COMPARISON OF INTERNAL ANCHOR TAGS AND FLOY FT-6B DART TAGS FOR TAGGING SNOOK, *Centropomus undecimalis*

Snook, *Centropomus undecimalis* (Bloch), have been tagged in the Naples-Marco Island region of southwest Florida since 1975 to study movement, growth, and population dynamics. Dart tags were originally selected for use because application was swift, easy, and produced a small wound, thereby reducing possible stress and infection. Also, the external streamer was thought to be highly visible to anglers. Operations in 1975 were primarily a trial of capture and tagging procedures; only 107 fish were tagged. Two tags were returned by anglers within a year of tagging (1.9% return). I did not consider the return rate unusual because sample size was small, and a similar study of snook by Volpe (1959) resulted in a comparable return rate (2.9% overall return rate).

After one month of tagging in 1976, separation of the polyvinylchloride (PVC) streamers from darts became apparent. Tag separation and/or low retention rates of similar tags have been reported by Armstrong and Blackett (1966), Latapie (1966), Wilbur and Duchrow (1973), and Davis (1978). The loss of marks or tags may seriously bias population statistics (Ricker, 1975). Therefore, internal anchor tags were subsequently applied, either alone or in conjunction with dart tags, to assess the magnitude of dart tag failure.

METHODS

Snook were caught in a 300 m haul seine during the summer spawning season along open sandy beaches where fish congregate in large schools (Marshall, 1958; Volpe, 1959). They were transferred to v-shaped, padded cradles, tagged, measured, and released. Factors that may have been ultimately detrimental to a fish's health were noted.

Dart tags (Model FT-6B; Floy Tag and Mfg., Seattle, Wash.) consisted of a double-barbed nylon dart with a 25 mm shaft joined to a 140 mm PVC streamer with a cyanoacrylate adhesive (Eastman Chemical International, Kingsport, Tenn.). Internal anchor tags were oval plastic discs (32 x 8 mm; Howitt Plastics, Molalla, Ore.) with a 100 mm streamer inserted through a hole in the center of the disc. Each tag was imprinted with information to anglers, a reward notice and tag number.

Many dart tags were structurally defective when received from the manufacturer. Common defects were inadequate bonds between streamers and nylon darts, and barbs too short to have anchored effectively among the pterygiophores. Therefore, each tag was inspected and given a gentle pull (< 1 kg) to reduce the number of defective tags deployed. The pull was not sufficient to weaken a sound bond (confirmed by Margaret Anderson, Floy Tag and Mfg.) but would reveal obviously defective tags.

Dart tags were inserted into the left side below the soft dorsal fin at an angle that would allow barbs to anchor among pterygiophores. Internal anchor tags were inserted into the body cavity through an incision in the ventral musculature. The streamer protruded from the incision. Antiseptics or sutures were not used.

RESULTS

A total of 1734 tagged snook were released in 1976 and 2163 in 1977 (Table 1). Defective dart tags comprised between 2 and 22% of each tag batch tested upon receipt from the manufacturer ($\bar{x} \pm$ s.d., $9.2\% \pm 1.7\%$). The mean number of days fish were free with various tags intact suggests that widespread separa-

TABLE 1. Summary of snook tagging and recapture data, 1976 and 1977, Naples-Marco Island region of southwest Florida.

	Tag Type	Number Tagged	Number Returned ($\leq$ 1 year)	Percentage Returned ($\leq$ 1 year)	Mean and Range of Days at Liberty
	Dart	1455	37	2.5	22.1 (0-145)
	Dart plus		dart intact-6	11.8	17.7 (2-47)
1976	Internal	102	dart lost*-6		
	Internal	177	25	14.1	162.5 (95-289)
	Total	1734	74	4.3	117.4 (0-323)
1977	Internal	2163	234	10.8	

*separation or total loss

tion of apparently sound dart tags occurred within a few weeks of tagging (Table 1). Only one fish bearing an intact dart tag was recaptured and reported more than 47 days after release (at 145 days); by contrast 122 internal anchor tags were reported from fish at liberty 317 to 816 days.

Anglers returned a total of 74 tags in one year following tagging in 1976 (4.3% overall return; Table 1), but internal anchor tags were returned in a significantly greater proportion ($P < 0.01$) than dart tags (Table 2). Returns of internal anchors and internal anchors plus darts were not significantly different.

On 7 June 1976 approximately equal numbers of dart and internal anchor tags were deployed among 470 fish from a single school. The returns from fish tagged with internal anchors on this day were also significantly greater ($P < 0.01$) than from fish tagged the same day with dart tags (Table 3).

Estimates of dart tag loss (separation plus total loss) rely upon the assumption that internal anchor tag returns represent true fishing and return rates. The overall return rate from internal anchor tags applied in 1976 (13.3%) and 1977 (10.8%) indicates a minimum loss of between 75 and 81% of all dart tags deployed.

