Subsurface Fish Handling to Limit Decompression Effects on Deepwater Species

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Introduction

Fish commonly suffer barotrauma caused by rapid decompression as they are hauled to the surface by conventional fishing techniques. The problems are more serious for fish caught at greater depths and especially for physoclistous fishes with closed swim bladders. Common physical effects of such drastic volume changes are everted stomachs, eyes forced from orbits, and distortion of scales and subcutaneous flesh.

Barotrauma can have implications for the success of some research investigations. Regurgitation and stomach eversion adversely affect research results in dietary studies (Bowman, 1986). Fish in tag-and-recovery studies suffer increased mortality and their natural behavior may be altered (Grimes et al., 1983; Matthews and Reavis, 1990). Hauling snappers to the surface at slow or controlled rates does not greatly reduce the effects of barotrauma (Haight, 1989). Attempts to relieve distended air bladders at the surface by puncture using hypodermic syringe needles 1) require repositioning of fish stomachs, 2) involve more handling, and 3) do not eliminate the risk of internal injury during hauling. An injured bladder may not be capable of regulating volume properly, or at best it may require a prolonged recovery period (Harden-Jones, 1957). Thus, fish returned to native depths with artificially vented gas bladders may have trouble maintaining normal buoyancy and behave abnormally for an unknown period of time after release.

Studies (Matthews and Reavis, 1990; DeMartini et al.[1]) have shown that fish tagged at depth by scuba divers provide a greater number of tag returns than those tagged at the surface by conventional techniques. Methods for successful tagging at depths inaccessible to scuba divers have been developed by Grimes et al. (1983) using breakaway hooks and by Priede and Smith (1986) using an ingestible acoustic tag. Unfortunately, neither method provides information as to the size (or even species in the case of Grimes et al. (1983)) of the tagged individual at the time of tagging, and both methods are poorly suited to multispecies fishery situations.

In the course of studying the juvenile Hawaiian snapper, *Pristipomoides filamentosus*, we have found it necessary to tag individuals acoustically to evaluate their diel movement patterns. However, these fish routinely suffer severe barotrauma when hauled to the surface from their normal depths of 65–100 m (Parrish, 1989). Assuming unrestricted expansion, a fish brought from 65 m may experience a 7.5-fold increase in gas volume in its swim bladder. Surface handling of the fish for release, including venting the swim bladder with a syringe and repositioning the stomach when everted, has resulted in only about 40–50% survival at the surface and an unknown additional mortality after release (Moffitt and Parrish[2]). The small size of the fish, 8–25 cm fork length (FL), adds a further complication by restricting acceptable transmitter size, which in turn limits battery life. A short battery life requires that collection of data representative of normal fish behavior begin at once and not be affected by buoyancy problems associated with an artificially vented swim bladder.

To prevent these problems with our acoustically tagged fish, we developed a subsurface handling method which is also applicable to other tagging and dietary study programs. The interception of hauled fish at an intermediate depth by divers offers the potential to prevent damaging barotrauma by minimizing expansion of the swim bladder.

Methods

Transmitter Placement

Because of the small size of our fish, we used the smallest available transmitter (approximately 8 mm diameter × 35 mm long) and restricted

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ABSTRACT—A method of handling hooked fish at intermediate depth was developed for species which occur deeper than conventional scuba depths. Juvenile pink snappers, Pristipomoides filamentosus, *were hauled from 65–100 m to a depth of only 30 m, where the ambient pressure change was a fraction of that produced by hauling fish to the sea surface. This method afforded a unique opportunity to acoustically tag deepwater, physoclistous fish without the need to alter the fish's original swim bladder volume and without the high risk of further injury associated with surface handling. Tagged* P. filamentosus *survived and behaved well and were tracked successfully. This basic method could be applied to a variety of deepwater species in a number of research approaches, including tagging and dietary studies.*

[1]DeMartini, E. E., A. M. Barnett, T. D. Johnson, and R. F. Ambrose. In review. Growth and production estimates for biomass-dominant fishes on a southern Californian artificial reef. Bull. Mar. Sci.

[2]Moffitt, R. B., and F. A. Parrish. Unpublished data on file at Honolulu Lab., Southwest Fish. Sci. Cent., Natl. Mar. Fish. Serv., NOAA, 2570 Dole Street, Honolulu, HI 96822-2396.

the size of our target fish to ≥15 cm FL. The transmitter was introduced orally and pushed down the esophagus of the fish by a small dowel (8 mm diameter × 18 cm long), equipped with a sleeve to hold the transmitter. Small barbs attached to the transmitter assisted in lodging and retaining it in the gut of the fish (Fig. 1). The time required to implant the transmitter never exceeded 5 seconds. The effects of tagging and tag retention were also evaluated in a tank experiment in which dummy transmitters were implanted in two juvenile snappers as described above and observed over a 3-week period.

