Short-term retention of coded wire and internal anchor tags in juvenile common snook, *Centropomus undecimalis*

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Short-term retention of coded wire tags and internal anchor-external streamer tags with disk- or T-style anchors was evaluated in snook 110–180 mm SL for 30 days after tagging. The major differences between the two types of internal anchor tags were the shape of the anchor and the size of incision needed to apply the tags, either of which could affect retention or mortality. This study provides baseline information on tag retention rates in common snook that can be used to interpret catch records correctly and to evaluate common snook stocking programs.

Common snook, *Centropomus undecimalis*, are popular gamefish in southern Florida (Bruger and Haddad, 1986) and throughout their range in the southeastern United States and Central America. Snook populations in Florida declined during the 1970's and 1980's despite increasingly strict limits on the fishery (Taylor[1]). In an effort to enhance snook populations, the Florida Department of Environmental Protection has considered developing a stocking program to supplement depleted wild snook stocks. To evaluate a stocking program's success or impact on native populations, hatchery-released fish must be marked to distinguish them from wild fish. Mark retention rates must be known to correctly interpret catch records and to make inferences about the stocking program or the wild population (Wallin and Van Den Avyle, 1994).

Coded wire tags (CWT's) are common in fish stocking programs because they can be applied quickly and economically to small, juvenile fish (<100 mm standard length, SL). Although retention rates of CWT's vary considerably among different species because of morphological differences (Heidinger and Cook, 1988; Szedlmayer and Howe, 1995), retention rates are generally very good (>95%) if appropriate tagging tissues are identified and used (Dunning et al., 1990; Pitman and Isaac, 1995).

A disadvantage with using CWT's is that they cannot be detected by recreational or commercial fishermen; therefore, recovery of CWT data must be obtained independently. Internal anchor-external streamer tags with imprinted information allow recapture information to be obtained from recreational or commercial fisheries. However, these tags are generally restricted for use on fish >110 mm SL. As with CWT's, retention rates of these tags may vary because of morphological differences (Vogelbein and Overstreet, 1987; Waldman et al. 1990).

In this study, we evaluated retention of CWT's and two types of internal anchor-external streamer tags in age-0 common snook. The fish sizes in this study were similar to sizes that would be produced in a large-scale stocking program. We also evaluated the effects of tagging on growth and mortality. Retention of coded wire tags inserted in the cheek musculature was evaluated in common snook 60–115 mm SL for approximately 60 days after tagging. Retention of internal anchor-external streamer tags with disk- or T-style anchors was evaluated in snook 110–180 mm SL for 30 days after tagging. The major differences between the two types of internal anchor tags were the shape of the anchor and the size of incision needed to apply the tags, either of which could affect retention or mortality. This study provides baseline information on tag retention rates in common snook that can be used to interpret catch records correctly and to evaluate common snook stocking programs.

Methods

Coded wire tag retention

We evaluated retention of CWT's and the effects of tagging on growth and mortality in 60–115 mm SL common snook. Equal numbers of fish were randomly assigned to one of three treatment groups: 1) tagged fish, 2) untagged fish that were handled in the same manner as tagged fish but were not tagged, and 3) control fish that were not tagged or handled. The cheek muscle was chosen for tag implantation because of the high CWT retention rates for this location in red drum and striped bass.

Tagged and untagged snook were anesthetized (100 ppm MS-222) just prior to treatment. One person applied all tags. Tags (1-mm-long, 0.25-mm-diameter) were injected vertically, 2 mm deep into the left adductor mandibularis muscle, posterior to the eye with a Northwest Marine Technology (Shaw Island, WA) Mark IV tagging machine.

[1] Taylor, R. 1997. Florida Marine Res. Inst., Florida Dep. of Environmental Protection, 100 Eighth Ave. SE, St. Petersburg, FL 33701-5095. Personal commun.

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Fish were passed through a quality control device (QCD) to ensure tag presence. Fish in the untagged treatment were handled and passed through a QCD in the same manner as tagged fish but were not impaled on a tagging needle. Tagged and untagged fish were placed in separate 1,300-L tanks. Control fish were transferred directly to a 1,300-L tank with minimal disturbance.

