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Sea Turtle Abundance at Isolated Reefs of the Mariana Archipelago

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Abstract—Seven shallow-water banks, shoals and isolated reefs of the Mariana Archipelago were surveyed for sea turtles using surface and underwater survey techniques as part of efforts to ascertain turtle distributions and numbers throughout the Mariana region. Three green turtles *(Chelonia mydas)* were observed, one each at Supply Reef, Zealandia Bank and Arakane Reef. No other turtle species were seen. Twenty-six species of macroalgae were identified at six of the seven reefs, three (12%) of which are known to be utilized by green turtles. The limited number of turtles at isolated reef systems may be due to low recruitment rates, inadequate habitat range and resources, increased exposure to predation, and/or increased effort required to remain on location. Although sea turtles in some cases utilize shallow isolated reef systems, these systems do not appear to support large turtle numbers on a resident basis in the Mariana region.

Introduction

Quantitative information on sea turtle abundances and distributions is a prerequisite to understanding the status and recovery of turtle populations within U.S. territorial waters of the Pacific (NMFS & USFWS 1998a–f). The National Marine Fisheries Service has advised, sponsored and/or participated with local agencies in assessing the location and status of resident and breeding turtle populations in Guam and the southern arc islands of the Commonwealth of the Northern Mariana Islands (CNMI; Johannes 1986, McCoy 1997, NMFS &USFWS 1998a–e, Pultz et al. 1999, Belt Collins Hawaii & Marine Research Consultants 2000, Kolinski et al. 2001, 2004, Ilo & Manglona 2001, 2002, Cummings 2001, 2002, Belt Collins Hawaii 2003, The Environmental Company 2004). Although four species of turtles *(Chelonia mydas, Eretmochelys imbricata, Dermochelys coriacea* and *Lepidochelys olicavea)* have been observed in

Mariana Archipelago waters (Pritchard 1982, NMFS & USFWS 1998a, c), recent estimates suggest between 1,000 and 2,000 mainly immature resident green turtles reside around southern arc islands of the CNMI (Kolinski et al. 2004). Such surveys for resident turtles have recently expanded, with the aid of the NOAA Ship R/V *Oscar Elton Sette,* to encompass the remote northern arc islands along with many isolated reefs throughout the Mariana region. This paper presents information on in-water assessments for turtles at seven isolated reef systems along the northern, southern and back arcs of the Mariana Archipelago. To our knowledge this is the first time these areas have been surveyed for sea turtles.

Study Area

The Mariana Archipelago consists of northern and southern arc islands and reefs and a back-arc of isolated reefs oriented parallel in a north-south direction from 12.5º to 20.8ºN (142.4º to 146.5ºE, Figure 1). The area is politically divided between the U.S. Territory of Guam (Guam Island and surrounding reef systems) and the U.S. Commonwealth of the Northern Mariana Islands (comprised of 14 islands extending from Rota to Uracas and regional submerged reef systems). Twenty-eight isolated reef systems (i.e., reefs not associated with land) are reported to occur within the region (Defense Mapping Agency Hydrographic/Topographic Center 1979, Hunter 1995, Micronesian Environmental Services 1997, Western Pacific Regional Fishery Management Council 2002). Half of these appear shallow enough to potentially be suitable for resident sea turtle habitation (< 40 m depth; Defense Mapping Agency Hydrographic/Topographic Center 1979, Micronesian Environmental Services 1997).

Seven isolated reef systems were surveyed: Stingray Shoals (20º29.64'N, 142º26.31'E), Pathfinder Reef (16º30.39'N, 143º8.93'E), and Arakane Reef (15º38.03'N, 142º45.67'E) in the back-arc; Supply Reef (20º8.49'N, 145º5.86'E) and Zealandia Bank (16º53.70'N, 145º51.02'E) in the northern-arc of the CNMI; Tatsumi Reef (14º54.18'N, 145º39.77'E) in the southern-arc of the CNMI; and Santa Rosa Reef (12º49.47'N, 144º25.55'E), located south of Guam (Figure 1). Reef areas and shallowest recorded depths are located in Table 1. Stingray Shoals was dominated by a topographically complex hermatypic scleractinian coral community with steeply sloped shoal walls. Arakane and Pathfinder Reefs were characterized by convoluted mounds of pavement with soft and hard corals. The mounds were separated by wide meandering grooves of sand, rubble and/or pavement. Supply Reef had a 30 m deep plateau with ridges reaching 9 m depth. The reef was rugose and was dominated by hermatypic scleractinian corals. Zealandia Bank had a 33 m deep platform with two thin basalt pinnacles occasionally breaking the waters surface. Platform topography appeared similar to that of Stingray Shoals, with topographic complexity a result of coral accretion. The majority of Tatsumi Reef appeared as pavement with scattered corals. However, breaks within the reef provided limited topographic complexity. Santa Rosa Reef consisted of aggregations of corals and sand, and large areas of pavement.

