Initial Behavior of Displaced Yellowtail Rockfish *Sebastes flavidus* in Lynn Canal, Southeast Alaska

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ABSTRACT: Initial behavior and movements of displaced yellowtail rockfish *Sebastes flavidus* were observed by divers and in telemetry experiments to test response of fish when first released. Active response behavior began almost immediately upon release, and no signs of stress or disorientation were seen. Circling behavior of displaced fish occurred soon after release and was observed repeatedly. Newly released fish promptly displayed movement away from the release site, in most instances toward the homesite. Waters deeper than 100 m appeared to hinder initial homing efforts.

INTRODUCTION

Rockfishes *Sebastes* constitute a large and diverse group in the North Pacific. In Alaska, rockfishes are valued in commercial fisheries (O'Connell et al. 1994; Clausen and Heifetz 1994) and sport fisheries (Mills 1994). Recent (1990–1992) values for rockfish products from commercial fisheries off Alaska ranged from $35.5 to $54.5 million (Kinoshita et al. 1994). Knowledge concerning homesite fidelity is important to identify discrete populations for use in rockfish management and is of basic scientific interest because of the slow growth, longevity, and worldwide distribution of rockfish (Clay and Kenchington 1986). Homing in rockfish has been documented for several species: yellowtail rockfish *S. flavidus* in Southeast Alaska (Carlson and Haight 1972); black-and-yellow rockfish *S. chrysomelas* in Carmel Bay, California (Hallacher 1984); the eastern sea perch *S. taczanowski* in the Sea of Okhotsk (Markevich 1988); and copper *S. caurinus* and quillback rockfish *S. maliger* in Puget Sound (Matthews 1990). More recently, Pearcy (1992) described homing behavior of yellowtail rockfish off coastal Oregon and pointed out the lack of information available concerning behavior of tagged rockfish immediately following their release.

Almost unknown are underwater observations of marine fish after displacement from their homesite. Displacement experiments off Newfoundland with the radiated shanny *Ulvaria subbifurcata*, a small member of the family Stichaeidae, involved underwater observations from a habitat and with scuba. These showed that this species could orient to its homesite from the release site 35 m away (Green and Fisher 1977) and that olfaction is important to its homing (Goff and Green 1978).

Carlson and Haight (1972) conducted the first study that demonstrated discrete populations and homing ability in yellowtail rockfish by testing inclination and ability of fish to return following displacement from a homesite. In that study, 76 of 337 (22.6%) tagged yellowtail rockfish were recovered, all but 2 (0.6%) at the homesite. Three types of release groups had highest proportions of returns (41–50%): (1) releases into other yellowtail rockfish populations, which tested the idea of site suitability alone rather than site fidelity, as a factor in determining their homesite; (2) captive holding for months, which tested memory for the homesite; and (3) controls released at the homesite, which tested the effects of capture and release on site fidelity. The high proportion of homesite returns in these 3 groups was convincing evidence that yellowtail rockfish present at the homesite would remain there, and those displaced from it would attempt to return, with good likelihood of success.

Because homing for this species was well documented by Carlson and Haight (1972), it was not the primary question. Using fish from the same population and homesite described by Carlson and Haight (1972), the work we now report had different objectives: (1) What was the initial reaction of displaced yellowtail rockfish upon release? (2) Did the initial

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behavior appear to involve homing? (3) How long does it take fish to return to their homesite — hours, days, or weeks? (4) Does homing follow a direct route across open water or do fish follow a shoreline?

METHODS

The initial behavior following release of displaced yellowtail rockfish was described from scuba observations; telemetry experiments were used to discern first movements and selection of homing routes. The work took place near Point Lena in Lynn Canal, Southeast Alaska.

As described by Carlson and Haight (1972), adult yellowtail rockfish were captured on 4 occasions with hook and line at 13- to 28-m depths at their homesite, a sunken vessel at Point Lena, Lynn Canal, Southeast Alaska (Figure 1), described by Carlson and Barr (1977). Fish were transported 8 km by skiff, in barrels of seawater, to the Auke Bay Laboratory. They were held in circulating seawater tanks overnight for the scuba observation experiment and for 5–13 d for the telemetry experiments.

