

## Migrations of the green turtle, *Chelonia mydas*, breeding in Yap State, Federated States of Micronesia

STEVEN P. KOLINSKI<sup>1</sup>

Marine Resources Management Division, P.O. Box 251, Colonia, Yap, F.M. 96943.

**Abstract**—The recapture of four of 13 male and 15 of 553 female adult *Chelonia mydas* tagged at breeding sites in Yap State, Western Pacific Ocean, between 1990 and 1992 is documented. Post-breeding migrations of tagged turtles to areas in Yap State, the Philippines, Papua New Guinea and the Marshall Islands involved distances ranging from 170 to over 3400 km, and demonstrate that green turtles which breed in Yap State range widely within the Pacific and southeast Asian regions. In addition, tagged turtles migrated 14–101 km between breeding sites in eastern Yap State, and one male and one female turtle were recaptured near their tagging sites during a breeding season three years subsequent to that in which they were tagged.

### Introduction

Yap State, the western-most constituent of the Federated States of Micronesia, is situated between latitude 7°N to 10°N and longitude 137°E to 148°E. The State is comprised of four closely associated high islands constituting Wa'ab (the Yap Islands), three raised coralline islands (including Satawal) and 12 coral atolls (including Ngulu, Ulithi, Woleai, Olimarao, Elato, and Lamotrek; Figure 1).

The green turtle, *Chelonia mydas*, and its eggs are valued as traditional and subsistence resources by the people of Yap State. A perception common amongst these people is that over the years and despite annual fluctuations, there has been a gradual decline in the number of turtles migrating to, or residing in, this region.

Since 1990, personnel from the Yap State Marine Resources Management Division have organized and conducted turtle tagging and monitoring projects at selected breeding and feeding areas within Yap State in an effort to gather base-line information crucial to forming turtle management and conservation strategies. Information on the recapture of adult green turtles tagged while breeding in Yap State between 1990 and 1992 is presented and discussed.

### Methods

Tagging and monitoring of breeding turtles (turtles observed courting, mating or attempting to nest) between 1990 and 1992 was conducted at the following

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<sup>1</sup> Present address: Dept. Zoology, University of Hawaii at Manoa, Honolulu, HI 96822.