DISCUSSION

Although several factors may have contributed to some extent to disproportionate returns of dart and internal anchor tags, it does not appear that any factor or combination was as detrimental as dart tag separation. Massive tagging mortality or aberrant behavior among fish tagged with darts is unlikely. Anglers and tagging personnel have recaptured many snook that retained a firmly anchored monofilament dart (without streamer) after more than one year at liberty, but no

TABLE 2. Chi-square tests for significant differences in return rates of dart and internal anchor tag combinations released 10 May to 9 July 1976, using internal anchor tag return rate as the standard for expectation.

Tag Type	Number Released	Number Returned (Observed)	Percentage Returned	Number Expected
Dart	1455	37	2.5	205.5
Dart plus Internal	102	12	11.8	14.4
Internal	177	25	14.1	—

χ^2 (darts) = 138.16** (Tabular χ^2, 1df, ($P < 0.01$) = 6.63)
χ^2 (darts + internals) = 0.40 n.s.

TABLE 3. Chi-square tests for significant differences in return rates of dart and internal anchor tag combinations released 7 June 1976, using the internal anchor tag return rate as the standard for expectation.

Tag Type	Number Released	Number Returned (Observed)	Percentage Returned	Number Expected
Dart	222	6	2.7	31.7
Dart plus Internal	73	8	11.0	10.4
Internal	175	25	14.3	—

χ^2 (darts) = 20.84** (Tabular χ^2, 1df, ($P < 0.01$) = 6.63)
χ^2 (darts + internals) = 0.55 n.s.

complete dart tags were found among nearly 2200 snook examined in 1977. It is also improbable that a significantly large number of intact dart tags would have been unreported by anglers. Publicity about the program was extensive and emphasized dart tags and rewards paid for their return. Use of internal anchor tags was not publicized in 1976 and returns nonetheless exceeded 12%. Finally, the tagging on 7 June effectively reduced many forms of possible bias to a minimum. If the probability of recapture was independent of tag type, return rates for each type released on 7 June should have been equivalent. The significantly different return rates imply that tag type was the primary factor responsible for differential rates.

Separation of dart tags may be the result of properties inherent in materials used to make the tags, quality control methods employed by Floy, or a combination of the factors. The cyanoacrylate adhesive used to attach the PVC streamers to nylon darts forms a bond that will ". . . weaken with time in hot, humid environments" (Eastman Kodak Company, 1977). Furthermore, ". . . bonds in which both materials are rigid substances such as. . . thermosetting plastics probably should not be used outdoors continuously unless the edges of the bonded area are sealed against moisture" (Eastman Kodak Company, 1977). The non-uniform diameter of the nylon shaft may therefore allow penetration of moisture into the bonded area because "cyanoacrylate adhesives have very limited gap-filling ability" (Eastman Kodak Company, 1977). Floy Tag's quality control was performed by pulling the tag as I had done, but with considerably more force. This testing may have fractured a sound bond without causing the tag to fail (Margaret Anderson, Floy Tag and Mfg., personal communication), and thereby increased susceptibility to moisture intrusion and ultimate failure of the bond.

Loss of a great quantity of data, time, money, and effort in this study suggests that anyone who desires to use dart tags should thoroughly test the desired tag model under conditions similar to those expected in the field situation, prior to initiation of a large-scale project.

LITERATURE CITED

Armstrong, R. H. and R. F. Blackett. 1966. Use and evaluation of dart tags to study the migration habits of dolly varden, *Salvelinus malma* (Walbaum). Trans. Am. Fish. Soc. 95(3):320-323.

Davis, G. E. 1978. Field evaluation of a tag for juvenile spiny lobsters, *Panulirus argus*. Trans. Am. Fish. Soc. 107(1): 100-103.

Eastman Kodak Company. 1977. The *Eastman 910* adhesives. Kingsport, TN. 19 p. (Publ. No. PA-16B).

Latapie, W. R., Jr. 1966. Evaluation of various tagging methods on several

freshwater fishes and estuarine fishes of Louisiana. M. S. Thesis, Louisiana State Univ., Baton Rouge, LA. 47 p.

Marshall, A. R. 1958. A survey of the snook fishery of Florida, with studies of the biology of the principal species, *Centropomus undecimalis* (Bloch). Fla. Board Conserv. Mar. Res. Lab. Tech. Ser. 22. 39 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Bull. Fish Res. Board Can. 191. 382 p.

Volpe, A. V. 1959. Aspects of the biology of the common snook, *Centropomus undecimalis* (Bloch) of southwest Florida. Fla. Board Conserv. Mar. Res. Lab. Tech. Ser. 31. 39 p.

Wilbur, R. L. and R. M. Duchrow. 1973. Differential retention of five Floy tags on largemouth bass *(Micropterus salmoides)* in hatchery ponds. Proc. 26th Ann. Conf. Southeast. Assoc. Game Fish Comm., 1972: 407-413.

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