

RELEASE AND RECAPTURE OF CAPTIVE-REARED GREEN SEA TURTLES, *CHELONIA MYDAS*, IN THE WATERS SURROUNDING THE CAYMAN ISLANDS

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ABSTRACT

Cayman Turtle Farm released 26,995 yearling and hatchling green sea turtles, *Chelonia mydas*, into the waters surrounding the Cayman Islands, between 1980 and 1991. Released turtles were the offspring of the farm's captive breeding colony. Tagged turtles were regularly recaptured and re-released locally and demonstrated growth rates of 3.0 kg/year. With turtles recaptured from other regions of the Caribbean, recapture rate for turtles released as yearlings was 4.1%. 66% of the locally recaptured turtles were infected with cutaneous fibropapillomas, a condition increasingly observed among turtle populations worldwide.

INTRODUCTION

Historically, the Cayman Islands supported a huge turtle rookery and subsequently the "turtling industry" provided a means of support for the islands through the export of hawksbill shell and green turtle meat (King, 1982). The Cayman Islands fishing fleet obtained turtles from foreign turtle populations. Cayman Turtle Farm, CTF, began operation in 1968 to commercially raise the green sea turtle. Currently CTF is a major tourist attraction on Grand Cayman and produces turtle products for local consumption. The farm's breeding herd produces an average of 10,500 hatchlings per year. Hatchling and yearling green sea turtles are tagged and released into the waters surrounding the Cayman Islands as part of a continuing study to assess turtle survival and the establishment of a resident turtle population.

Most tagging programmes focus on mature adults to monitor breeding populations simply because the turtles are accessible for tagging while on the nesting beaches. Limited studies have been done on juvenile populations to assess growth rates of the populations (Bjorndal & Bolten, 1988; Frazer & Ehrhart, 1985). The development of an autograft tag has the potential to monitor turtles as part of a population group (Hendrickson & Hendrickson, 1981). Effective tagging and recovery methods are critical in determining the success of population management programs and to allow for the determination of basic questions of sea turtle biology such as how long turtles live and do sea turtles return to their natal beaches to nest.

METHODS

Facilities and husbandry procedures at CTF have been previously described (Wood, 1991). Turtles designated for release were released as either hatchlings or as yearlings. Several tagging methods have been used. All hatchlings released since 1983 received a "living tag" which involves transfer of a 4 mm disk from the plastron to the carapace. The location of the graft was designated by the carapace scute and identified a release age group. A surgical biopsy punch was used to puncture the dermal layer of the plastron and carapace. The disks were then removed with a scalpel and interchanged. The graft was secured with a surgical glue (@Histoacryl, B. Braun Melsungen AG, Melsungen, Germany).

Mutilation tags were used in 1980-1983. The trailing marginals of the turtle were notched to identify the release age

group. Yearlings released prior to 1984, received individually, numbered plastic tags in the rear flipper (Dalton Supplies, England). Titanium tags (Stockbrands Pty Ltd, Western Australia), individually numbered and identified with the inscription "Premio remitir, Turtle Farm, Grand Cayman, BWI" have been used for yearling turtles since 1984. Tag location was the trailing edge of the left front flipper. Tag size for yearling turtles was 50 x 6 mm. A larger titanium tag, 69 x 8 mm, was used for larger (>15 kg) turtles captured during local tag-recapture efforts. Fig. 1 illustrates the various tags used. Local recaptures were done by setting traditional hanging turtle nets. The freely-floating bottoms of the net (varying in surface length from 12 - 25 m with a net depth of approximately 3 m) allowed a captured turtle to surface easily until removed. Nets were set and checked on a daily basis for one to two week periods throughout the year. Since 1985, nets have been set a total of 863 net days resulting in 218 turtle captures. Nets have been set during each month except March, April and November with turtles captured during all months nets were set. Occasionally, turtles were seen or caught by locals and reported to the farm. Overseas recoveries of tagged turtles were most often from fishermen.

On release of farm stock, some yearlings were individually weighed and measured. Curved carapace length, CCL, was measured with a fiberglass sewing tape from the leading edge of the nuchal scute to the notch between the two supracaudals. Curved carapace width, CCW, was measured at the widest part of the carapace from the edge of the marginals. If the turtles were not individually weighed, the average stock weight for the group was used as the release weight. Upon recapture, the turtles were weighed and measured. Reported sizes for overseas recaptures were considered approximate and not included in statistical analysis.

