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# Survival and Movement Patterns of Released Tarpon (*Megalops atlanticus*)

Randy E. Edwards
*Mote Marine Laboratory*

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# Survival and Movement Patterns of Released Tarpon (*Megalops atlanticus*)

RANDY E. EDWARDS

**Survival of tarpon caught and released by anglers near Boca Grande Pass in Southwestern Florida was assessed by sonic tracking. Dart tags attached to ultrasonic transmitters were applied to tarpon just before release. The tarpon were tracked for 1.1–12.1 hr (mean = 4.8 hr), until a corrodible magnesium link allowed the transmitter to detach and float to the surface. Twenty-six of 27 (96.3%) tarpon survived, as determined by continued movement of the fish during the tracking. Fourteen of 25 fish that were caught in Boca Grande Pass remained in the pass, 7 moved into the Gulf of Mexico, and 4 moved into Charlotte Harbor. Swimming speed ranged from 1.8 to 2.9 knots (mean = 2.4 knots) and was not related to time (after release) or size. The high survival rate may be at least partially attributable to local angling techniques and handling practices.**

The tarpon (*Megalops atlanticus*) has long been a prized game fish throughout the Gulf of Mexico, the Caribbean, and the tropical western Atlantic (Breder, 1944; Robins, 1977). Tarpon, not highly valued as a food fish but esteemed as a sport fish, are usually released after being caught by anglers. In Florida, a state regulation implemented in 1989 requires that any angler or guide wanting to keep a tarpon purchase a $50 permit in advance. The extent to which this regulation is effective is dependent on the extent to which caught and released tarpon survive or, conversely, on the extent to which release mortality is low. The importance of release morality in fishery management has recently been recognized for many fisheries (e.g., Waters and Hunstman, 1986; Bugley and Shepherd, 1991; Muoneke and Childress, 1994; Edwards and Berkeley, 1999). The goal of this study was to assess release mortality of tarpon that are caught in one of Florida's largest recreational tarpon fisheries.

## METHODS

The study area was on the southwestern coast of Florida and included Boca Grande Pass, the adjoining nearshore Gulf of Mexico, and the northern portion of Charlotte Harbor (Fig. 1). This area is famous for its tarpon fishing, and on good days during the main season (early to mid-summer), dozens of tarpon are caught in the immediate area of Boca Grande Pass, providing a source of released fish for study purposes.

Release mortality was assessed by attaching acoustic transmitters to tarpon immediately before release and tracking the fish for several hours, with continued movement indicating survival. Ultrasonic transmitters (16 × 66 mm, Model XTAL-87, Sonotronics, Tuscon, AZ) were attached to the monofilament streamer of a stainless steel dart tag (FH-69, Floy Tag, Seattle, WA). A small fluorescent orange styrofoam float (17 × 74 mm) was attached to the other end of the transmitter. The float caused the transmitter to float to the surface when it detached from the tarpon. A small spring-loaded magnesium corrodible link was located between the dart tag filament and the transmitter. The link released the transmitter and float at a time (nominally 3–12 hr) that was roughly determined by the thickness of a small magnesium strip. The thickness of the strip could be adjusted by sanding or filing it. The release link allowed the transmitter to be retrieved when it floated to the surface during tracking and permitted it to be reused. Detachment of the transmitters also prevented confusion that might have occurred if previously acoustically tagged tarpon had been encountered. The release mechanism varied (± 1.5 hr) with regard to intended retention time and is not described in further detail.

Fish were tagged with a transmitter tag mounted on a standard tagging stick. All tarpon were tagged by insertion of a dart into the dorsal muscle below the dorsal fin. The tagging procedure did not delay the release by more than a few seconds. Since most guides and anglers in the Boca Grande area use dart tags to tag all or most of the tarpon that they catch and release, the utrasonic tagging did not introduce any additional handling or delay.

