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Short communication

A comparison of tagging methodology for North Pacific giant octopus *Enteroctopus dofleini*

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ABSTRACT

New opportunities for the export of food grade octopus have furthered interest in developing an actively managed directed fishery for North Pacific giant octopus *Enteroctopus dofleini* in Alaska state waters. Trawl, long-line, and pot fisheries already harvest over 230 metric tons of octopus as bycatch annually. Managed under the authority of commissioner's permits, applications for directed harvest in most management regions have historically been rejected due to the lack of information on stock status. Our limited knowledge of octopus movement, age structure, and demography hamper the ability to successfully manage this potential fishery. Chief among these obstacles is the lack of abundance estimates on which to base harvest guidelines. While catch-per-unit-effort estimates can be made from bycatch data and used as a proxy of abundance, these estimates can often be inaccurate. Mark-recapture estimates can be more accurate, but can also be expensive and require an effective means of marking individuals. We compared two different tags in order to assess their effectiveness for use on octopuses. We tagged 97 octopuses with modified Peterson discs and visible implant elastomer tags in Kachemak Bay, Alaska. Three tagged octopuses were recaptured, making a statistically sound tag comparison difficult. Our data suggest that visible implant elastomer tags will be a more effective means of marking octopuses.

1. Introduction

External tags have been used to study animal behavior, movement and migration, and to provide information on age, growth, mortality, and abundance (McFarlane et al., 1990). Growing interest in an actively managed directed fishery for North Pacific giant octopus (*Enteroctopus dofleini*) has raised both management and ecological questions, including those concerned with octopus movement patterns and abundances. While early tagging studies looked at residence times (Hartwick et al., 1984; Mather et al., 1985), little is known about large-scale dispersal or abundance.

A variety of chemical (Ikeda et al., 1999, 2003), electronic (Anderson and Babcock, 1999; Mather et al., 1985; Scheel et al., 2007), external (Hartwick et al., 1984; Nagasawa et al., 1991; Robinson and Hartwick, 1986) and tattooing/branding (Nagasawa et al., 1991; Replinger and Wood, 2007) tags have been used to study cephalopods. External tags such as Atkins and Petersen tags are the most commonly used tag to study *E. dofleini* (Hartwick et al., 1984; Nagasawa et al., 1991; Robinson and Hartwick, 1986). Cosgrove (*Royal British Columbia Museum, pers. comm.*) investigated the use of numbered plastic discs secured through the mantle with a plastic cable tie, but octopuses ripped those out leaving large wounds in the mantle. Tattoo and branding, particularly visible implant elastomer tags (VIE; Northwest Marine Technology, Shaw, Washington) have been used successfully on the squid *Sepioteuthis sepioidea* to investigate growth rates (Replinger and Wood, 2007). However, when used on the cuttlefish *Sepia (Mesembrisepia) latimanus* this method (injecting latex between skin and cuttlebone) led to significant wounds and mortalities (Nagasawa et al., 1991) suggesting that its usefulness may be limited to animals of a certain size.

While Peterson tags are the most commonly used tag, the extent to which they affect animals is debated. Robinson and Hartwick (1986) observed no ulcerations around tags and octopuses did not seem to be adversely affected by tagging. Domain et al. (2000) compared spaghetti and Petersen disc tags for use on *Octopus vulgaris*, and determined that Petersen disc tags stayed on longer. However, the authors did not attribute observed tag loss to necrosis of surrounding tissue or manipulation of the tag by octopuses. In either case visible implant elastomer (VIE) tags may decrease tag loss and provide a more effective and efficient means of marking. The goal of this study is to compare two different marking techniques.

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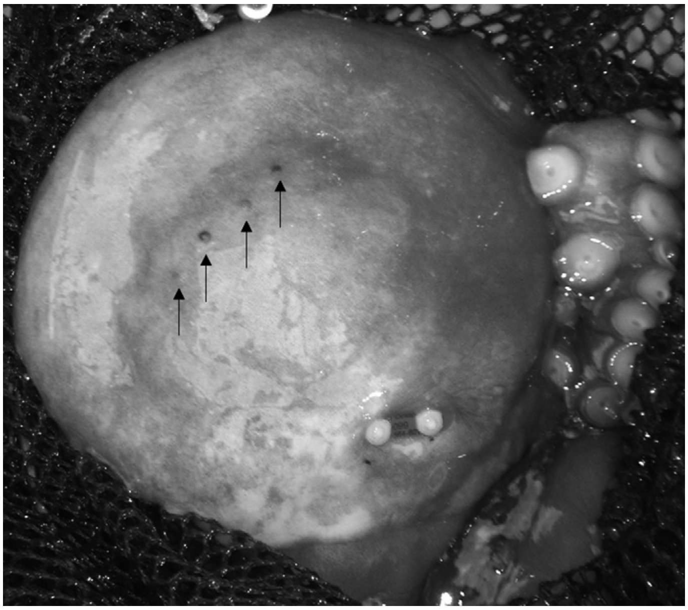

Fig. 1. Giant Pacific octopuses (*Enteroctopus dofleini*) were tagged using two different marks: Petersen disc tags and visible implant elastomer (VIE) tags. This photo shows the location of both tags on the ventral side of the mantle. Arrows indicate where each VIE dye was injected. Injected as a liquid, the elastomer forms a pliable biocompatible solid. The Peterson discs were inserted through the opening in the mantle on the ventral surface by puncturing the mantle with the two plastic screws, and securing a plate with two plastic nuts.

