# An estimate of the tag-reporting rate of commercial shrimpers in two Texas bays

**R. Page Campbell**
**Terry J. Cody**
Texas Parks and Wildlife Department
100 Navigation Circle, Rockport, Texas 78382

**C.E. Bryan**
**Gary C. Matlock**
**Maury F. Osborn**
**Albert W. Green**
Texas Parks and Wildlife Department
4200 Smith School Road, Austin, Texas 78744

Tag return rates are used to estimate exploitation rates for many animal species including penaeid shrimp. To avoid systematic underestimation of exploitation, the number of tagged animals recaptured but not reported must be reliably estimated (Paulik 1963, Youngs 1972, Seber 1973). Some investigators have offered rewards for tags to increase the tag return rate, but have incorrectly assumed that all or nearly all harvested tagged animals were reported (Kutkuhn 1966) or the rate of non-reporting remained the same throughout the experiment (Klima 1974, Kutkuhn 1966). Studies to measure the reporting rate of commercially-caught shrimp were conducted by Klima (1974) and Johnson (1981). The numbers of shrimp placed in both studies were small ($n$ 71 and 20, respectively) and return rates differed markedly (82% and 10%, respectively). One drawback of these studies is that tagged shrimp were placed into the catch at shrimp houses or in the final processing stages, and not on the vessel during shrimping operations. Therefore, return rates during fishing operations were not measured.

Accurate reporting rates for recovered tags are essential for the determination of fishing mortality rates. The objective of the present study was to determine reporting rates of tagged shrimp captured during regular shrimping operations. To that end, tagged shrimp were surreptitiously placed in unculled catches. The reporting rates determined in this study are intended for use in correcting fishing-mortality estimates generated from a tagging program conducted during the same period.

## Materials and methods

Texas Parks and Wildlife Department (TPWD) personnel placed tagged shrimp in the catch aboard Galveston and Aransas Bays' commercial bay and bait shrimp boats, May–November 1984. TPWD personnel and game wardens boarded shrimp vessels during bay shrimping operations. While a game warden distracted the crew by checking licenses, other TPWD personnel placed a single tagged shrimp in unculled catches (on deck) or in a live bait box. To conceal surreptitious placement of shrimp, 20 individuals of the target species *Penaeus aztecus* or *P. setiferus* were measured to the nearest mm total length (TL) on each vessel. A total of 219 shrimp (115 brown and 104 white) were surreptitiously placed aboard vessels in Aransas ($n$ 125) and Galveston ($n$ 94) Bay systems during the study period. No more than 12 shrimp were surreptitiously placed in each bay system in any one week.

Each tag was a uniquely-numbered black vinyl streamer (95mm long × 4mm wide) tapered at each end (Klima et al. 1987). Each tag was inserted between the second and third abdominal segments of the shrimp. Shrimp in Aransas Bay were measured (TL) prior to placement and after being returned by the fisherman. Since lengths were not required in the original study, measurements were not recorded in Galveston Bay. Lengths of shrimp placed in the catches and lengths of shrimp returned by fishermen were compared using student's $t$-test. Also, length frequencies of measured shrimp on commercial boats ($n$ 2402) and of shrimp surreptitiously placed ($n$ 105) aboard boats were compared visually using length-frequency histograms.

As part of a larger bay shrimp-tagging program conducted jointly by the TPWD and the National Marine Fisheries Service (NMFS), rewards were offered for tag returns. The program was promoted by distribution of posters to area shrimp dealers and through newspaper articles. No information was provided to the public concerning the surreptitious tagging activity.

Reporting rates ($n$ reported/$n$ placed, expressed as percent) were estimated for each species and bay system. Reporting rates and confidence intervals were estimated for the two bay systems combined. Reporting rates between species and between bay systems were compared using a Chi-square test (Sokal and Rohlf 1981).

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## Results

Overall, 16% (95% CI, 11–21%) of 219 tagged shrimp were returned (Table 1). The return rate of 21% for brown shrimp was greater than the 11% for white shrimp ($\chi^2$ 4.415, 1df, $P \leq 0.05$). Reporting rates did not differ between bay systems for brown shrimp ($\chi^2$ 2.081, 1df, $P > 0.05$) or white shrimp ($\chi^2$ 1.059, 1df, $P > 0.05$). Reporting rates for the two species of shrimp were similar in Galveston Bay ($\chi^2$ 0.001, 1df, $P > 0.05$); in Aransas Bay, reporting rates were greater for brown shrimp ($\chi^2$ 6.890, 1df, $P \leq 0.05$). Sixty-eight percent of shrimp returned were reported found on the same day as placement.