To obtain information that might be relevant to survival rates of the released tarpon,

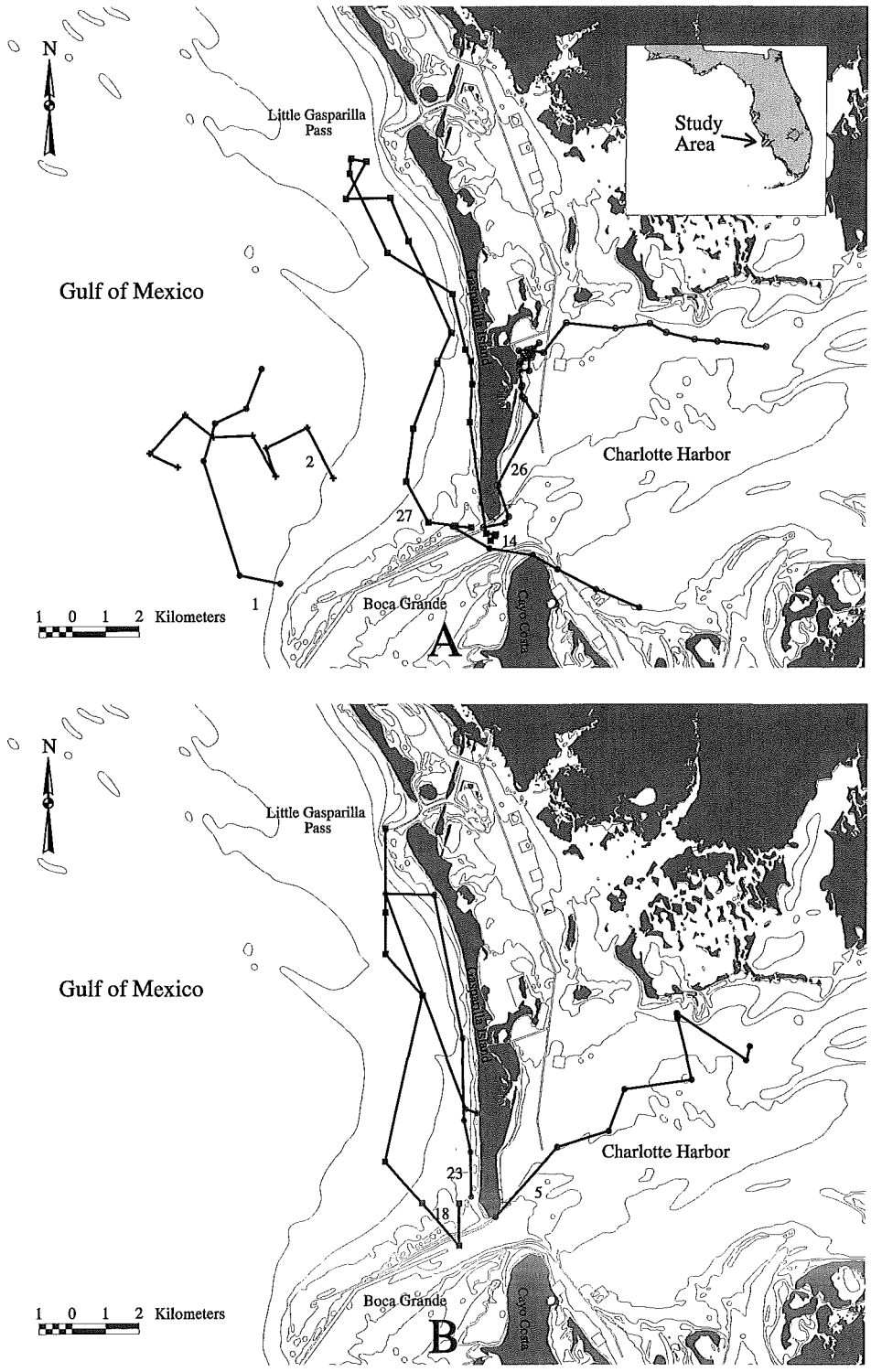


Fig. 1. Tracks of tarpon that moved away or were released away from Boca Grande Pass. (A) Tarpon 1, 2, 14, 26, and 27. (B) Tarpon 5, 18, and 23. (C) Tarpon 7 and 9. (D) Tarpon 12, 19, and 24. Tracks are labeled nearest their starting points.