2. Materials and methods

We caught *E. dofleini* during three surveys (29 May to 18 June 2006, 2–13 October 2006, and 25 November to 6 December 2006) in Kachemak Bay, Alaska. Unbaited lair pots and three baited pots (Korean hair crab pots, both commercial and personal use Ladner shrimp pots, and black cod pots) were used.

Upon capture, we sexed animals and recorded morphometric measurements including the interocular distance (IOD), mantle length (ML), and weight, as well as any identifying marks. Before tagging, each octopus was transferred to water cooled to approximately 1 °C to anesthetize them.

Due to the difficulty in tagging larger octopuses (>11 kg [kilograms]) with the Petersen discs, and to minimize the effect of handling time on the health of each animal when many octopuses were caught in a string of pots, 28 octopuses were tagged using only the VIE tags. Modified Petersen discs were inserted through the ventral side of the mantle, secured with plastic nuts, and the excess screw length cut flat using scissors (Fig. 1). We injected the VIE tag subcutaneously on the ventral side of the mantle where the pigmentation is lightest (Fig. 1). Each elastomer tag consisted of four injected dye spots, occupied by any of four colors (red, orange, yellow and/or green) to individually identify each animal. Tags were injected using a tuberculin syringe fitted with a 20-gauge needle. We released tagged octopuses within 10 m of the GPS coordinates at which they were captured. During the third survey, animals were not tagged with either Petersen or VIE tags.

3. Results

During the first and second surveys 3 and 94 *E. dofleini* were tagged respectively using Petersen discs and VIE tags to allow for their direct comparison. Of the three recaptures, two animals were marked with both tags while the other had only the VIE tag (Table 1). We observed from one individual that the Petersen discs can irritate the tissue surrounding the tag resulting in necrosis (Fig. 2). Of the two individuals recaptured that were initially tagged with both methods, one had lost its Petersen tag while all retained the VIE tag. Upon examination of the VIE tags no noticeable tissue damage was caused at the site of injection. None of the colors became dull or difficult to distinguish, and there was no noticeable difference in size of the marks between mark and recapture.

4. Discussion

Our results indicate that VIE tags may be a more reliable tagging method than the commonly used Petersen tag and that animals may exhibit a strong trap response. While our results have implications for tagging studies for studying growth, movement, and survival, we focus here on the implementation of mark-recapture on estimates of abundance.

Results of recaptures suggest that VIE tags may provide a more durable method of marking octopuses than Petersen tags. Petersen tags were obvious upon recapture and were easily felt and seen when handling recaptured octopuses, but led to significant tissue damage in two individuals which may lead to tag loss. Because they are external tags, octopus may be able to remove the plastic nuts which secure both plates in the mantle. The VIE tags led to no signs of irritation, but are not immediately obvious upon recapture without manipulation of the posterior mantle. Also, consecutively injected elastomer colors can be embedded in the epidermis such that the colored dots move with respect to each other when the mantle tissue is manipulated and this may lead to the misidentification of recaptures. Of the three recaptures, the one individual that had lost the Petersen tag showed significant tissue damage around the site where the tag had been inserted. Although brown trout have been observed to absorb the VIE during growth or for layers of musculature or epidermis to cover the tag (Olsen and Vollestad, 2001), we would still be able to identify octopuses in this study by their Petersen tag. Consequently, low recapture rates in the third survey are not likely due to tag loss.

Materials used in the construction of the Peterson disc tags as well as the part of the body tagged may determine the extent to which wounds develop. Robinson and Hartwick (1986), Domain et al. (2000), and Cosgrove (*pers. comm.*) used Peterson disc tags secured by nickel pins to the base of the left third. The smaller diameter of the nickel pin may cause less irritation to surround tissue than the plastic screws with which we constructed our tags. Tagging at the base of the left third arm where muscle is the thick-

Table 1
Summary statistics from three recaptured North Pacific giant octopuses in Kachemak Bay, AK. Upon capture we recorded sex, weight, inner ocular distance (IOD), and mantel length (ML).

Animal ID		Sex	Weight gained (kg)	Change in IOD (cm)	Change in ML (cm)	Distance moved (km)	Days between captures
Peterson	VIE						
85	OOYY	F	1.5	0	0	7.53	52
N/A	GRRY	F	4.5	1.5	2.5	5.31	48
118	RRGG	M	1.25	2.5	2	1.44	63
		Avg	2.42	1.33	1.33	4.76	54.33

Fig. 2. Piercing the mantle of the North Pacific giant octopus (*Enteroctopus dofleini*) may cause significant wounds and result in necrosis and tag loss. Left: This photo shows part of the ventral mantle where the tag has been successfully inserted immediately after application of the mark. Tissue was healthy and the tag was clearly visible. Right: This photo shows the ventral side of the mantle where a Petersen tag was beginning to cause necrosis after approximately 54 days.

est may extend the time for which it takes the tissue to reject the tag. While no tissue damage was observed in these three studies, animals were not double marked and tag retention was not estimated.

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