On the day of the scuba observation experiment, we transported 10 captive fish from the laboratory to a site 1.8 km southeast of the homesite along the same (eastern) shoreline. A float anchored at the 10-m depth contour marked the release site. Two groups of 5 fish each were released at the surface within a few minutes of each other. Prior to release, 4 scuba divers were positioned directly under the release-point marker, 1 diver near the surface, another at 5 m, and 2 divers on the bottom at 10 m in depth. The 2 uppermost divers merely observed appearance and actions of fish upon release. The 2 divers on the bottom observed initial appearance and activity, then followed the fish when they left the release site.

For the telemetry experiments, we inserted an activated sonic tag (2 cm diameter, 9 cm long, 29.5 g) into the stomach of each rockfish and returned it to the holding tank overnight to assure that the tag was functioning, that it had not been regurgitated, and that the fish appeared normal.

The telemetry equipment (manufactured by Smith-Root Inc.[1], Seattle, WA) included a TA-60 receiver, an SR-70-H directional hydrophone, and SR-69-A sonic transmitter tags. Each sonic tag had a frequency of 74 kHz, a unique pulse code, and a 60-d-rated battery life. The sonic tag signal range was rated at 1.6 km. However, field conditions often reduced reception range, and our skiff stayed within 0.2–0.4 km of sonic-tagged fish while we tracked them. As in the homing study by Carlson and Haight (1972), when possible we released 4–5 untagged fish along with the tagged rockfish to mitigate the possible need for schooling to effect homing.

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

RESULTS

Diver Observation Experiment

When the 2 groups of 5 fish were released at the surface for the scuba observation experiment at about 1400 hours on 13 August 1971, the 2 divers in midwater saw the newly released rockfish descend slowly past them. Underwater visibility was 5–8 m at the 10-m depth. On the bottom (10 m) we saw the displaced rockfish slowly spiral down to within 1 m of the bottom. There the fish briefly milled in clusters of 2–4, circling (roughly 3-m-wide circles) slowly counterclockwise. All fish behaved in a manner similar to yellowtail rockfish seen at the homesite as reported by Carlson and Barr (1977). That is, they displayed no signs of stress or fright: none attempted to hide in the limited cover available on the bottom, and they could be approached closely (1–2 m) by divers. They appeared calm and unhurried in their movements and did not appear disoriented. Some moved quickly out of sight, and within 5 min they all had left the release site.

We noted a group of 3 fish that started swimming westward toward the homesite. With scuba, we followed 5–8 m behind this group of 3 fish for 200–300 m. The fish showed little or no awareness of our presence. They swam parallel to shore at an unhurried, moderate pace, then angled deeper to a 15-m depth (visibility >10 m), remaining a few meters above bottom. Several times the group slowed and made a small (roughly 3–5 m) counterclockwise circle before continuing toward the homesite. Once, 1 of the 3 fish momentarily trailed 6–7 m behind, then suddenly sped up to rejoin the others.

After observing and trailing the 3 fish for 20 min, we followed them to an area where the slope was steeper and we could not see the seabed. Here, the group made a wide (roughly 10–15 m) counterclockwise circle until they were in shallower water where we could see the seabed. Then they continued toward the homesite as our air supply dwindled, terminating the observations.