The general health of local recaptures was noted. Particularly, with the common occurrence of cutaneous fibropapillomas, turtles were graded as to the extent of the infection according to the following designations:

- Grade 0:* no cutaneous fibropapillomas.
- Grade 1:* cutaneous fibropapillomas less than 6 mm.
- Grade 2:* cutaneous fibropapillomas 7 mm - 50 mm.
- Grade 3:* cutaneous fibropapillomas 5 mm - 100 mm.
- Grade 4:* cutaneous fibropapillomas greater than 50 mm which must physically hamper movement or have resulted in blindness.

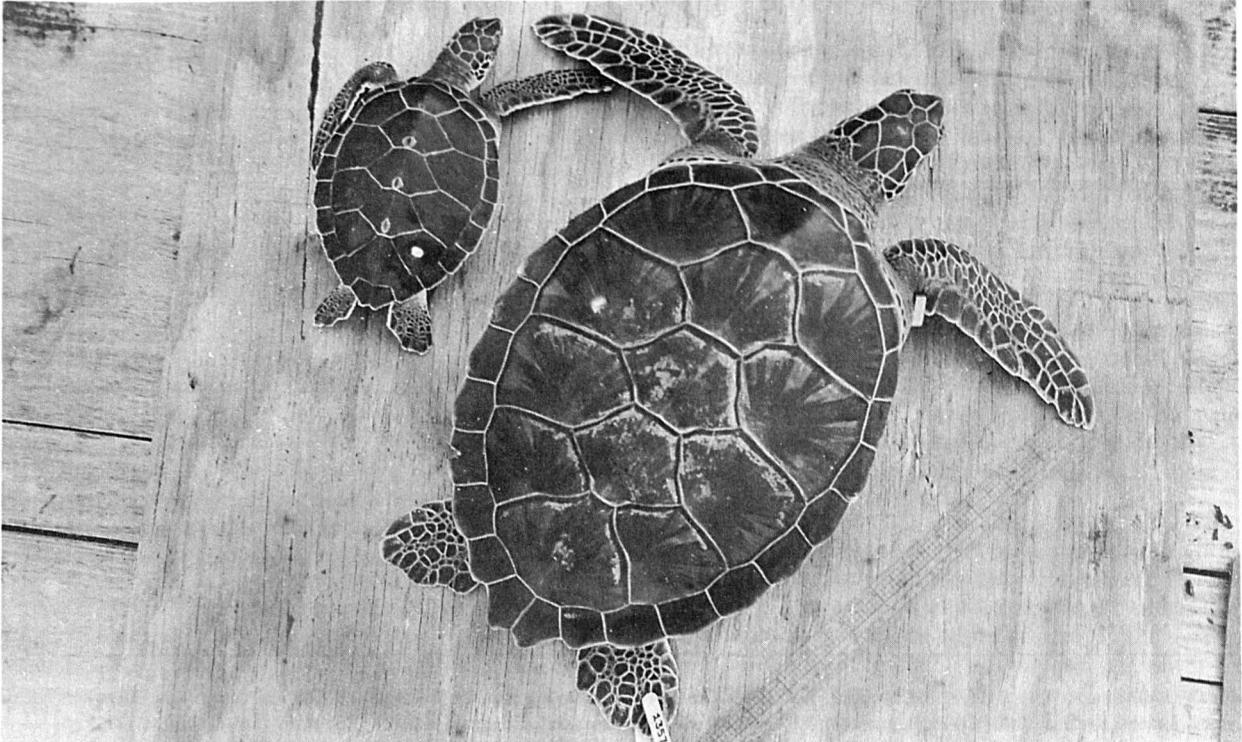


Fig. 1 Captive reared green turtles, six months old and 18 months old specimens, with representative tags. The younger turtle on the left has a living tag in the right coastal no. 4 scute. The older turtle on the right has a living tag in the left coastal no. 2 scute; a plastic roto-tag in the right rear flipper; a titanium tag in the trailing edge of the right front flipper; and a mutilation notch in a left marginal.

A one way analysis of variance and/or the Student-Newman-Keuls multiple range test were used to compare sample means.