The three tanks were aerated and had sand, diatomaceous earth, ultra-violet light, and biological filters. To prevent fish from jumping out, half of each tank was covered with 5-mm nylon mesh net and the other half was covered with opaque black plastic. Water temperatures averaged 24°C (range: 17–30°C); salinity averaged 26 ppt (range: 22–30 ppt); dissolved oxygen averaged 6.4 ppm (range: 4.0–7.4 ppm), and pH averaged 7.8 (range: 7.7–7.9). Fish were fed baitfish or commercially prepared fish chow daily.

Fish in the tagged treatment were checked for tag retention at 3, 30, and 60 days after tagging. At each tag check, fish were anesthetized (100 ppm MS-222), checked for tag presence with a field sampling detector (Northwest Marine Technology), and measured. Fish in the untagged treatment were similarly anesthetized and measured at 3 and 30 days after tagging. Dead fish were removed from the tanks and checked for tag presence.

We assumed that mortality associated with tagging or handling would occur within 30 days of tagging (Szedlmayer and Howe, 1995). Therefore, after 30 days, fish in the untagged and control groups were combined and then randomly divided into two groups that received either the tagged or untagged treatment. This created a second trial of the experiment to evaluate CWT retention. Fish in the second trial were checked for tag retention at 3 and 30 days after tagging.

The entire experiment was repeated three times with fish from different culture facilities, resulting in three trials in which tag retention was evaluated for 30 days and three trials in which tag retention was evaluated for 30 and 60 days. Mean initial fish sizes varied among trials from 62 to 115 mm SL, and numbers of fish per treatment varied among trials from 24 to 76 (Table 1).

Table 1

Tag (coded wire) retention rates and fish survival rates at 3, 30, and 60 d after tagging for each treatment (tagged fish, untagged fish, and control fish) and fish sizes at the time of tagging. Starting no. = number of fish at the beginning of the experiment. Survival rates are from the start of the experiment until 3, 30, or 60 d after tagging. Standard length at the time of tagging is given as the mean with standard deviation in parentheses.

Trial	Treatment	Starting no.	Standard length (mm)	Tag retention rates (%)			Survival rates (%)		
				3-day	30-day	60-day	3-day	30-day	60-day
1	Tagged	26	92 (6.8)	100	100	100	100	92.3	92.3
	Untagged	24	95 (5.9)	—	—	—	92.3	92.3	—
	Control	26	94 (6.4)	—	—	—	100	100	—
2	Tagged	24	115 (9.7)	100	100	—	100	95.8	—
	Untagged	24	117 (9.6)	—	—	—	100	100	—
3	Tagged	76	62 (8.3)	98.6	92.0	85.4	98.7	67.1	63.1
	Untagged	76	59 (8.3)	—	—	—	100	93.1	—
	Control	75	59 (8.2)	—	—	—	100	81.3	—
4	Tagged	62	63 (9.2)	100	87.1	—	100	100	—
	Untagged	61	63 (9.2)	—	—	—	100	100	—
5	Tagged	74	74 (7.8)	100	95.8	95.8	98.6	98.6	98.6
	Untagged	75	71 (8.4)	—	—	—	98.7	98.7	—
	Control	75	75 (8.7)	—	—	—	100	100	—
6	Tagged	74	82 (10.1)	100	98.6	—	100	97.3	—
	Untagged	75	81 (9.4)	—	—	—	100	100	—
Overall	Tagged	—	71 (14.5)	99.8	95.6	93.7	99.6	91.9	84.7
	Untagged	—	73 (16.6)	—	—	—	98.5	97.4	—
	Control	—	72 (17.3)	—	—	—	100	93.8	—

Retention of internal anchor tags with external streamers

We evaluated retention of internal anchor tags with external streamers (disk and T-style) in 110–180 mm SL common snook. Tags with disk anchors (Model FM-89SL, Floy Mfg., Seattle, WA) consisted of a plastic 5 × 15 mm imprinted elliptical disk and 50-mm imprinted streamer. T-anchor tags (IEX tags, Hallprint Ltd., Holden Hill, Australia) consisted of an 18-mm T-shaped anchor and a 42-mm imprinted streamer. Equal numbers of fish were randomly assigned to one of three treatments: 1) fish tagged with disk anchor tags, 2) fish tagged with T-anchor tags, and 3) untagged fish that were handled in the same manner as tagged fish.

