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Short communication

Determination of angler reporting level for red drum (*Sciaenops ocellatus*) in a South Carolina estuary

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Abstract

Angler reporting of tagged red drum (*Sciaenops ocellatus*) was examined using three tag reward messages: ''No Reward''; ''Reward''; and ''$50 Reward''. ''Reward'' is the standard message used in all state sponsored fin fish tagging programs in South Carolina (SC). Hatchery produced red drum were tagged with external tags containing the various messages and released in four replicate areas ($n = 100$ fish/message/area) near Port Royal Sound. Analysis of the return data for ''Reward'' (18.7%) and ''$50 Reward'' (22.9%) tags found no statistical differences ($P > 0.05$) between the two groups. However, significantly ($P < 0.05$) fewer ''No Reward'' (11.1%) tags were returned than tags containing the other messages. If $50 is an adequate incentive to elicit 100% reporting, then reporting of fish tagged with the standard reward message accurately represents angler capture level while the offer of no reward would result in only 48% reporting.

Keywords: Red drum; *Sciaenops ocellatus*; Tagging; Reward

1. Introduction

Historically, red drum (*Sciaenops ocellatus*) have supported highly important recreational and commercial fisheries along the south Atlantic coast and in the Gulf of Mexico (Matlock, 1986). Due to apparent population decreases, strict regulations were imposed during the late 1980's which were intended to reduce fishing mortality (ASMFC, 1991). Numerous mark-recapture programs were established throughout the southeastern USA to study red drum life history and population structure. Results of these studies have been used to develop management plans to protect red drum from over-fishing (ASMFC, 1991).

Species specific reporting level (λ), post-tagging survival (S), and tag shedding (ϕ) are three factors which must be determined to use mark-recapture data to model fishing mortality (Pollock et al., 1991). Attempts have been made to identify λ for a number of species. Marine recreational anglers in Texas reported only 28% of marine fin fish species surreptitiously tagged by creel clerks (Matlock, 1981). A similar study in Georgia found that λ equaled 55% (Woodward, 1992).

Low λ has also been documented for freshwater fishes. Reporting level for bluegill (*Lepomis macro-*

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chirus), largemouth bass (*Micropterus salmoides*), and white catfish (*Ictalurus catus*) tagged with external tags ranged from 22–84% and varied by site, species and fish size (Rawstron, 1971). Studies conducted with hatchery rainbow trout (*Oncorhynchus mykiss*) in California showed that λ was influenced by publicity, angler interest and recovery efforts (Butler, 1962). Results of these studies also suggest that small cash awards may not provide adequate incentive for anglers to report all captures (Rawstron, 1971; Matlock, 1981). Nichols et al. (1991) found that hunter λ of banded mallard ducks (*Anas platyrhynchos*) varied by reward value and that 100% λ occurred between rewards of $50 and $100. The monetary threshold for receiving 100% angler λ has not been determined, and λ probably varies by site and species. Thus, results of angler tag reporting studies are difficult to interpret. In addition, when wild fish are used for such studies, small sample sizes often make variation within treatments too high to detect statistical differences (Murphy and Taylor, 1991). Hatchery produced fish might allow researchers to reduce variation by releasing large numbers of similar-sized fish over a short time period.

This paper presents the results of a study which examined the effects of reward value on angler λ using externally tagged hatchery produced red drum released into four sites in one SC estuary.

2. Materials and methods

Legal creel size (356 cm TL) red drum were raised in ponds at SC Department of Natural Resources's (DNR), Waddell Mariculture Center (WMC) using methods described by Smith et al. (1997). Fish were harvested in fall (October) when water temperature was $\leq 23^{\circ}$C, to minimize handling stress. After harvest, random groups of fish were anesthetized in a 0.1 g/L solution of MS-222 and individually measured and tagged with an abdominal anchor tag. Each tag consisted of a 17 mm covered T-shaped monofilament anchor section, and an orange 45 mm long streamer portion (Hallprint, Australia, model T991). This tag was selected based on results of a 14 month study using similar sized red drum which showed that $\phi = 0\%$ and $S = 91.5\%$ (Smith et al., 1997). Each tag contained the word "Report", a return address, a unique tag number, and one of three reward messages: "Reward", "No Reward", or "$50 Reward".

