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## Tag Location and Retention in Black Rockfish: Feasibility of Using PIT Tags in a Wild Marine Species

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**Abstract.**—Tag and recovery programs can provide valuable information on population size and exploitation rates in fishes. Passive integrated transponder (PIT) tags are ideal for use in such programs because they provide identification of individual fish and are invisible to anglers, circumventing problems with nonreporting of tags. Our objective was to determine whether PIT tags could be used successfully to tag black rockfish *Sebastes melanops*. We tested tag placement and tag retention using intramuscularly injected PIT tags (12 × 2.1 mm) in 227 black rockfish (25–47 cm); three tag placement sites located outside of the area normally filleted were evaluated. Tag retention for all tag sites was 100% after 49 weeks; however, two fish retained inoperative tags, which possibly sustained damage during the tagging procedure. The results indicated that the best tagging site is ventral and anterior to the origin of the pectoral fin. At this site, tag retention is excellent, risk of infection is low, tag movement is minimal, and little or no tissue damage results from the tagging procedure.

Passive integrated transponder (PIT) tags have been used in a variety of freshwater, mammalian, and terrestrial applications for more than a decade (Prentice et al. 1986; Fagerstone and Johns 1987). Although these tags have been used extensively in salmonids (Prentice et al. 1990; Brännäs et al. 1994) and occasionally in broodstock of nonsalmonids (Harvey and Campbell 1989; Jenkins and Smith 1990; Moore 1992; Baras et al. 1999; Das Mahapatra et al. 2001), they have not been used in rockfishes *Sebastes* spp. The tagging of adult fish with these miniature tags creates more opportunity for tag placement sites than the typical peritoneal implant but also creates a higher potential for tag movement and loss, depending on tag site location. In addition, for effective use of these tags in fisheries on wild fish, each tag must be located where it will remain detectable after the fish has been filleted for consumption. If an adequate tag site is identified, PIT tags offer major benefits to mark–recapture experiments because they are invisible to anglers, thereby removing the major problem associated with variable tag re-

porting rates. If anglers are not needed to detect and report tags, then the only variable becomes the detection rate of tagged fish in the sample, which can be directly estimated through sampling checks. Our objectives were to determine where PIT tags can be safely located in black rockfish *S. melanops* and to measure the tag retention rates at those locations. This information may then be used to determine the feasibility of a tagging program for wild fish in an important recreational fishery.

### Methods

We used 149 black rockfish held previously for more than 1 year at the Oregon Coast Aquarium, Newport, Oregon, and 78 black rockfish that were captured for this experiment by use of hook and line, for a total of 227 black rockfish. The size distribution of fish tagged in this experiment covered the range of sizes caught in the recreational fishery, so that the results would be applicable to any future field tagging study (Figure 1). All experimental fish were in good overall health and were feeding, though some exhibited residual non-lethal effects from barotrauma at capture (e.g., exophthalmia). These injuries were noted at tagging and were tracked during the study.

The tags used were Destron-Fearing ISO FDX-B 134.2-kHz PIT tags. Tag dimensions were 12 × 2.1 mm. The tags were injected by means of a 12-gauge stainless steel veterinary needle and modified syringe (Biomark, Boise, Idaho) (Prentice et al. 1990; PIT Tag Steering Committee 1999). Injectors were sterilized in 70% ethanol between fish. Tags were read with either a Destron-Fearing FS-2001 portable scanner with a handheld wand (Biomark, Boise, Idaho) or an Allflex (Dallas, Texas) portable scanner unit. Read distances were up to 20 cm for the Destron-Fearing scanner and 10 cm for the Allflex scanner. However, almost all tags were detected immediately when placed within 5 cm of the detecting antenna.