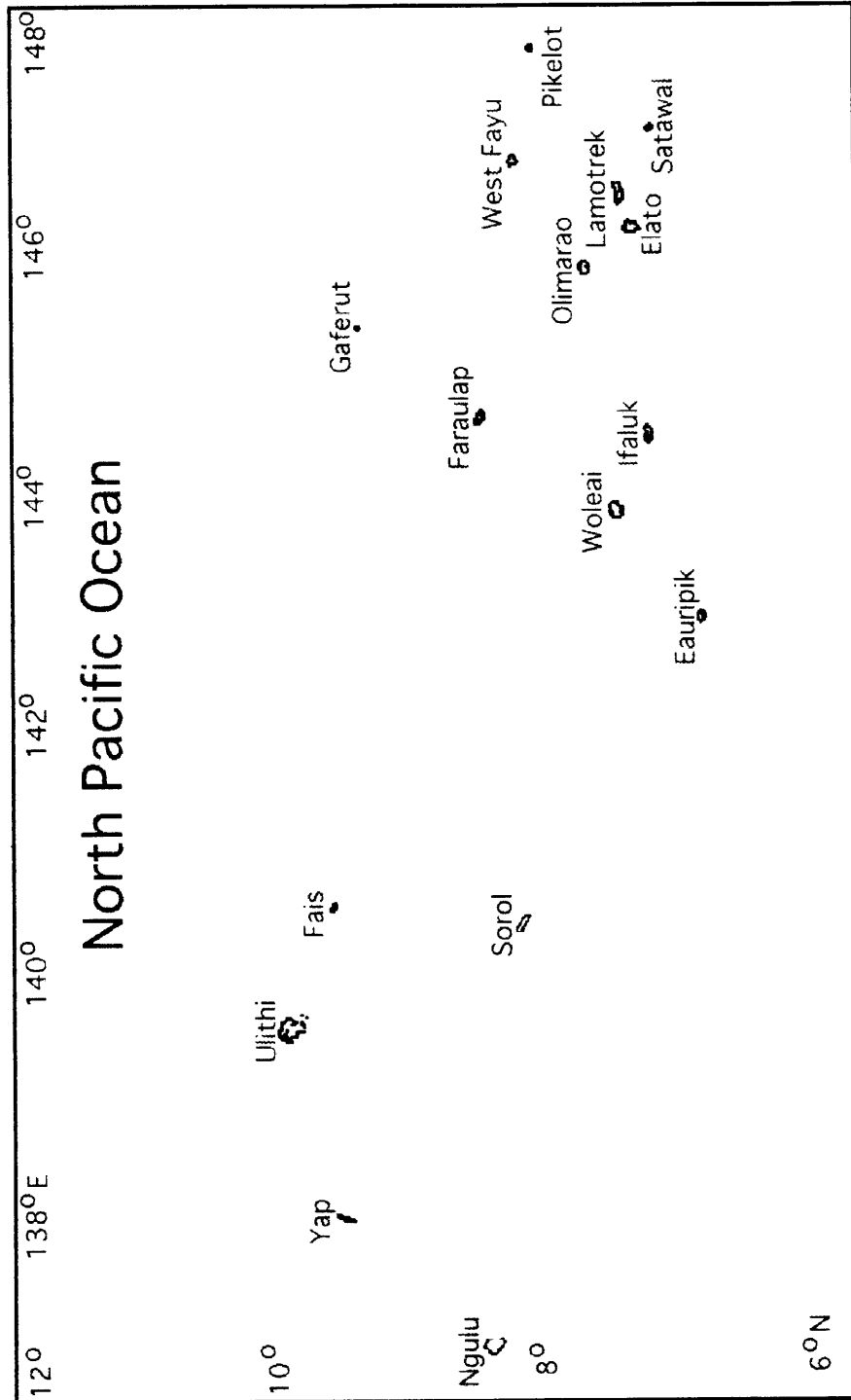


Figure 1. Island and atoll areas in Yap State, Federated States of Micronesia.

islands of Yap State: Olimarao and Falipiy Islands in Olimarao Atoll between April and September, 1990; Gielop Island (one of two islands in an atoll adjacent to Ulithi Atoll) between May and August, 1991; Lathow and Meseran Islands in Ngulu Atoll from May to July, 1992; Falipiy, Toas and Ulor Islands in Elato Atoll from July to September, 1992; and Pig Island in Ulithi Atoll from August to September, 1992.

At each island attempts were made to capture and tag all observed turtles, both on land and in surrounding waters. A tag was applied to the trailing edge of one or both fore-flippers (depending on the number of tags available) of each turtle, proximal to the large scales close to the axillary part of the flipper. Numbered inconel tags (681-C, National Band and Tag Co., Newport, Kentucky U.S.A.) were used in 1990 and 1991. Titanium tags (Stockbrand Co. Pty. Ltd., Australia) were preferentially used in 1991 and 1992.

All recaptures of tagged turtles were made by the public. Information related to the recapture of these turtles was obtained from correspondence or through the return of completed questionnaires sent to respondents.

### Results

Four of 13 male and 15 of 553 female adult green turtles tagged when breeding in Yap State had been recaptured as of 1993 (Table 1). Tags were recovered from six of 33 turtles tagged at Olimarao Atoll, seven of 418 turtles tagged at Gielop Island, two of 73 turtles tagged at Ngulu Atoll, four of 38 adult turtles tagged at Elato Atoll, and none of four turtles tagged at Pig Island in Ulithi Atoll. Thirteen of the 19 turtle recaptures were of post-breeding turtles in areas including Yap State, Papua New Guinea, the Philippines and the Marshall Islands. Four turtles were recaptured in Yap State after having migrated to breeding sites outside of their tagging areas, and two turtles were recaptured at or near their tagging sites during a subsequent breeding season.

#### POST-BREEDING TAG RECOVERIES

Information pertaining to post-breeding migrations of three male and ten female green turtles is shown in Table 2. Eight of the 13 turtles were recaptured

Table 1. General geographic distribution of recaptured turtles tagged in Yap State (SSR = same-season recapture of turtles breeding outside of tagging areas; SBR = subsequent breeding season recapture of breeding turtles).

Sex	Number Tagged	Post-Breeding Recaptures				SSR	SBR	Total
		Yap State	Papua New Guinea	Philippines	Marshall Islands	Yap State	Yap State	
Male	13	2	0	1	0	0	1	4
Female	553	1	1	7	1	4	1	15
Total	566	3	1	8	1	4	2	19

Table 2. Tag recoveries from post-breeding green turtles tagged when breeding in Yap State.