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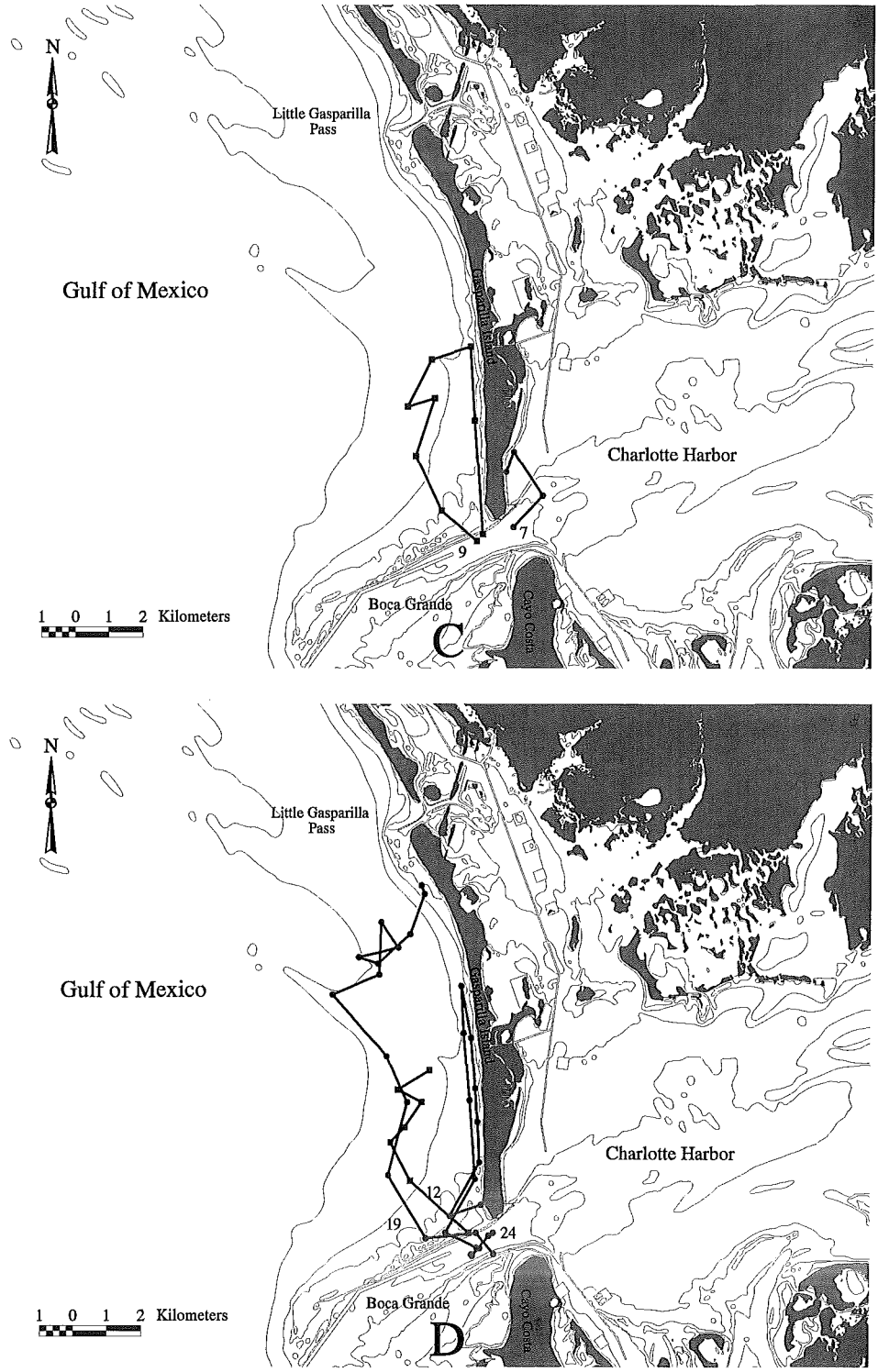


Fig. 1. Continued.