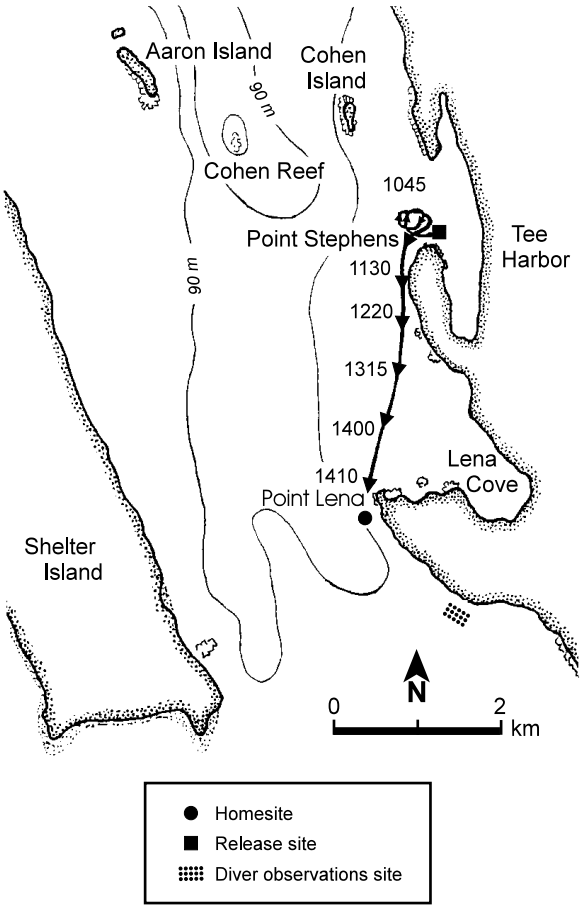

Figure 1. Site of diver observations, and track (arrows) for first coastal test of a sonic-tagged yellowtail rockfish in Lynn Canal, Southeast Alaska, 21 September 1971.

Telemetry Experiments

Coastline Tests

On 21 September 1971 we displaced a sonic-tagged yellowtail rockfish to Point Stephens (Figure 1), 2.8 km from its homesite at Point Lena. This fish could choose to return to the homesite by following a shoreline or return directly through waters 70–80 m deep (open-water return). Furthermore, we exercised a rare and unique opportunity to experiment with a fish with proven homing ability. This particular rockfish had previously been tagged and displaced (Carlson and Haight 1972) from Point Lena to Point Stephens and had returned to Point Lena sometime during the 12 months between September 1970 and September 1971, its return validated by marking (spaghetti tag) and subsequent recapture. So, the question was not the ability of the fish to home, but how quickly and directly it would return.

The tagged fish was displaced with 4 other (no sonic tag) yellowtail rockfish captured at the Point Lena homesite 5 d earlier. At 1045 hours, we released all 5 fish near the shore at Point Stephens in water 5 m deep. The sonic-tagged fish circled around the release site for 45 min, frequently changing direction, but with sustained movement counterclockwise. At 1130 hours the tagged fish swam roughly parallel to shore in the direction of the Point Lena homesite. The fish then moved in a straight line, without stopping, through open water, across the mouth of Lena Cove (Figure 1), directly back to the homesite where it arrived at 1410 hours. Excluding the initial circling period, this yellowtail rockfish homed 2.8 km in 2.66 h.

On 25 August 1972 a single sonic-tagged yellowtail rockfish captured at the homesite 7 d earlier was released at a site 1.8 km northeast of the Point Lena homesite, along the same shoreline (Figure 2). Following release, the fish began swimming in a series of

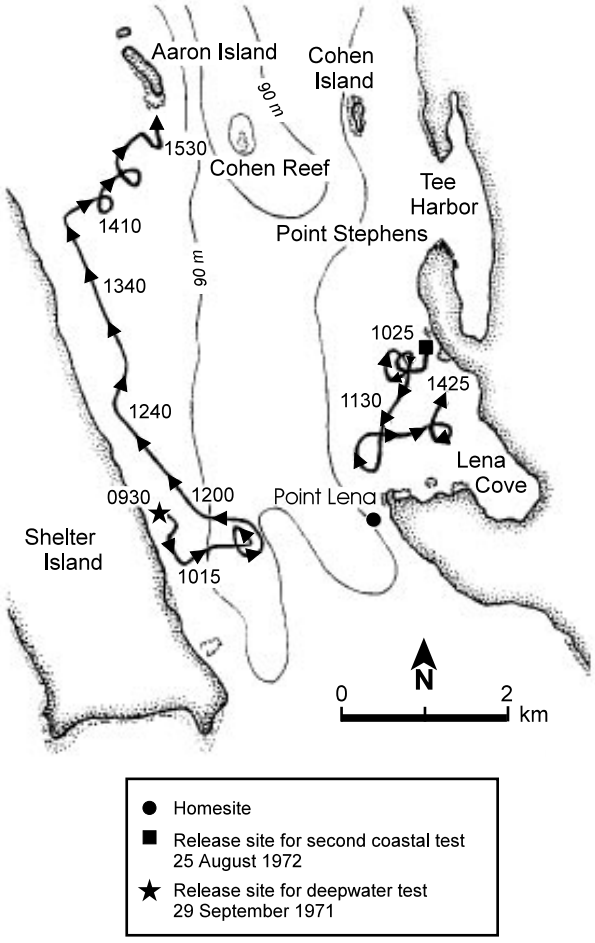

Figure 2. Tracks (arrows) of sonic-tagged yellowtail rockfish for the second coastal test and the open-water test in Lynn Canal, Southeast Alaska, 29 September 1971.

circling patterns out as far as 1.5 km, and after 4 h it had returned to near the original release site, where it remained as we ended observations.