All fish were anesthetized (100 ppm MS-222) and measured just prior to treatment. To apply disk anchor tags, we used a scalpel to make an approximately 6-mm vertical incision into the body wall and then inserted the disk into the incision. To apply the T-anchor tags, we used a sharpened tag-applicator needle to make an approximately 2-mm diameter puncture and then inserted the T-anchor into the opening. Incisions were made on the left ventral side of the fish, anterior to the vent and posterior to the pectoral fin. Anchors were dipped in betadyne prior to insertion to minimize infection. Fish in the tag treatments were distinguished by fin clips: disk anchor-tagged fish received a left pectoral fin clip and T-anchor-tagged fish received a right pectoral fin clip. Fish in the untagged treatment were anesthetized, measured, and handled in the same manner as tagged fish but did not receive an incision or finclip. All fish were transferred immediately after treatment to a 13,300-L tank containing approximately 9,000 L of water. The tank was aerated and had sand, diatomateous earth, and biological filters. Water temperatures averaged 27°C (range: 24–29°C); salinity averaged 26 ppt (range: 11–30 ppt); dissolved oxygen averaged 6.5 ppm (range: 4.9–8.4 ppm), and pH averaged 7.8 (range: 7.7–7.9 ppm). Fish were fed live baitfish daily.

Fish were checked for tag retention at 14 and 30 days after tagging. At each tag check, fish were anesthetized (100 ppm MS-222), checked for tag and finclip presence, measured, and weighed. The entire experiment was repeated twice; numbers of fish per treatment varied between trials from 61 to 78 fish per treatment (Table 1). During the first trial, necropsies were performed on three to ten fish from each treatment after 14 days to evaluate a bacterial infection. Six of ten T-anchor-tagged fish examined had anchors that were inserted into the swim bladder, whereas all disk-anchor-tagged fish examined (n=3) had anchors that were correctly placed in the peritoneal cavity. Because of the potential for misapplication with the T-anchor tag, during the second trial we applied T-anchor tags by making a 3-mm scalpel incision rather than by making a puncture with a tag applicator needle. At the end of the second trial, ten randomly selected fish from each tag treatment were dissected and examined for tag implant locations and tissue healing.

Analyses

Estimates of the rates of tag retention and survival were arcsine-transformed prior to analysis (Sokal and Rohlf, 1981). Fish size at the time of tagging differed significantly among trials in both the CWT experiments (ANOVA, df=5, F=517.6, P<0.01) and in the internal-anchor-tag experiments (ANOVA, df=1, F=6.7, P<0.01). Therefore, mean size at tagging was used as a covariate in analysis of covariance (Sokal and Rohlf, 1981; SAS, 1989) to compare rates of tag retention, survival, and growth among time periods and treatment groups. Post hoc comparisons were conducted with the method of least-square means (SAS Institute, Inc., 1989).

Results

Overall, retention rates of coded wire tags averaged 99.8%, 95.6%, and 93.7% at 3, 30, and 60 days after tagging, respectively (Table 1). At 3 days, tag retention rates for all sizes of snook ranged from 98.6 to 100% (Fig. 1). Fish size at the time of tagging significantly affected tag retention rates (F=12.5, P<0.01); larger fish had higher retention rates, particularly during the 30- to 60-d period after tagging (Fig. 1). Tag retention of common snook >70 mm SL at the time of tagging was ≥95% at 30 and 60 days after tagging, whereas tag retention in snook <65 mm SL was 92.0% and 85.4% at 30–60 days after tagging, respectively (Table 1; Fig. 1). Tag retention rates decreased between 3 and 30 days after tagging (LSMEANS, P=0.02) but did not change significantly between 30 and 60 days (LSMEANS, P=0.89; Fig. 2).

Survival rates of CWT fish were not significantly different from those of the untagged or control fish (df=2, F=0.5, P=0.61). Survival rates of fish in all treatments averaged 99.6%, 91.9%, and 84.7% at 3, 30, and 60 days after tagging, respectively (Table 1). Poor survival of fish in the third trial (63%, Table 1) is attributed to parasitic infection. Growth rates of CWT fish were also not significantly different from those of untagged or control fish (df=2, F=0.87, P=0.42).