TABLE 1. Tarpon release mortality data summary.

| Fish no. | Date (1991) | Start (hr:min) | Stop (hr:min) | Time (hr:min) | Track[a] | Result[b] | Weight (lb) | Boat[c] | Line (# test) | Fight (min) | Hook[d] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 05/25 | 16:23 | 17:50 | 01:27 | O (N, E, N) | S | 75 | P | 15 | 75 | J (OJ) |
| 2 | 05/26 | 11:00 | 14:00 | 03:00 | O (N, W, S) | S | 155 | G | 40 | 75 | H (UJ) |
| 3 | 05/28 | 11:00 | 13:40 | 02:40 | P–RP | S | 100 | G | 80 | 15 | H (UJ) |
| 4 | 05/28 | 15:00 | 18:40 | 03:40 | P–RP | S | 130 | G | 80 | 15 | H (J) |
| 5 | 05/29 | 10:18 | 12:55 | 02:37 | P–CH (NE) | S | 100 | P | 30 | 75 | J (OR) |
| 6 | 05/29 | 15:10 | 18:10 | 03:00 | P–RP | S | 100 | G | 80 | 22 | H (J) |
| 7 | 05/30 | 10:33 | 12:00 | 01:27 | P–CH (N) | S | 65 | G | 80 | 18 | H (J) |
| 8 | 05/30 | 15:57 | 17:52 | 01:55 | P–RP | S | 100 | G | 80 | 22 | H (UJ) |
| 9 | 06/04 | 10:50 | 14:50 | 04:00 | P–GG–P | S | 120 | G | 80 | 20 | H (J) |
| 10 | 06/05 | 09:40 | 12:14 | 02:34 | P (E, W)–RP | S | 60 | G | 80 | 15 | H (J) |
| 11 | 06/05 | 14:32 | 16:49 | 02:17 | P–RP | S | 50 | G | 80 | 10 | H (J) |
| 12 | 06/06 | 09:53 | 11:42 | 01:49 | P–GG (N) | S | 95 | G | 80 | 15 | H (J) |
| 13 | 06/13 | 09:35 | 13:13 | 03:38 | P–RP | S | 60 | G | 80 | 15 | H (J) |
| 14 | 06/13 | 14:10 | 16:10 | 02:00 | P–CH (SE) | S | 80 | BG | 25 | 20 | J (OJ) |
| 15 | 06/14 | 09:50 | 12:05 | 02:15 | P–RP | S | 150 | P | 25 | 40 | J (OJ) |
| 16 | 06/14 | 16:25 | 19:15 | 02:50 | P–RP | S | 60 | P | 50 | 15 | ND |
| 17 | 06/17 | 08:48 | 16:15 | 07:26 | P–RP | S | 60 | P | 30 | 20 | J (J) |
| 18 | 06/19 | 10:11 | 12:58 | 02:47 | P–GG (N) | S | 140 | BG | 30 | 33 | J (J) |
| 19 | 06/19 | 13:56 | 18:15 | 04:19 | P–GG (N) | S | 145 | G | 80 | 20 | H (J) |
| 20 | 06/20 | 14:30 | 15:36 | 01:06 | P–RP | S | 75 | G | 80 | 15 | H (UJ) |
| 21 | 06/21 | 10:32 | 18:01 | 07:29 | P–RP | S | 50 | G | 50 | 20 | H (J) |
| 22 | 06/28 | 07:12 | 15:07 | 07:55 | P–RP | S | 70 | G | 80 | 15 | H (J) |
| 23 | 07/03 | 08:38 | 15:41 | 07:03 | P–GG (N, S) | S | 80 | G | 80 | 10 | H (UJ) |
| 24 | 07/05 | 08:15 | 19:40 | 11:25 | P–GG–P | S | 80 | G | 80 | 10 | H (UJ) |
| 25 | 07/07 | 09:42 | 14:40 | 04:58 | P–GG (NW) | M | 120 | BG | 30 | 15 | J (J) |
| 26 | 07/08 | 08:04 | 20:11 | 12:07 | P–CH (N, E) | S | 40 | G | 30 | 10 | J (UJ) |
| 27 | 07/12 | 08:25 | 14:51 | 06:26 | P–GG–P | S | 90 | G | 80 | 10 | H (UJ) |