Mean lengths of placed and returned brown shrimp from Aransas Bay were similar ($t$ −0.48, $P > 0.05$) (Fig. 1), while the mean length of placed white shrimp was smaller than the mean length of those returned ($t$ −4.01, $P \leq 0.05$). Placed brown shrimp were similar in length to those measured from the unculled catches on commercial shrimp boats (Fig. 2) whereas placed white shrimp were clearly smaller than those measured on commercial boats.

## Discussion

Tag reporting rates for bay-caught shrimp have been reported by Klima (1974) and Johnson (1981). Tag reporting rates presented in this study are more precise because sample sizes were larger than in previous studies. Moreover, tag return rates in this study are more realistic because the tagged shrimp were placed in the catch before any processing occurred, rather than at dockside during the final processing stages.

**Table 1**

Number and percent of tagged *Penaeus* shrimp surreptitiously placed on shrimp boat decks which were found and returned to TPWD.

| Species | Bay system | No. tagged | Returned | |
|---|---|---|---|---|
| | | | *n* | % |
| *P. aztecus* (brown shrimp) | Galveston | 43 | 6 | 14 |
| | Aransas | 72 | 18 | 25 |
| | Total | 115 | 24 | 21 |
| *P. setiferus* (white shrimp) | Galveston | 51 | 7 | 14 |
| | Aransas | 53 | 4 | 8 |
| | Total | 104 | 11 | 11 |
| Combined species | Galveston | 94 | 13 | 14 |
| | Aransas | 125 | 22 | 18 |
| | Total | 219 | 35 | 16 |

The detection rate, and thus the reporting rate, of tagged shrimp in unculled catches may be influenced by size of tagged shrimp relative to size of other shrimp in the catch and by overall volume of catch being processed. In the fall shrimping season (15 August–15 December), there are no restrictions on the amount of shrimp that can be retained. During 15 August–31 October, when white shrimp dominate the catch, the minimum shrimp count size is 50 (heads-on) per pound in major Texas bays (State of Texas 1987–88). Thus, commercial fishermen selectively retain larger shrimp during this interval. Since the TPWD gear used to collect white shrimp for tagging was relatively non-selective, surreptitiously-placed shrimp in Aransas Bay were smaller than those in the catch in which they were placed. In contrast, brown shrimp dominated the catch in summer when there was no count size restriction, and thus placed shrimp were similar in size to those in the commercial catch. Because the placed white

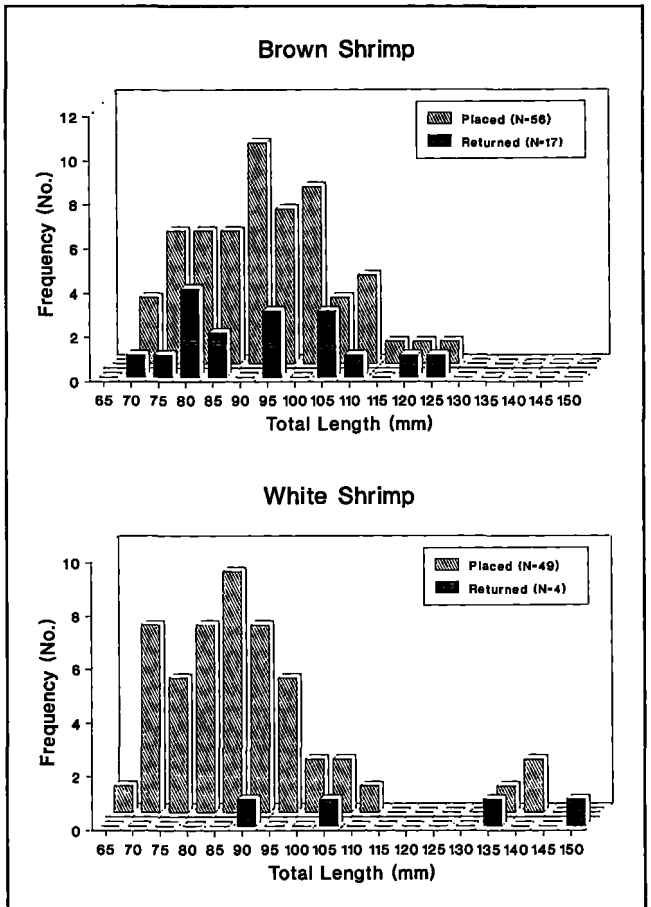


**Figure 1**

Length-frequency (TL) of surreptitiously-placed brown and white shrimp, and of returned brown and white shrimp from Aransas Bay, May–November 1984.