RESULTS

Table 1 summarizes the release of turtles from CTF since 1980. Fig. 2 designates release sites on Grand Cayman and the number of turtles released from each site. Of the 26,995 turtles released, 14,100 turtles released as hatchlings were tagged by "living tag" only. This would identify the year of release only. 2,322 hatchlings and 1,944 yearlings were released with no tag. 1,283 yearlings were released with a

	weight (kg)	CCL (cm)	CCW (cm)
mean	11.9	45.7	40.8
SD	5.4	6.8	6.4
maximum	24.5	58.0	53.0
minimum	5.5	36.0	31.5

TABLE 2. Size data for 18 hawksbill sea turtles captured in North Sound, Grand Cayman. CCL is curved carapace length; CCW is curved carapace width.

year of release	no. of hatchlings released	no. of yearlings released	tagging comments
1980	/	1208	mutilation tag only
1981	79	1685	60 yearlings; mutilation tag; 1331 yearlings with rototags
1983	4405	71	all hatchlings with "living tag"
1984	/	2000	titanium tags
1985	3107	/	2641 hatchlings with "living tag"
1986	/	1936	all with titanium tags; 938 with "living tag" also
1987	5559	500	5082 hatchlings with "living tag"; all yearlings with "living tag" and titanium tag
1988	/	1202	"living tag" and titanium tag
1989	2800	1769	1500 hatchlings with "living tag"; 119 yearlings with titanium tag
1990	/	104	"living tag" and titanium tag
1991	472	98	hatchlings with "living tag"; yearlings with titanium tag
total	16422	10573	

TABLE 1. Number of hatchling and yearling green sea turtles released by CTF, 1980-1991. If tag designation is not entered, turtles were released without a tag.

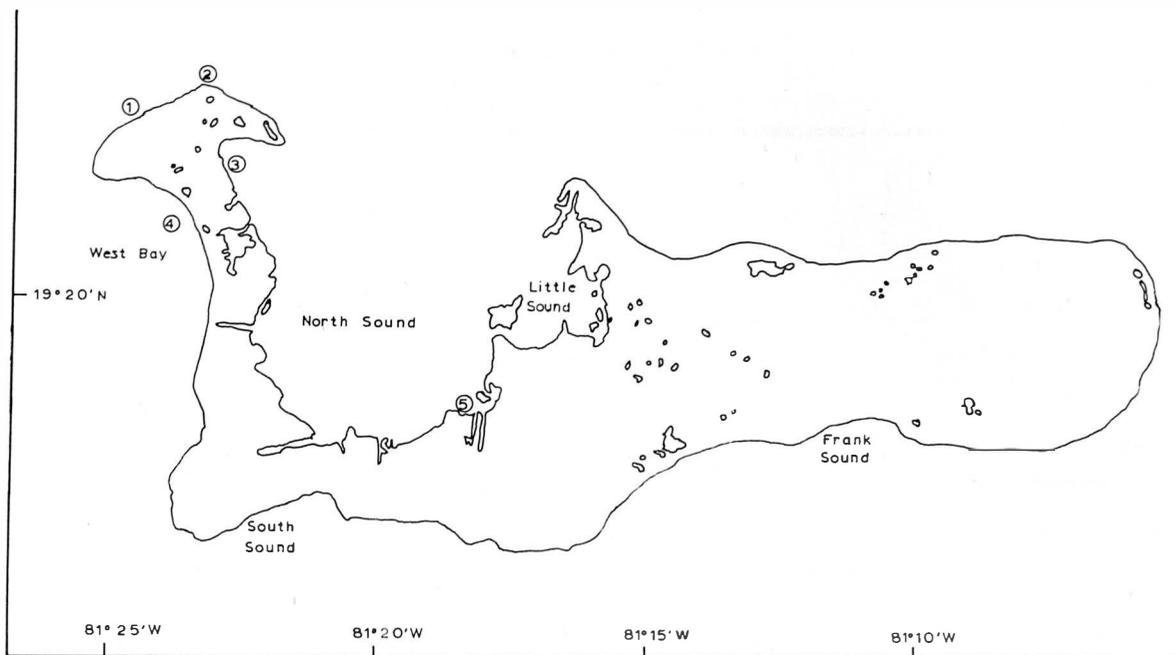


Fig. 2 Outline map of Grand Cayman, Cayman Islands, BWI. Numbers in circles represent the following: 1, Cayman Turtle Farm; 2, Barkers release site; 3, Batabano release site; 4, West Bay release site; 5, North Sound release site.