[a] Tracks indicate general movement patterns (and directions) as follows: P = Boca Grande Pass; O = offshore; RP = remained in pass; GG = along Gulf side of Gasparilla Island; CH = Charlotte Harbor.

[b] S = survived; M = mortality.

[c] Boats were classified as follows: G = guide; BG = backcountry guide; P = private.

[d] Types of hooks: H = single hook; J = jig. Location of hook: UJ = upper jaw; J = jaw (exact location not determined); OJ = outside of jaw; OR = orbit; ND = not determined.

the guide or angler was immediately interviewed regarding estimated size (weight), duration of fight (time from hookup to release), tackle (line class), type of bait or lure, and hook location and removal. Most of the professional guides released tarpon by manually breaking the wire leader, leaving the hook in the fish. Fish caught using artificial lures (leadhead jigs) or monofilament leaders or by unguided anglers were brought to the boat, where the hooks were removed or the leader was cut near the hook or lure.

We tracked tarpon from a small (7 m) boat using two parabolic directional hydrophones (Sonotronics DH-2) and two receivers (Sonotronics USR-4D). One hydrophone was rigged on each side of the boat to provide stereophonic determination of the transmitter position relative to the boat, as described in Edwards and Berkeley (1999). Position (latitude and longitude) during the tracking was determined by Loran-C.

## RESULTS

A total of 27 tarpon were tagged and tracked (Table 1). The estimated size of the tarpon ranged from 40 to 150 lb (18 to 68 kg) and averaged 85 lb (38 kg). The tarpon had been fought for 10–75 min (mean = 22 min) before release. Nineteen of the tarpon had been caught using live bait on single hooks, and eight were caught on jigs with single hooks. Twenty-two tarpon had been hooked inside the mouth in the jaw, three on the outside of the jaw, and one outside the orbit, and hook location was not determined for one fish. All four of the fish hooked on the outside of the mouth had been hooked on jigs. All fish caught from pass guide boats were hooked in the central junction of the maxillae and were released by breaking the leader while the fish was swimming next to the boat. The hooks and lures were removed prior to release of all fish caught on jigs.


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Twenty-six of 27 tarpon were swimming and behaving "normally" at the end of tracking periods that ranged from 1.1 to 12.1 hr (mean = 4.8 hr). One tarpon was obviously behaving abnormally immediately after release. It jumped or thrashed at the surface several times during the first few minutes after release, stayed within 200 m of the release location, and ceased movement 1.5 hr after release. This fish was found about 100 m west of the release location, floating belly-up at the surface but still alive (opercular moments could be seen), 2.6 hr after release. It was followed, as it drifted with the tide, for an additional 2.4 hr, at which time all opercular movements ceased. Therefore, release mortality during the tracking period was 3.7% (1/27). The binomial 95% confidence interval (Zar, 1984) for 1/27 is 0.1%–19.0%.

Most of the tarpon swam with the tide for a few minutes after release, appeared to gradually but quickly regain strength, and then often turned back against the tidal current. Eleven of the 25 tarpon caught within Boca Grande Pass left the immediate area of the pass after being released, while 14 remained in the pass during the entire tracking period. Of the 11 tarpon that left the pass, 7 moved into the Gulf and 4 moved into Charlotte Harbor. The tracks of the fish that left or were caught outside the pass are shown in Figure 1. Movements and positions of the fish that stayed in the pass could not always be determined precisely because of the swift current, background noise, interfering boat traffic, and multiple echoes from the hard and irregular bottom.