Tag No.	Sex	Last Date Seen— Tagging Area	General Activity	Recapture Site	Activity	Approx. Dist. (km)	Time at Large
R3208	F	07/09/92	Nesting	Camarines Norte, Philippines	Dead in Fish Trap	1690	84 dys.
R3210		Ngulu Atoll					
R3220	F	07/14/92	Nesting	Tawi Tawi, Philippines	?	2020	<217 dys.
R3221		Ngulu Atoll					
RMTP 641	F	06/29/91	Nesting	South Cotabato, Philippines	Trapped in fish net	1700	212 dys.
		Gielop Island					
RMTP 704	F	07/30/91	Nesting	Yap Island, Yap State	Swimming	170	1 yr. 179 dys.
		Gielop Island					
RMTP 789	F	05/27/91	Nesting	Majuro Island, Marshall Islands	?	3410	<239 dys.
		Gielop Island					
RMTP 807	F	05/21/91	Nesting	Camarines Norte, Philippines	Feeding	1950	139 dys.
		Gielop Island					
RMTP 885	F	08/01/91	Nesting	Masbate, Philippines	Swimming	1840	279 dys.
P121		Gielop Island					
RMTP 898	M	06/04/91	Mating	Northern Samar, Philippines	Resting under water	1650	<257 dys.
		Gielop Island					
RMTP 912	F	07/03/91	Nesting	Suriago Del Norte, Philippines	Dead in water	1550	1 yr. 165 dys.
		Gielop Island					
X534	M	05/14/90	Mating	Woleai Atoll, Yap State	Resting under water	200	2 yrs. 182 dys.
X535		Olimarao Atoll					
R4048	F	08/02/92	Nesting	Kavieng, Papua New Guinea	Feeding	1270	171 dys.
R4049		Elato Atoll					
R4051	M	07/15/92	Mating	Woleai Atoll, Yap State	Resting under water	230	73 dys.
R4052		Elato Atoll					
R4076	F	08/10/92	Nesting	Quezon, Philippines	Dead on beach	2760	1 yr. 19 dys.
R4077		Elato Atoll					

in the Philippines, having migrated distances exceeding 1500 km. These included two female turtles tagged while nesting at Ngulu Atoll, one male and four female turtles tagged at Gielop Island, and one female turtle tagged while nesting at Elato Atoll (she traveled over 2700 km). The longest migrational distance recorded was for a female turtle which traveled at least 3400 km between Gielop Island, Yap State and Majuro Atoll, Marshall Islands. One female turtle tagged while nesting at Elato Atoll migrated across the equator and was recaptured while feeding off Kavieng, Papua New Guinea, a distance of 1270 km.

Three of the post-breeding turtles were recaptured in Yap State. One male turtle tagged while mating at Olimarao Atoll was found 200 km away resting underwater in the lagoon at Woleai Atoll. One male turtle tagged while mating at Elato Atoll was located 230 km distant resting along an outside reef edge at Woleai Atoll. One female turtle tagged while nesting on Gielop Island was speared while swimming along an outside reef edge at Wa'ab, 170 km distant.

The turtles recaptured in Yap State and Papua New Guinea were reportedly consumed by local inhabitants. Of the eight turtles recaptured in the Philippines, four were reported to have died prior to recapture or while in captivity, and two were said to have been released. The fates of two turtles recaptured in the Philippines and the one turtle recaptured in the Marshall Islands are unknown.

#### SAME-SEASON RECAPTURES OF TURTLES BREEDING OUTSIDE THEIR TAGGING AREAS

Information on the movements of four female turtles between rookery areas in eastern Yap State is shown in Table 3. Turtle X508 bypassed the islands of Olimarao Atoll, where she was tagged while mating, to nest 101 km distant at Satawal Island. Two tagged turtles nested at both Olimarao and Elato Atolls on islands approximately 38 km distant. One turtle nested at Elato and Lamotrek Atolls on islands 14 km apart. The four turtles were killed and eaten by local inhabitants.

#### TAG RECOVERIES FROM SUBSEQUENT BREEDING SEASONS

One male and one female adult green turtles tagged at Olimarao Atoll in 1990 were recaptured, following a three year interval, in a subsequent breeding

Table 3. Same-season tag recoveries of four breeding female green turtles.

Tag No.	Last Date Seen— Tagging Area	General Activity	Recapture Site	Activity	Approx. Dist. (km)	Days at Large
X508	05/16/90	Mating	Satawal Island	Nesting	101	35
X509	Olimarao Atoll					
X519	05/24/90	Nesting	Oletel Island, Elato	Nesting	38	19
X520	Olimarao Atoll		Atoll			
X544	08/05/90	Nesting	Elato Island, Elato	Nesting	40	2
X545	Olimarao Atoll		Atoll			
R4011	07/22/92	Nesting	Falaite Island,	Nesting	14	54
R4012	Elato Atoll		Lamotrek Atoll			

season (Table 4). The male turtle was recaptured while mating at Elato Atoll, approximately 40 km distant from Olimarao Atoll. The female turtle was found nesting at Olimarao Atoll. Both turtles were consumed by local inhabitants.