release site	no. released	recapture site				Total
		North Sound	Other, local	Cuba	Other, foreign	
North Sound	2336	104 (4.5)	/	35 (1.5)	3 (0.1)	142 (6.1)
Batabano	530	5 (0.9)	2 (0.4)	4 (0.8)	/	11 (2.1)
Barkers	909	24 (2.7)	1 (0.1)	13 (1.4)	/	38 (4.2)
West Bay	2184	8 (0.4)	2 (0.1)	62 (2.8)	8 (0.4)	80 (3.7)
Total	5959	141 (2.4)	5 (0.1)	114 (1.9)	11 (0.2)	271 (4.5)

TABLE 3. Number of turtles recaptured and site of recapture for released yearling turtles. Numbers in parentheses represent % of the released turtles subsequently recaptured.

no. years between release and recapture	no. local recaptures	no. foreign recaptures	total recaptures	% of total recaptures in year designated
1	45	22	67	23.2
2	55	22	77	21.6
3	51	39	90	31.1
4	8	11	19	6.6
5	5	20	25	8.7
6	2	4	6	2.1
7	1	4	5	1.7
total	167	122	289	

TABLE 4. Time between release and recapture for locally and foreign recaptured turtles.

fibropapilloma infection grade	time between release and recapture (yrs)			
	<1	1-2	2-3	>3
0	32	15	9	8
1	7	8	5	2
2	3	13	23	5
3	1	18	8	0
4	1	1	6	1
total	44	55	51	16

TABLE 5. Degree of fibropapilloma infection among 166 locally recaptured turtles.

mutilation tag only identifying year of release, 1,387 yearlings were released with a roto-tag and 5,959 yearlings were released with a titanium tag.

Since 1984, 294 green turtles tagged by CTF have been recaptured either in local waters or overseas. In addition 69 other turtles, including 18 hawksbill sea turtles have been captured, tagged and released during tag recapture efforts of CTF in North Sound, Grand Cayman. All the hawksbills captured were subadults. Table 2 gives size data for the hawksbills captured. All the hawksbills were in good condition; two had small barnacles on the carapace. One hawksbill was missing rear marginals as if it had been bitten by a shark. Two of the hawksbills were recaptured in the same location, one within 13 days. The other hawksbill was recaptured 321 days later and had gained 6.7 kg (recapture weight = 13.7 kg) and increased in CCL 10.6 cm (recapture length = 50.0 cm).

Fifty-one green sea turtles were captured in North Sound without a "living tag", flipper tag, or obvious tag scar. Mean weight (\pm SD) was 11.0 ± 5.3 , range 3.3-24.5 kg; mean CCL was 45.8 ± 6.9 cm, range 31.8 - 59.5 cm. The sizes of these turtles were similar ($P > 0.1$) to sizes of known release turtles. One hundred and twenty-eight turtles captured in North Sound with titanium tags had a mean weight (\pm SD) of 10.0 ± 4.9 , range 2.7-29.9 kg; mean CCL was 43.9 ± 7.2 , range 29.0-66.0 cm. Eight of these turtles were subsequently recaptured in the same location within one year. One turtle was subsequently reported taken in Nicaragua 1,178 days later.

Of the 294 recaptures of turtle identified as released by CTF, 271 had a titanium tag which enabled the turtle to be identified as to exact release site and release date. The other recaptures were identified by "living tag" as a CTF release, but individual data was incomplete for analysis or because of incomplete information from overseas recaptures, the turtle's history remained incomplete. Table 3 identifies the number and site of recaptures for yearlings released and tagged with a titanium flipper tag. Of the 271 recaptures listed, 28 are repeat captures of the same turtle. The net rate of turtles recaptured is 243 individual turtles of the 5,959 individually tagged yearlings, or 4.1%. Of the 243 turtles recaptured with a titanium tag, 40 were noted as having a visible "living tag" at release. Of these 40, 26 were noted as having a "living tag" on recapture.