Three of the fish (tarpon 9, 24, and 27) that left the pass were eventually tracked all the way back to the pass. Tarpon 23 was tracked back to about 500 m from the pass, at which time tracking ended due to transmitter release. Tarpon that entered the Gulf of Mexico from the pass all moved northward along Gasparilla Island, but none moved farther than the northern tip of the island (12.5 km from Boca Grande Pass), where they tended to mill around offshore or slightly south of Gasparilla Pass until they began moving consistently back southward toward Boca Grande Pass.

Swimming speed (as estimated from the movement and position of the boat) of the tarpon in open water usually was in the range of 1 to 4 knots. Average speed (Table 2) over relatively straight and long portions of some of the tracks ranged from 1.8 to 2.9 knots.

TABLE 2. Average speeds of nine tarpon over portions of their tracks in which position and speed could be accurately estimated. Distance and time are summed for a series of continuous segments of the track.

| Fish no. | Segments (n) | Distance (nautical miles) | Time (hr) | Average speed (knots) |
|---|---|---|---|---|
| 1 | 4 | 3.43 | 1.25 | 2.74 |
| 2 | 7 | 4.08 | 1.78 | 2.29 |
| 5 | 4 | 3.32 | 1.28 | 2.59 |
| 9 | 6 | 4.56 | 2.10 | 2.17 |
| 12 | 3 | 2.01 | 0.95 | 2.11 |
| 18 | 6 | 6.44 | 2.33 | 2.76 |
| 23 | 3 | 4.00 | 2.28 | 1.75 |
| 24 | 9 | 7.06 | 3.22 | 2.19 |
| 27 | 14 | 10.13 | 3.48 | 2.91 |
| Total | 56 | 45.02 | 18.68 | 2.41 |

## DISCUSSION

These results indicate that mortality is low for tarpon caught and released using techniques similar to those used at Boca Grande. The low mortality rate may be attributable largely to angling and handling techniques. All of the so-called "pass guides" use styles and sizes of hooks that have been found to consistently hook tarpon in the jaw. When a fish strikes, they do not let it "run" with the bait and immediately set the hook as soon as a strike is detected. Also, pass guides usually released tarpon without removing them from the water. The tarpon that died had been pulled from the water onto the boat for photographing. Only one other tarpon (tarpon 5) had been removed from the water. Additionally, most of the tarpon were caught on relatively heavy tackle (Table 1) using aggressive angling techniques whereby the fish were brought to the boat and released in a relatively short time. Tarpon caught or handled differently may have different release mortality rates.

The tracking periods during this study were relatively short. It is reasonable to assume, based on other studies of other species and fish physiology, that most mortality occurs very soon after release and therefore that relatively short tracking periods will detect most mortality (Edwards and Berkeley, 1999). However, the extent to which additional delayed tarpon mortality occurs cannot be directly estimated. Therefore, results from short-term tracking such as ours provide minimum estimates of mortality.

Tarpon are physostomatous, obligate air breathers and frequently roll at the surface to gulp air (Robins, 1977). This behavior allowed them to be observed periodically during tracking. Not only did such observations help confirm that the fish were being tracked accurate-

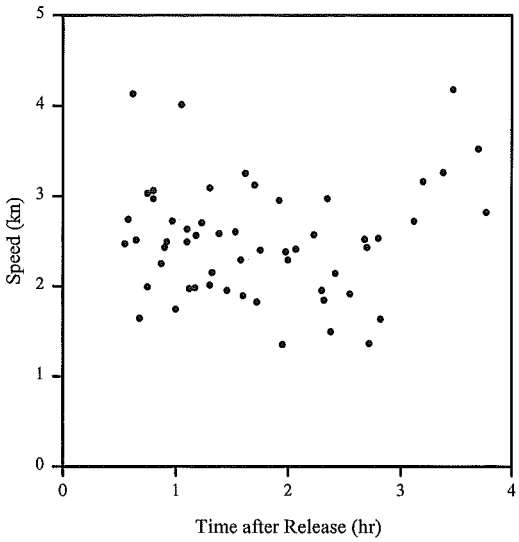


Fig. 2. Swimming speed vs time after release (first 4 hr) for the track segments of the nine tarpon summarized in Table 2.