Overall, retention rates of T-anchor and disk-anchor tags averaged 100% and 99.2%, respectively, after 30 days (Table 2). Fish size at the time of tagging did not significantly affect internal anchor tag retention rates (df=1, F=0.3, P=0.64). Retention rates did not differ significantly between disk- and T-anchor–tagged fish or among time periods (for both comparisons, df=1, F=0.8, P=0.43). There were also no significant differences in survival (df=2, F=0.7, P=0.55) or growth (df=2, F=0.03, P=0.10) among treatments . Survival rates of T-anchor- and disk-anchor–tagged fish averaged 97.0 and 91.9% at 14 and 30 days after tagging, respectively (Table 2).

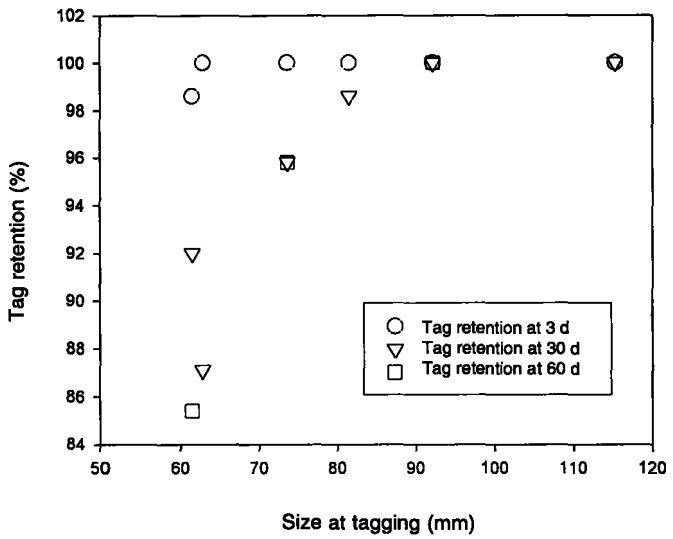

Figure 1

Retention rates of coded wire tags and average size (standard length) of juvenile snook at the time of tagging.

Nearly all (80%) fish with internal anchor tags examined at 30 days had inflammation or a proliferation of epithelial cells at the tag insertion site. Of the ten disk-tagged fish examined after the second trial, six fish had anchors encapsulated in the peritoneum, two fish had anchors inserted in the swim bladder or gastrointestinal tract, and two fish had anchors freely moving in the peritoneal cavity. Of the ten T-anchor–tagged fish examined, two fish had anchors encapsulated in the peritoneum, one had an anchor inserted in the swim bladder, and seven had anchors that were freely moving in the peritoneal cavity.

Discussion

The high retention rates of CWT's reported in this study (85–100%) indicate that CWT's are effective for marking age-0 common snook and that the cheek musculature is appropriate for tagging. CWT's did not affect snook survival or growth during the first 30–60 days after tagging, indicating that CWT's have negligible adverse effects during this time period. CWT retention rates increased with initial fish size (Fig. 1) from 87–92% for snook with an initial mean size of 62 mm SL to 95–100% for snook with initial mean sizes of 71–117 mm SL. Several authors have noted the importance of fish size or target tissue size in the retention of CWT's (Heidinger and Cook, 1988; Szedlmayer and Howe, 1995). Our study also shows a relation between initial tagging size and CWT retention.