**Tag location.**—We used carcasses from black rockfish captured in the recreational fishery to develop tag-retention test locations. Given the normal fillet range used by professional filleters at

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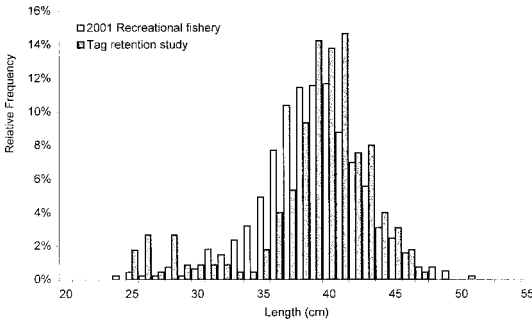


FIGURE 1.—Length-frequency distributions of black rockfish sampled from the recreational hook-and-line fishery off Newport, Oregon, during 2001 ( $n = 934$ ; Oregon Department of Fish and Wildlife, unpublished data) and black rockfish used in this tag-retention study ( $n = 225$ ).

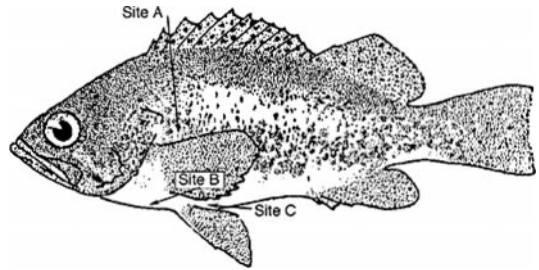


FIGURE 2.—Diagram of three PIT-tag sites tested on black rockfish, showing the orientation of injectors (angle of arrows) at each site. Diagram courtesy of Miller and Lea (1972).

local charter-boat businesses, we focused on areas on or near the head. We also targeted areas with substantial muscle volume for tag placement in an effort to minimize tag movement under the skin, which could result in tag loss or tag migration into the fillet range. Finally, we looked for areas that were not heavily vascularized, so as to minimize bleeding during tagging and any subsequent effects on fish health. We identified three areas that met these criteria (Figure 2). Tagging at site A placed the PIT tag under the supracleithral bone at a depth of approximately 1.5 cm in the intermuscular space between the pectoral adductor muscles of the pectoral fin and the hypaxial musculature covering the ribs. Tagging at site B placed the tag in the hypaxial musculature ventral to the cleithrum at a depth of 0.5–1.0 cm. Tagging at site C placed the tag in the hypaxial musculature on the dorsal side of the pelvic girdle at a depth of approximately 1.0 cm.

We tagged 69 fish at site A, 75 fish at site B, and 83 fish at site C (Table 1). We tagged a portion of the fish with an anesthetic solution of 100 mg/L MS-222 (tricaine methanesulfonate) and some without to determine whether anesthesia was necessary to inject the PIT tags or whether fish motion affected later tag loss. Fish tagged at site A were placed ventral side down on a moist foam pad, the needle was inserted to a depth of approximately 1.0 cm dorsoventrally and medial to the supracleithral bone, and the tag was injected (Figure 2). Tagging methodology for sites B and C consisted of placing the fish dorsal side down in a moist, foam-lined trough and injecting the PIT tag approximately 1.5 cm from the incision, at a depth of approximately 0.5–1.0 cm below the skin. Tags

in site A were injected with the syringe oriented ventrally, while tags in sites B and C were injected with the syringe oriented anteriorly. Excluding any time required for anesthesia, the entire tagging process from capture to tag insertion lasted 30–60 s. Fish tagged at the Oregon Coast Aquarium were held in an aerated recovery tank for 10–15 min or until they were oriented and actively swimming, and then were transferred to the long-term holding tank. Fish collected from the Newport area (Table 1) were tagged at sea with the same procedures, held in aerated recovery totes, transported to the aquarium’s holding facility, and then transferred to the main holding tank. The holding tank was circular (9-m diameter, 2-m depth, 106,000-L volume) and supported by a temperature-controlled (9–14°C), semiopen recirculating seawater system. The water was filtered by rapid sand filters, a bead filter, and foam fractionation. A single daily treatment with copper to control external parasites was applied from week 15 through week 29. The holding tank was checked daily for any mortalities and monitored for water quality (ammonia, temperature, and ozone level). Fish were fed a mixture of Atlantic silversides *Menidia menidia*, shrimp, and

TABLE 1.—Details of experimental groups of PIT-tagged black rockfish. See Figure 2 for the locations of tagging sites A–C.