Subsurface Tagging Operations

The "tagging array" (Fig. 2) consisted of a polypropylene line connected to a rectangular wire trap (100 × 75 cm) which was suspended 30 m below a surface buoy loosely roped to a surface support vessel. Shock absorbing cords were affixed to the line at both the buoy and trap ends to minimize the effect of surface movement on the trap. Attached to the line 17 m below the surface was a T-bar where divers waited to intercept fishing lines hauled by fishermen in the boat.

When a fish was hooked, a fisherman reeled the monofilament line in until a premeasured depth mark on the line was reached. A carabiner was clipped around both the fishing line and a taut high-test monofilament "transport line" connected between the fishing boat and one end of the T-bar. The heavy carabiner slid down the transport line, pulling the fishing line close to the array and the waiting divers. The divers were then able to find the nearly invisible monofilament fishing line at the end of the T-bar and proceed with the tagging operations.

If the divers determined that the fish on the line was not suitable for tagging, a diver signaled the surface crew to continue fishing by clipping a particular color-coded buoy around the fishing line and freeing it from the T-bar. Once a suitable fish was hooked, they descended to the 30 m depth where the hooked fish hung suspended close to the wire holding trap. Wearing latex gloves to protect the fish, a

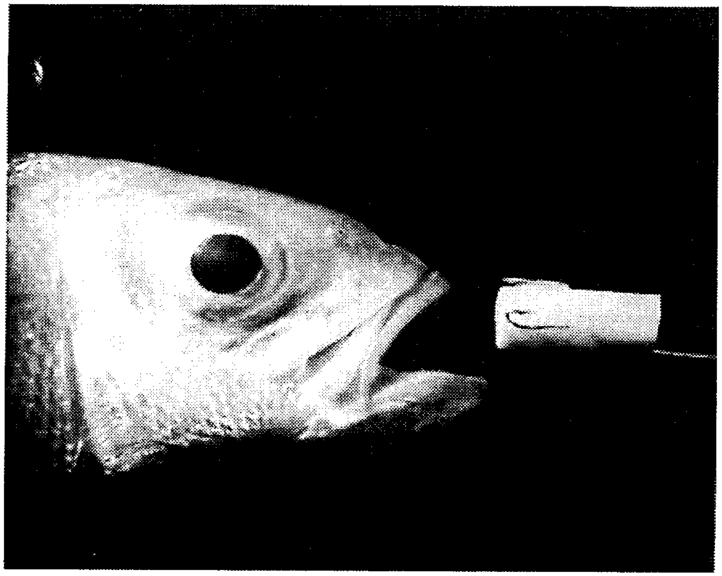

Figure 1.—An intragastric acoustic transmitter (35 mm long) being implanted in a juvenile pink snapper.

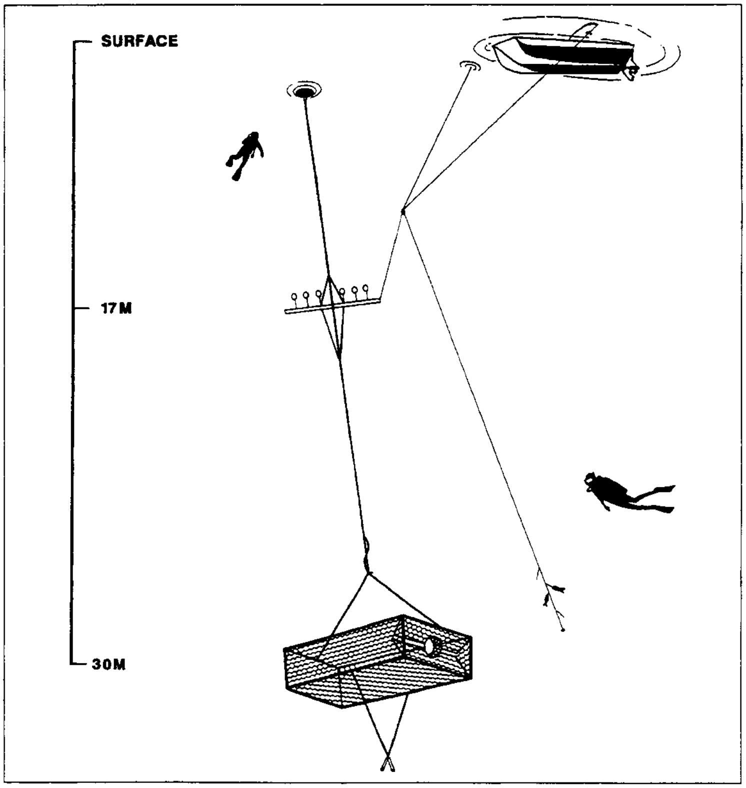

Figure 2.—Schematic representation of the subsurface tagging array.