One hundred and twenty-nine recaptures have been reported from outside the Cayman Islands. One hundred and

seventeen of these were from Cuba, five from Honduras, two from Belize, and one each from Mexico, Nicaragua, USA, and Venezuela. The recapture reported from Venezuela was the farthest distance traveled, 1,931 km. The turtle was recaptured 274 days after release, traveling 7.1 km/day. The sea speed record goes to a turtle released as a two-year old from the west shore of Grand Cayman which was recaptured within 24 days, 644 km away in Honduras, traveling 26.9 km/day.

Table 4 summarizes recaptures for 289 turtles on the basis of recapture site and time between release and recapture. Time between release and recapture ranges from 13-2,511 days, mean 795 ± 511 . There is a statistically significant difference for the number of days from release to recapture between turtles recaptured locally ($n = 167$, mean (\pm SD) = 697 ± 421) and those recaptured overseas ($n = 122$, mean (\pm SD) = 931 ± 589 ; $P < 0.0001$).

Sixty-eight percent of all green sea turtles recaptured in local waters had cutaneous fibropapillomas present. None of the hawksbill sea turtles were infected. Table 5 summarizes the relationship between the degree of infection and time between release and recapture. Seventy-two percent of the turtles recaptured within less than one year from release showed no fibropapillomas, while only 26% of the turtles recaptured after more than one year after release showed no fibropapillomas. Eight turtles were recaptured more than once in North Sound, Grand Cayman. In two instances, the turtles had fibropapillomas on initial capture and no fibropapillomas upon recapture after periods of 11 and 21 months. In the other six instances of recaptures, five turtles were first captured with no fibropapillomas present and subsequently developed fibropapillomas after periods of 10, 11, 13, 14, or 14 months. One turtle recaptured within 11 months increased in the degree of fibropapilloma infection.

Sixty of the turtles recaptured in North Sound were individually weighed at the time of release. Table 6 summarizes the parameters of weight and age at release and recapture and observed weight gain. For the sixty turtles recaptured, the mean (\pm SD) weight gain was 3.04 ± 1.11 kg/year. These turtles ranged in age from 11 to 15 months at release and mean time between release and recapture was 583 \pm 384 days. All turtles were recaptured in good condition with the presence of cutaneous fibropapillomas ranging from grade 0 to 3. There was no significant difference in observed weight gain among groups of turtles of various degrees of infection with fibropapillomas. (Respective weight gain, means \pm SD, for grade 0, 1, 2, and 3 fibropapilloma infection were 3.13 ± 0.88 , 3.23 ± 1.10 , 3.32 ± 1.36 , 2.35 ± 1.05 , $F = 2.11$, $P = 0.109$.) Mean gain in CCL for 22 of the recaptures for which CCL was measured at release was 8.4 ± 3.1 cm/year. At release, these 22 turtles were 13 to 14 months old and mean CCL was 30.4 ± 3.1 cm, range 24.0 - 34.0 cm. Mean CCL on recapture was 41.5 ± 7.3 cm, range 29.0 - 56.0 cm. Mean number of days between release and recapture was 506 ± 375 days, range 41-1199 days. Thirty-two overseas recaptures were reported which included a weight measurement for turtles individually weighed at release. One of these turtles was 13 months old at release, the others were 14 months old. Mean weight gain for these turtles was 7.83 ± 3.46 kg/year. There was a significant difference in weight gain between local and overseas recaptures ($P < 0.0001$). Mean time from release to recapture for this group of overseas recaptures was 773 ± 295 days, and as

with the larger subgroups quantified in Table 4, there was a significant difference in the time from release to recapture between the local and overseas recaptures ($P < 0.05$).

DISCUSSION

The turtle recapture rate of 4.1% for yearlings tagged with a titanium tag is not unusual. Excluding the local recaptures, which represent an active recovery effort, the overseas recapture rate is 2.0%. Witham (1976, 1980) reported tag recovery rates of 0.7-0.9% for over 10,000 captive reared yearling green sea turtles released in Florida, USA. Tag recoveries for yearling Kemp's ridley sea turtles released in Texas, USA, averaged 4.8% (Fontaine *et al.*, 1989). None of the captured turtles in North Sound without a titanium tag showed tag scars. Locally captured turtles up to 30 kg successfully retained the smaller titanium tag. The longest known retained tag is 82 months from release to recapture.