Fish origin	Tag location	Number tagged	Number anesthetized
Aquarium <sup>a</sup>	Site A	50	50
	Site B	54	54
	Site C	45	45
Newport area	Site A	19	
	Site B	21	
	Site C	38	32
Total		227	181

<sup>a</sup> Aquarium fish were captured and held for more than 1 year before the experiment for exhibit purposes.

squid *Loligo spp.* twice weekly at a maintenance rate of 5% body weight per feeding.

*Tag retention.*—Periodically, the fish were crowded, individually netted, scanned for the presence of a PIT tag, and released back into the tank. These retention checks occurred 1, 3, 11, 28, and 49 weeks after tagging. Tag checks were conducted more frequently shortly after tagging because some studies suggest that most tag loss occurs shortly after tagging, during the wound healing process (Clugston 1996; Baras et al. 1999). Any fish that did not possess a working PIT tag was euthanized with an overdose of MS-222, and the tag site was dissected to determine whether a tag was either present and malfunctioning or lost. Any other mortalities were scanned, the tag site inspected, and a physical evaluation conducted to determine whether the cause of death was directly linked to the PIT tag. A magnetic strip was placed around the circular drain at the center of the tank to collect any shed PIT tags.

## Results and Discussion

### *Tag Location*

The best overall tag site location was found to be site B (ventral and anterior to the insertion of the pectoral fin; Figure 2). Placing a tag at this site embeds the tag in the obliquus inferioris muscle (Winterbottom 1974). There is little vascularization in the immediate area of the tag site, though a deep injection could lacerate vascular tissue supplying the gills. The site is well outside the fillet range, and is seldom eaten even if the fish is cooked whole. Tag site A was situated between two muscle groups (adductor superficialis and hypaxial muscles), and the tag in several mortalities had migrated into the fillet range. In addition, poor tag placement could result in laceration of the kidney, as observed in one mortality. Although tag site C was outside the fillet range, the needle would often hit the pelvic girdle, several tags entered the peritoneal cavity, and the sharp pelvic spines made it difficult to inject in an anterior direction without injury to the tagger. Because these tags would be used for long-term studies in rockfishes, which spawn annually, we avoided placement of PIT tags in the peritoneal cavity. Locating PIT tags in areas outside the peritoneal cavity precludes a potential problem with fish shedding tags during spawning, as has been found in salmonids (Prentice et al. 1990).

### *Tag Retention*

Tag retention was excellent at all three locations. All tags were physically retained for 49 weeks for each of the three sites. One tag did not scan after week 1 and another tag did not scan after week 3. The two undetectable tags were determined to be cracked and inoperative. These tags were functional after injection, but may have been cracked during injector handling and rendered inoperative after submersion in the tank. Nonfunctioning but retained tags were included as retained in the retention estimates.

Anesthesia did not influence the overall tag retention rate, with 100% retention whether anesthesia was used or not. Anesthesia also required additional time and handling, and had no effect on short-term mortality. For these reasons, as well as a 21-d restriction on human consumption of MS-222-treated fish (USOFR 2001), we consider the use of anesthesia unnecessary for injecting PIT tags at these locations on black rockfish.

Although this study was not designed to measure any mortality associated with the PIT tagging of black rockfish, no fish died within 40 d of tagging, indicating no directly lethal trauma from tagging in the short term. Of the 34 fish that died during the 49-week experiment, none exhibited infections at the tagging sites, based on necropsy and dissection of tag locations.

Passive integrated transponder tags appear to be ideal for use in black rockfish. They are small and uniquely coded, have excellent retention rates, and can be located in areas not normally filleted. This technique can likely be transferred directly to other rockfish species without modification, although tag retention studies should be conducted for alternate tag insertion sites or methodologies. Because the tags are invisible to anglers, this technique can allow researchers to avoid the issue of unknown and variable tag reporting rates in mark-recapture programs and will be a valuable tool in marine research.

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