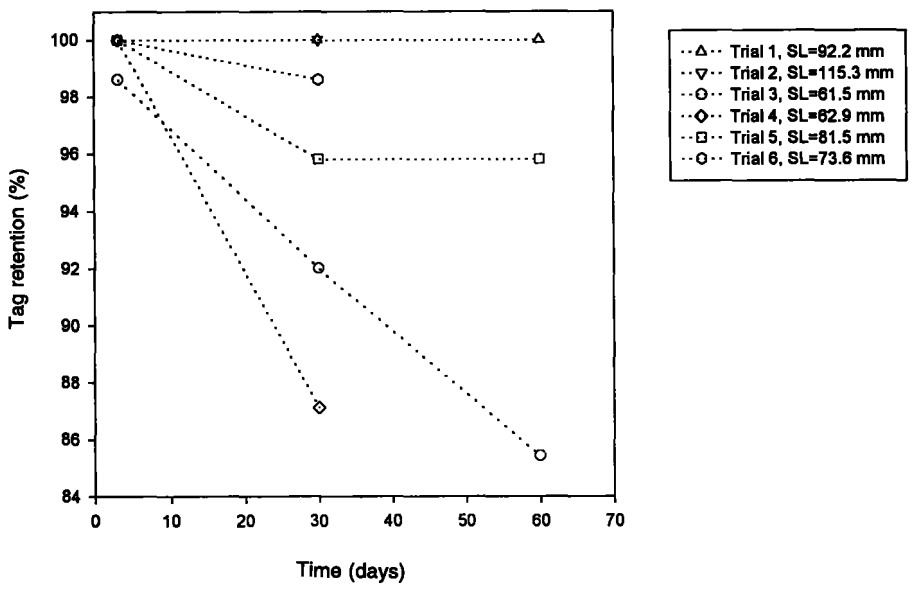

Figure 2

Retention rates of coded wire tags in fish 3, 30, and 60 days after tagging. The key shows mean initial size (SL) of fish in each trial.

Most tag loss occurred between 3 and 30 days (Fig. 2). Other studies have noted

Table 2

Internal anchor tag retention rates and fish survival rates at 14 and 30 d after tagging for each treatment (t-bar–tagged fish, disk-tagged fish, and control fish) and fish sizes at the time of tagging. Starting no. = number of fish at the beginning of the experiment. Survival rates are from the start of the experiment until 14 or 30 d after tagging. Standard length at the time of tagging is given as the mean with standard deviation in parentheses.

Trial	Treatment	Starting no.	Standard length (mm)	Tag retention rates (%)		Survival rates (%)	
				14-day	30-day	14-day	30-day
1	T-bar–tagged	78	139 (13.1)	100	100	93.6	93.6
	Disk-tagged	78	138 (13.0)	100	100	91.0	75.6
	Control	78	137 (13.7)	—	—	97.4	82.1
2	T-bar–tagged	61	135 (11.3)	100	100	100	100
	Disk-tagged	61	136 (10.4)	100	98.4	100	100
	Control	61	134 (10.7)	—	—	100	100
Overall	T-bar–tagged	—	136 (12.5)	100	100	96.8	96.8
	Disk-tagged	—	137 (11.9)	100	99.2	95.5	87.8
	Control	—	137 (12.6)	—	—	98.7	91.1

that most CWT loss in juvenile fish occurs within two to four weeks after tagging, the time period corresponding with the time required for the tagging puncture wound to heal (Dunning et al., 1990). Although there was no significant change in retention rates after 30 days, tag retention rates in the smallest fish (mean SL 62 mm) continued to decline between 30 and 60 days (Fig. 2), providing further evidence of the importance of fish size for tag retention.

Thirty-day retention rates of both types of internal anchor-external streamer tags were very high (>99%), indicating that these tag types are effective tools for marking >110 mm common snook. However, other studies have suggested that retention of disk- and T-anchor tags may decrease over months or years and should therefore be evaluated for longer periods of time (Collins et al., 1994). Although the incisions required to apply disk tags are larger than incisions required for T-anchor tags, there was no difference in survival or growth rates of fish with either tag type. Both tag types caused similar incidences of irritation at the tag insertion site. Similar irritation has been noted in other fish species and can eventually result in tag loss (Mattson et al., 1990; Collins et al., 1994). After 30 days, disk anchors were more frequently encapsulated and attached to the inside of the body wall than were T-anchors. Both tag types were equally likely to be incorrectly inserted in the swim bladder or gastrointestinal tract when the incision was made with a scalpel; overall, incorrect insertions were noted in 10–20% of the fish examined. We recommend using scalpels to insert the T-anchor tags; when a tag applicator needle was used, incidences of incorrect insertion increased to 60%, probably because of difficulty in controlling puncture depth.

In conclusion, because CWT retention rates were significantly improved for fish >70 mm SL, we recommend tagging snook at this size whenever possible. We also recommend that CWT retention in snook be evaluated for 30 days after tagging so that accurate estimates of tag-loss rates can be calculated. For snook >110 mm SL, both the T-anchor and disk internal anchor-external streamer tags were effective marking techniques. For all types of tags and all sizes of fish in our study, tagging did not significantly affect snook survival or growth.

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