Tags were implanted in a random sequence and checked to ensure proper attachment. Fish were allowed to recover in an oxygenated hauling tank and transported to either of two nearby landings (transport distance $\geq$4 and $\leq$10 km). At the landings fish were acclimated to ambient conditions and transferred to boats for transport to release sites. Fish were released in four areas of Port Royal Sound at flood tide in small groups (2–3 individuals/25 m of shoreline) in an attempt to reduce tag reporting interaction.

The study was a randomized complete block design, blocking by transport group or site. Each block consisted of $\sim$300 fish, $\sim$100 from each treatment (reward message). To mimic existing programs the study received no special publicity. Tag return data were collected from anglers by mail or telephone. Those reporting "Reward" tags received merchandise rewards (t-shirt or fishing caps) which were the same as those offered by other state sponsored tagging programs. Anglers reporting "$50 Reward" tags received a check. In an effort to minimize occurrence of increased fishing effort, no information was provided to anglers on the specifics of the reward study. Return data were collected for 13 months after fish were released.

Percent return data were arc-sine square-root transformed to normalize data prior to analyses (Steel and Torrie, 1980). A two-way analyses of variance (ANOVA) was performed on tags reported from each reward message, blocking by site. Tukey's test was used to examine treatment differences. Significance was accepted at $P \leq 0.05$. Data are presented as mean $\pm$ standard deviation.

3. Results

All fish were tagged and released on 21 October, 1992. Fish ranged in length from 34.0 to 53.7 cm TL with a mean of 39.8 $\pm$ 3.7 cm TL. 52 fish (4.4%) were tagged which were under the minimum legal size (35.6 cm TL). During tagging, 14 tags were broken, as a result only 1186 tagged fish were released (Table 1).

Reports of captured fish began one day after release and continued through 17 November, 1993. During the study, information on 209 tagged fish was returned by

Table 1
Overall percent return, by tag message and site for all tags reported during the study[a]

Release site	Tag message			Mean
	No Reward	Reward	$50 Reward	
1	8.2 ($n = 98$)	11.1 ($n = 99$)	15.5 ($n = 97$)	11.6 ± 3.7 B
2	11.0 ($n = 100$)	13.3 ($n = 98$)	21.0 ($n = 100$)	15.1 ± 5.24 B
3	21.2 ($n = 99$)	39.0 ($n = 100$)	40.0 ($n = 100$)	33.4 ± 10.6 A
4	4.0 ($n = 99$)	11.3 ($n = 97$)	15.2 ($n = 99$)	10.2 ± 5.6 B
Mean	11.1 ± 7.3 A	18.7 ± 13.6 B	22.9 ± 11.7 B	

[a] Number of tags deployed in each replicate site are shown in parenthesis. Data in columns and rows followed by different letters are significantly different ($P < 0.05$).

114 anglers. Multiple tag reporting occurred frequently. Multiple reporting is defined as captures of two or more tagged fish during a single trip, pooling tags from several trips before making a report and or multiple captures and reporting during the study. Multiple returns were made by 32% of anglers ($n = 37$). These multiple returns comprised 63% of the total number of returned tags. ''$50 Reward'' tags were returned by 59% of anglers ($n = 67$). 49% of anglers ($n = 33$) who returned ''$50 Reward'' tags reported them in combination with the other messages. Only five anglers reported ''Reward'' and ''No Reward'' tags in combination. Tags inscribed with ''No Reward'' were turned in individually on only 9 occasions, and on 33 occasions in combination with ''$50 Reward'' tags. One individual returned 12 tagged fish and received $250 and two merchandise rewards.

The overall returned data were examined by reward message and site. No significant difference was detected in mean return level between tags inscribed with ''$50 Reward'' (22.9%) and ''Reward'' (18.7%) (Table 1). However, the mean return level (11.1%) ($\lambda = 48.4\%$) for ''No Reward'' tags, was significantly lower than either reward message ($P = 0.014$, $F = 8.40$) (Table 1). Sites 1, 2 and 4 yielded statistically similar mean return levels (12.3 ± 4.8%), while site 3, near the towns of Beaufort and Port Royal, had a significantly higher return level (33.4%) ($P = 0.003$, $F = 17.54$) (Table 1). A review of the total number of anglers who reported tags from each area showed that 23, 32 and 22 anglers reported tags from sites 1, 2 and 4, respectively, while 53 anglers reported tags from site 3. 16 of the anglers from site 3 also reported fish from one of the other release sites and were included in the angler totals for each site.