## Discussion

### POST-BREEDING TAG RECOVERIES

Adult green turtles are not known to feed in great numbers anywhere in Yap State, yet they commonly breed at a number of locations in the state. It appears that most of these turtles migrate to and from feeding grounds located outside of Yap State. Limpus et al. (1992) showed that female green turtles in Australia display high fidelity to their particular home feeding area on their post-nesting migrations. Presumably the post-breeding recaptures of female turtles from Yap State occurred while they were en route to or at their particular feeding areas. Green turtles breeding in Yap State thus appear to have a widely scattered distribution of feeding grounds located 170–3400 km from their rookeries, in areas including Yap State, Papua New Guinea, the Marshall Islands, and most notably the Philippines.

Other sea turtle species may also make long migrations to and from, or through, Yap State waters. Records of hawksbill turtles (*Eretmochelys imbricata*) migrating to Yap State from nearby island groups exist but remain to be published. Most notable is the movement of a hawksbill turtle (tagged by the Division of Aquatic and Wildlife Resources on Guam on 25 August 1988) over 800 km from Guam to Wa'ab. The turtle was recaptured in Ma'ap channel on 30 June 1989. In addition, infrequent sightings of leatherback (*Dermochelys coriacea*) and olive ridley (*Lepidochelys olivacea*) turtles in Yap State suggest these animals migrate from other Pacific regions.

The migration of green turtles between nations highlights the concept that turtles are a resource shared across political boundaries. Declines in the number of turtles that breed in Yap State thus can not be fully attributed to the harvesting practices of Yap State citizens. The susceptibility of turtles during their migrations to exploitation by inhabitants of neighboring and distant islands and nations requires that cooperative management practices be implemented on a regional level, with the extent of the region being determined by the migration of the animals themselves.

Table 4. Tag recoveries from breeding green turtles in a subsequent breeding season.

Tag No.	Sex	Last Date Seen—Tagging Area	General Activity	Recapture Site	Activity	Approx. Dist. (km)	Recapture Interval
X528	M	04/28/90	Mating	Elato Atoll	Mating	40	3 yrs.
X529		Olimarao Atoll					13 dys.
X538	F	09/30/90	Nesting	Olimarao Island,	Nesting	0	c. 3 yrs.
X539		Olimarao Atoll		Olimarao Atoll			

#### SAME-SEASON RECAPTURES OF TURTLES BREEDING OUTSIDE THEIR TAGGING AREAS

Although the majority of female turtles tagged while copulating in Yap State were later found nesting at islands close to their observed courtship areas (Kolinski, unpublished data), the migration of turtle X508 101 km between Olimarao Atoll and Satawal Island demonstrates that considerable movement from the location of mating to nesting rookeries may take place. Limpus et al. (1984) postulated that such movement by female green turtles acts to disperse the genetic input of male turtles, which may mate with more than one female, across a number of rookeries.

The observed movements of nesting green turtles between Lamotrek, Elato, Olimarao and possibly Satawal rookeries require further investigation to see if sufficient gene flow exists to sustain a single "regional" population. Based on instances of female green turtles changing islands to nest within the Capricorn Bunker Group, Australia, Limpus et al. (1984) proposed that a genetically discrete population can be composed of turtles using a group of adjacent rookeries. Norman et al. (1994) later confirmed this proposition through genetic analysis of hatchling tissue samples.

The identification of separate breeding populations is key to managing turtles as a resource. Through recent work involving mitochondrial DNA analysis of hatchling tissue samples from Ngulu and Elato atolls, Moritz & Limpus (1993) demonstrated that green turtles breeding in Yap State form a population separate from those of other areas sampled in the Pacific, including Papua New Guinea, Australia, Japan, Malaysia and Indonesia. Their study further suggests that Ngulu and Elato Atolls (590 km distant) populations are separate.

#### TAG RECOVERIES FROM SUBSEQUENT BREEDING SEASONS

The recaptures of X528 and X538 provide evidence that male and female green turtles display fidelity to a particular breeding area in Yap State in subsequent breeding seasons. Site fidelity of female green turtles to the same rookery in successive breeding seasons is well documented (Meylan et al. 1990; see also Bowen et al. 1992). Male green turtles may display similar fidelity to particular courtship areas (Balazs 1983, Limpus 1993). The recapture of X528 40 km from its initial tagging site again draws into question the extent of a geographic breeding area for individual turtles in eastern Yap State.

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