Turtles released on the north side of the island are more likely to be captured locally than those released on the west shore. Possibly contributing to this observed tendency are the strong offshore currents on the open west shore as opposed to the barrier reef enclosed release sites on the north shore. Also, recapture efforts focus on the abundant north shore turtle grass beds. Approximately 60% of the 80 km² of North Sound is covered with *Thalassium testudinum* (turtle grass) interspersed with green algae of the genera *Halimeda*, *Penicillus*, and *Rhipocephalus* and an abundant population of bivalves (Roberts, 1977). Often associated with these turtle grass beds are populations of jellyfish, particularly of the genera *Aurelia* and *Cassiopeia*. South Sound and Frank Sound, on the south coast of Grand Cayman, also have extensive turtle grass beds.

The incidence of cutaneous fibropapillomas among locally recaptured turtles is similar to that reported for other populations recently (Balazs & Pooley, 1991). Significantly, some of the recaptured turtles have shown complete remission of the infection. None of the overseas recaptures were reported as having any fibropapillomas present, but because of the limitations in overseas reporting, the presence of fibropapillomas cannot be precluded. Nonetheless, the local recaptures occurred within protected sound areas of the island and the probable decrease of water circulation as opposed to open ocean habitats may influence the incidence of fibropapillomas. Although, both tagged and untagged turtles had fibropapillomas, there was a tendency for fibropapillomas to be associated with the titanium tags. Turtles that had fibropapillomas and a titanium tag, consistently had fibropapillomas enveloping the tag.

As expected with an altered diet, recaptured turtles showed a decrease in weight gain from the average projected weight gain from 6.6 kg/year for captive reared turtles in the size range sampled to 3.0 kg/year for the recaptured turtles. Although the rate of growth is significantly reduced, the appearance of the recaptured turtles is good with individuals showing no signs of emaciation. The turtles appear to adapt readily to feeding on the turtle grass beds around the island. As overseas size measurements were unconfirmed, the reasons for the difference noted between local and overseas weight gains remains speculative.

As summarized by Boulon & Frazer (1990), mean growth rates among juvenile green turtles are dependent upon geographical location and size class. Boulon & Frazer (1990) used straight line carapace length with recalculations of some of the data presented to establish uniformity because of differences in how the carapace length was measured. For the captive population of turtles at CTF, the relationship between straight line carapace length (SCL, measured from the leading edge of the nuchal scute to the notch between the supracaudals) and CCL is 0.96 and is linear for the size range reported here. Using this relationship to convert the mean growth rate (cm/yr) based on CCL to SCL, the mean growth rate for turtles released and recaptured in the Cayman Islands for a size class of 30 - 40 cm, SCL, is 8.26 ± 2.95 cm/year. This is in the range of growth rates reported for other populations, 8.8 ± 1.0 cm/year for the Bahamas (Bjorndal & Bolten, 1988) and 4.96 ± 1.72 cm/year for the U.S. Virgin Islands (Boulon & Frazer, 1990).

Head-starting as a conservation technique is controversial (Woody, 1990; Allen, 1992). Part of this controversy stems from the criteria by which such a program is judged a success or failure. If head-started turtles must be shown to be reproductively successful, then this program has not been proven to be beneficial, if for no other reason than insufficient time for reproductive maturity has not passed. If however, success is defined by adding turtles to their natural environment and documenting their ability to survive in this environment for a number of years, then this study can reasonably be considered as positively benefiting the wild population. Such turtles augment the wild stock and perhaps even relieve some natural and human predation. There is no reason to believe that once the animals reach sexual maturity they will not become reproductively successful as well.

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ANNOUNCEMENTS

ERRATUM

Wood, F. & Wood, J. (1993) Release and recapture of captive-reared green sea turtles, *Chelonia mydas*, in the waters surrounding the Cayman Islands. *Herpetological Journal* 3, 84-89.

Table 6 should have been as follows:

	Release weight (kg)	Release age (months)	Recapture weight (kg)	Recapture age (months)	Weight gain (kg/yr)
<i>n</i>	60	60	60	60	60
mean	3.6	13.6	8.7	32.4	3.04
SD	0.2	0.7	0.6	12.5	1.11
Max	9.2	15.0	24.5	83.0	6.15
Min	1.4	11.0	2.8	15.0	0.86

TABLE 6. Release and recapture weight and age for 60 green sea turtles.