Deepwater Test

We conducted one experiment in which a yellowtail rockfish would have to traverse deep water (>100 m) to return to the homesite. On 29 September 1971 we released a sonic-tagged yellowtail rockfish with 5 others near a site at southern Shelter Island, 2.6 km directly west of their Point Lena homesite (Figure 2). The return required crossing a channel with depths >100 m. All the fish had been captured at the Point Lena homesite 13 d earlier. We released the fish at 0930 hours in shallow water (3–5 m deep). The sonic-tagged fish remained in shallow water at first, moving south along the shore; then at 1015 hours, it moved east away from shore, directly toward the Point Lena homesite. The fish continued in this direction for about 0.6 km, circled counterclockwise, and at 1200 hours headed back toward Shelter Island. The fish then moved north, paralleling the shoreline about 0.2 km offshore; by 1410 hours it had traveled over 4.0 km in this direction. It then moved east, part way across the channel, through water 50–90 m deep. It began to circle, and arrived at a shallow reef (Figure 2) south of a small, midchannel island (Aaron Island) at 1500 hours. The fish remained there until 1530 hours, when weather and sea conditions forced us to end observations.

DISCUSSION

We generated some answers to the 4 questions posed in the Introduction. They are as follows:

(1) What was the initial reaction of displaced rockfish upon release? The observations by scuba divers and the telemetry experiments revealed an active, almost immediate response to displacement. We looked for signs of fright, distress, or disorientation, and instead saw calm, methodical behavior. Their movements were prompt and seemingly directed.

(2) Did the initial behavior appear to involve homing? The counterclockwise circling behavior, which began at once upon release, probably aided or effected orientation, a start for the homing process. In both the diver observation and telemetry experiments, fish periodically repeated the circling behavior, possibly to reconfirm their orientation.

(3) How long does it take displaced fish to return to their homesite — hours, days, or weeks? Our previous hypotheses, with no evidence to the contrary, were that homing for this species took days to weeks, and that much of this time involved exploratory searching. The quick, straight-line return of 1 sonic-tagged fish 2.8 km from release to homesite in 2.66 h demonstrated that return in a very short time is possible, and further that this individual (and presumably others) possessed remarkable homing ability.

(4) Does homing follow a direct route across open water or follow a shoreline? The first sonic-tagged fish could have followed a shoreline to the homesite (Figure 1), but instead returned in a direct line across waters 70–80 m deep, indicating these depths did not pose an obstacle to its return. The deepwater barrier or hindrance to homing suggested by Carlson and Haight (1972) was supported by the deepwater test, in which the fish appeared to key on the direction needed to return to the Point Lena homesite and followed that route until water depth exceeded 100 m in midchannel (Figure 2). Pearcy (1992) reported similar findings: most displaced yellowtail rockfish that he observed returned to a homesite on Heceta Bank, Oregon, but the one that had been displaced to deep water (150-m depth) did not. Yellowtail rockfish have been recorded from as deep as 274 m but are usually found from 24 to 46 m (Eschmeyer et al. 1983). In Southeast Alaska they often occur over 20- to 30-m depths, as found at the Point Lena homesite.

Stanley et al. (1994) did not test the idea of homing following displacement but documented that some yellowtail rockfish do not display site fidelity and can move >100-km distances. Site fidelity (resident behavior) has been reported for other rockfish species. O'Connell (1991) found all (3) recoveries of tagged yelloweye rockfish *Sebastes ruberrimus* off Southeast Alaska were from the site of original capture. Coombs (1979) reported similar findings for yelloweye rockfish off Oregon, with all (7) recoveries from the capture site. Pearcy (1992) hypothesized that yellowtail rockfish that inhabit rocky locations display greater site fidelity and less mobility than those found over coastal sites with level seabed. Our findings support this idea.

Perhaps the most significant finding of our work was that directed movement, probably involving homing, began immediately after release of the displaced fish. The circling behavior of displaced individuals, long known in avian homing (Matthews 1968), is virtually unknown in documented accounts of fish-homing behavior. It may play a key role in rockfish homing. This circling behavior in displaced yellowtail rockfish and its relation to orientation and homing is clearly an important area for future research, not only in rockfish, but in other species as well.

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