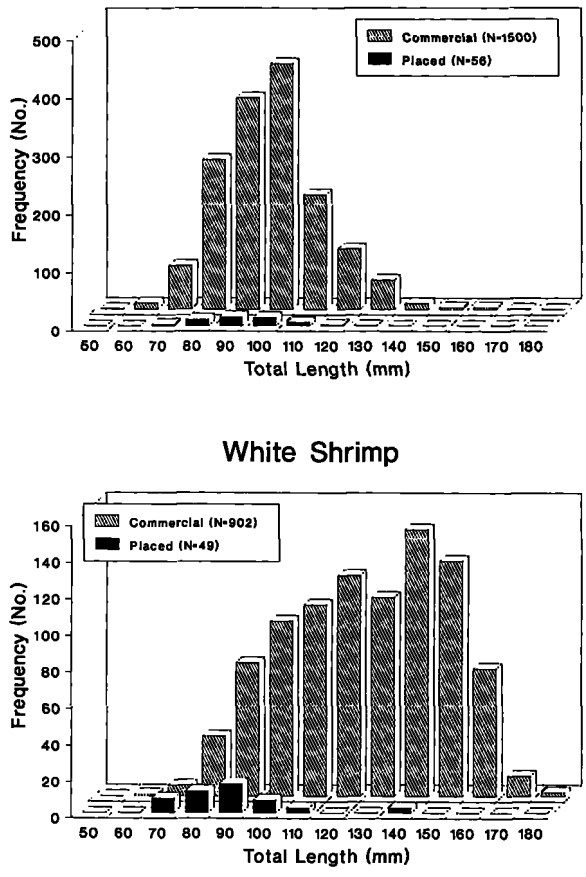


**Figure 2**
Length-frequency histograms of brown shrimp and white shrimp measured in commercial catches, and of tagged shrimp surreptitiously placed aboard boats in Aransas Bay, May–November 1984.

shrimp were smaller than those in the commercial catch, they may have been more difficult to detect and hence, were reported at a lower rate than if they had been similar in size to those in the commercial catch. The overall reporting rate with these white shrimp excluded was 19% (95% CI, 13–26%) which is similar to the reporting rate for brown shrimp (21%). Tagged and untagged brown shrimp sizes were similar.

Complete return of tags cannot be assumed even if rewards are offered. All tags used in the present study were potential reward tags ($50–500) inserted into the shrimp and placed into unculled shrimp catches; however, only 19% of these shrimp were reported. Past studies have relied on the use of monetary incentives to promote the return of tags. Rawstron (1971) determined that some reward tags in his fish-tagging study were not returned, but believed that this number was negligible. Likewise, Kutkuhn (1966) assumed low non-reporting rates for reward tags. Published estimates of tag-return rates for fish generally have ranged between 55 and 65%, with rewards. Green et al. (1983) reported much lower return rates by saltwater recreational anglers (29%) than had previously been estimated, and that rates differed among species and areas. Therefore, even with rewards, complete or high reporting rates cannot be assured.

Previous studies have relied on public-information dissemination plans to achieve high reporting rates of reward and non-reward tags. Matlock (1981) found that 83% ($n$ 102) of the anglers not reporting tags in their catch knew about TPWD tagging programs, and that 78% of these anglers failed to find the tag. This suggests that public-information programs cannot assure high reporting rates. Even if fishermen are aware of tagging programs, they may not report recaptured tags if these programs have continued over a long period. The shrimp fishery in Texas had been subjected to frequent tagging experiments during the previous 10 years, and the shrimp fishermen's enthusiasm for reporting tags may have decreased. However, there are no data to examine this possibility.

Tag-return rates can be affected by many factors. Each tagging study that depends on volunteer tag returns would be enhanced by a concurrent estimate of non-reporting rates. This would improve estimates developed from returned tags. For example, during the tagging program conducted during the same period as this study, there were 2% of 25,870 released tagged shrimp returned (Peng Chai, TPWD, Austin, pers. commun.). If the reporting rate had been assumed to be 100% rather than the observed 19%, fishing mortality would be overestimated about five times.

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