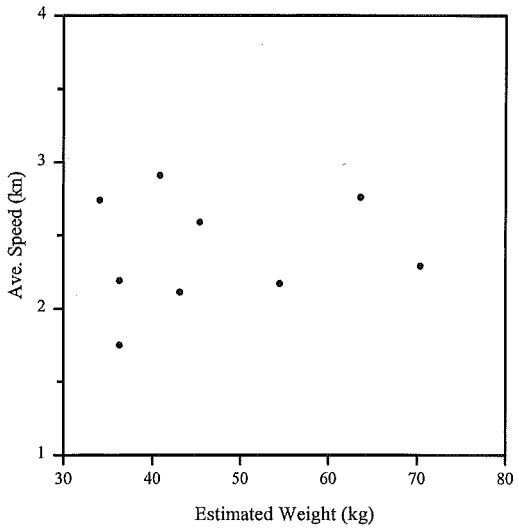


Fig. 3. Swimming speed vs estimated size (weight) for the nine tarpon summarized in Table 2.

ly, but they also provided an opportunity to visually assess the fish's condition and behavior. When a tagged tarpon rolled, the brightly colored float attached to the transmitter was easily visible from distances of up to about 100 m and allowed the fish to be positively identified.

Three of the tarpon that remained in the pass were observed soon after release to roll at the surface with other schooled tarpon that were rolling together in the swift water of the pass. These observations confirm that at least some of the tarpon quickly recovered and schooled "normally" with other tarpon. Tarpon that were tracked out of the pass were frequently observed rolling ahead of the tracking boat. While rolling, their behavior did not appear to be different from that of other tarpon.

The tarpon were sometimes difficult to track accurately. They often moved in irregular, zigzag, and looping paths that could not always be followed precisely. At times, they milled about in one area for several minutes, but at others, they moved in more direct and linear tracks. The swimming speeds in Table 2 are from the latter kind of movement and are derived from tracking data with accurately determinable positions and paths.

These swimming speeds (1.8–2.9 knots) are slightly faster than those determined by similar tracking techniques for blue marlin (*Makaira nigricans*) (1.1–2.3 knots) (Yuen et al., 1974; Holland et al., 1990a; Block et al., 1992; Edwards and Berkeley, 1998) and striped marlin (*Tetrapturus audax*) (0.6–2.1 knots) (Holts and Bedford, 1990; Brill et al., 1993). They are also faster than those recorded for bigeye tuna (*Thunnus obesus*) (1.5 knots) (Holland et al., 1990b) and albacore (*Thunnus alalunga*) (1.5–1.6 knots) (Laurs et al., 1977), but they are slightly lower than those for yellowfin tuna (*Thunnus albacares*) (1.3–4.2 knots) (Carey and Olson, 1982; Holland et al., 1990b).

The swimming speed data for the track segments summarized in Table 2 are plotted against time after release in Figure 2. This plot shows no clear pattern, and linear regression analysis showed no significant regression ($r^2$ = 0.004) of speed on time. Similarly, there was no significant relation ($r^2$ = 0.011) between weight and average swimming speed (Fig. 3). Swimming speed theoretically would be related more to length than to weight (Weihs, 1977), but since some of the smaller tarpon had average swimming speeds that were faster than those of the largest, weight/length conversion of the data would not change the conclusion. Because of the irregular and erratic swimming patterns of tarpon, it is unlikely that swimming speed data would be very useful in assessing condition or recovery state of released tarpon.

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