diver restrained the fish while using the modified dowel to push the transmitter down its gullet. The fish was then removed from the hook, and its FL measured with a scale (mounted on the trap) as the fish was placed in the trap through an escape-proof entrance. The trap was lined with fine mesh synthetic netting to cushion the interior. Fishermen in the boat were signaled to stop fishing by clipping a different color-coded buoy to the empty fishing line and releasing it from the T-bar. Each tagged fish was held in the trap for about 5 minutes, allowing evaluation of its physical condition before release with the transmitter installed. If the appearance or behavior of the fish seemed questionable, the diver dissected the fish and recovered the transmitter for implantation in the next suitable fish. If the tagged fish demonstrated brisk activity and normal orientation in the trap, it was released by a hinged panel being opened on the trap (Fig. 3).

Results and Discussion

Using the methods described above, we successfully implanted tags in juvenile snappers on each of five trials. None of the 17 fish that were brought to 30 m from depths of 65–90 m had everted stomachs or other obvious symptoms of barotrauma. This is not unexpected because, assuming unrestricted gas expansion, a fish brought from 65 m to 30 m would experience 1.9-fold expansion of its swim bladder instead of a possible 7.5-fold expansion if it were brought to the surface. Ten fish were not selected for tagging: Some were too small (<15 cm FL), and others were hooked deep in the mouth and therefore risked damage to gills or esophagus when the hook was removed. Two of the seven fish tagged had poor color and experienced difficulty orienting while in the holding trap. They were sacrificed to recover the transmitters. The remaining five fish were successfully tagged and released. Released fish swam immediately toward the bottom.

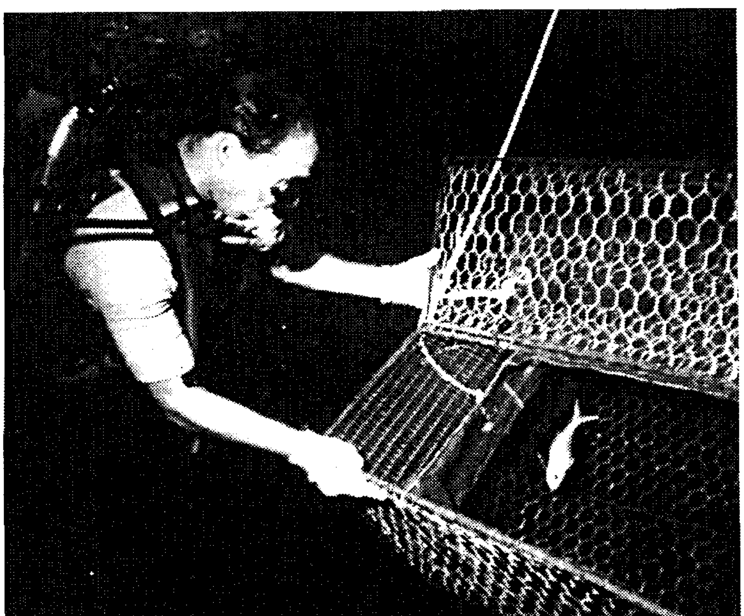

Figure 3.—Release of a juvenile pink snapper implanted with an acoustic transmitter at 30 m depth.

One of the two fish implanted with dummy transmitters in the holding tank died immediately. Death was probably due to internal injuries sustained when the transmitter was inserted. The second tagged fish in the tank study fed and behaved normally with the five conspecifics with which it was held throughout the 3-week period.

We elected to implant transmitters orally because of the ease of application by divers and the minimal handling time required. We anticipated success since others (McCleave and Stred, 1975; Hawkins and Urquart, 1983; Mellas and Haynes, 1985; Lucas and Johnstone, 1990) have reported minimally altered behavior of fish with gastric transmitter implants. Our resulting tracks, using this technique in our subsurface tagging, provided data with consistent behavioral trends over the 5-day duration of each track.

Our subsurface handling method has potential application to dietary and tag-release studies for a number of deepwater species. The need for such a technique and its effectiveness will probably vary with the depth of capture and the physiological tolerances of individual species. In dietary studies, fish could be removed from the hook and bagged at depth prior to regurgitation and stomach eversion, thus ensuring the integrity of the food sample. In tagging studies, including acoustic tracking, advantages include minimum handling (all in the water), reduced trauma from excessive swim bladder distension, avoidance of the effects of surgical puncture of the bladder, and opportunity to observe the condition of the fish before release. All these features increase the likelihood of releasing healthy, normal fish. However, the method is labor intensive (requiring a minimum of three people), and fishing time is limited by the time at depth safe for the divers. Therefore, the method may only be effective in situations where the target species can be caught readily.

Acknowledgments

We thank Karl Bromwell and Leslie Timme for their participation as divers in this project.

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