Tag returns by individuals who reported only one tag during the study were also examined. Mean return level for ''$50 Reward'' (8.6%) and ''Reward'' (8.6%) inscribed tags were not statistically different. However, both were returned more frequently ($P = 0.048$, $F = 4.86$) than ''No Reward'' tags (2.3%) ($\lambda = 26.7\%$) (Table 2). Analysis by site for single returns showed that significantly more fish were

Table 2
Percent returns by site for tags reported by individuals who reported only one tag during study[a]

Release site	Tag message			Mean
	No Reward	Reward	$50 Reward	
1	1.0 ($n = 98$)	4.0 ($n = 99$)	5.1 ($n = 97$)	3.4 ± 2.1 B
2	3.0 ($n = 100$)	6.1 ($n = 98$)	10.0 ($n = 100$)	6.4 ± 3.5 AB
3	4.0 ($n = 99$)	18.0 ($n = 100$)	12.0 ($n = 100$)	11.4 ± 7.0 A
4	1.0 ($n = 99$)	6.2 ($n = 97$)	7.1 ($n = 99$)	4.7 ± 3.3 B
Mean	2.3 ± 1.5 A	8.6 ± 6.4 B	8.6 ± 3.0B	

[a] Number of tags deployed in each replicate site are in showin in parenthesis. Data in columns and rows followed by different letters are significantly different ($P < 0.05$).

reported from site 3 than from sites 1 and 4 ($P = 0.021$, $F = 7.90$) while return level for site 2 was similar to all other sites (Table 2).

4. Discussion

In SC, there has been an ongoing effort to promote reporting of tagged fish. These efforts have included frequent articles in regional and local media plus presentations at fishing and civic clubs. In addition, information posters have been placed at tackle shops and boat landings. The SCDNR also sponsors a fishery dependent program which promotes tag and release by anglers. All the marine and estuarine tagging programs in the state use ''Reward'' as the standard tag message.

The greater return level and number of anglers reporting tags from site 3 was probably due to its proximity to the towns of Beaufort and Port Royal. The other sites were more remote and presumably received less fishing effort. In spite of the variability in reporting level among release sites, the return levels within and among sites for ''Reward'' and ''$50 Reward'' tags were statistically similar (Tables 1 and 2). This indicates that returns for ''Reward'' tags may reflect 100% λ for this area of SC. ''No Reward'' inscribed tags were returned at significantly lower levels at all sites ($\lambda = 48.4\%$). This difference in reporting between ''No Reward'' and ''$50 Reward'' was even more pronounced ($\lambda = 26.7\%$) when the reward message interactions were removed (Table 2). The significantly lower λ for ''No Reward'' tags is similar to results reported by others (Butler, 1962; Matlock, 1981) and demonstrates that the offer of a reward is essential for maximizing λ.

Return levels for ''Reward'' and ''$50 Reward'' tags (combined mean = 20.8%) in the present study approximate return levels for wild red drum (mean = $\sim$23%) obtained in other SC programs (Wenner et al., 1990). In addition, return levels from a smaller reward study conducted in Florida with the same maximum reward value, obtained return levels of $\sim$20% for red drum and found no differences in λ among various monetary reward values (Murphy and Taylor, 1991). However, the results of the present study contradict results from surreptitious tagging studies in Texas and Georgia which have suggested λ of $\leq$55% for red drum and other marine fish (Matlock, 1981; Green et al., 1983; Woodward, 1992).

5. Conclusions

Reward studies can be a valuable tool for evaluation of angler λ of tagged fish, if sample sizes and reward values are sufficiently high. Multiple captures by individual anglers in the present study introduced reporting bias. This bias was eliminated by examining reports from anglers who reported only one tag during the study. In this case no significant difference between ''Reward'' and ''$50 Reward'' tags was observed, indicating that λ for the two messages was equal. Based on the results of this study there seems to be an insignificant level of non-reporting in the area. This may be due in part to the extensive angler education efforts which have been underway in the state since the early 1970's. Alternately, and perhaps more likely, the ''$50 Reward'' may not have been adequate to obtain 100% λ. A study which reduces tag interaction by distributing fish over a larger area and offers a higher reward value may be necessary to test the latter hypothesis and better define λ for the red drum fishery.

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