were attached. Disruption of this type of sponge community by bottom trawling would be expected to have a negative impact on juvenile red rockfish survival in areas where other types of cover are not available.

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