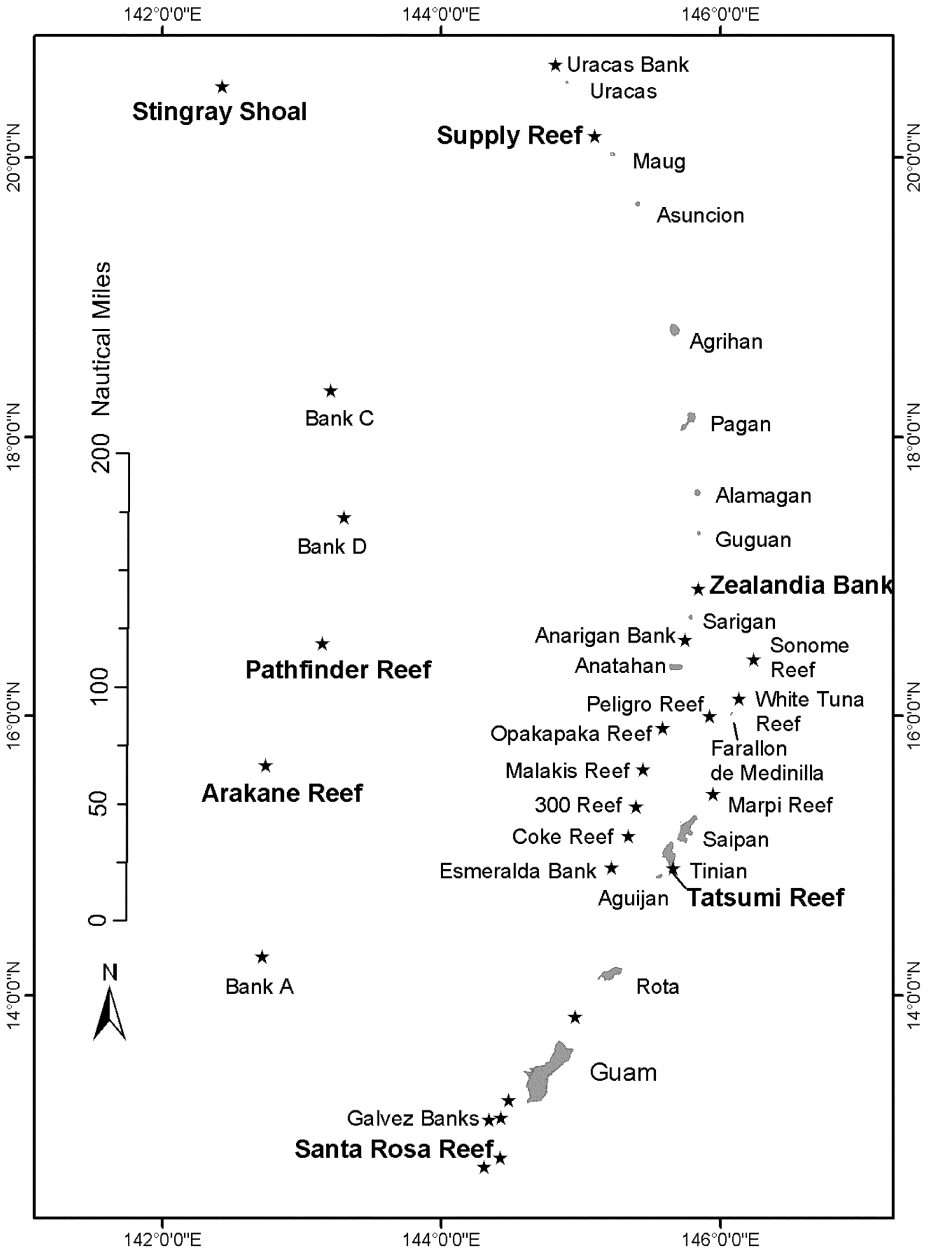

Figure 1. Map of islands and reported isolated reef systems in the Mariana Archipelago. ★ = isolated reef system. Sites assessed are in bold.

Methods

All surveys were conducted off the NOAA Ship R/V *Oscar Elton Sette* between 25 August and 28 September 2003. A combination of tow-board, dive and surface surveys were employed in assessing turtle presence. Towed-diver surveys (Hill & Wilkinson 2004) consisted of three SCUBA divers being towed by a single boat. Two of the divers searched from distances roughly 1 to 2 m above the substrate, while a third diver searched for turtles from a shallower depth in the water column. Although tows transited deeper waters, dive depths did not exceed 40 m and covered mainly shallower waters when surveying submerged reef tops and edges. Dive surveys were made between depths of 13 and 25 m by two additional teams of three and five people using SCUBA who collected data on turtles while assessing fish, invertebrate and algal (Preskitt et al. 2004) community composition along three 25 m transects at each dive location (dive surveys at Zealandia Bank were conducted along pinnacle walls where lines could not be laid. Transect lengths were estimated at 50 m for each of two pinnacles). A third team, responsible for mooring unrelated scientific instrumentation, also watched for and reported on turtle sightings at Supply and Santa Rosa Reefs. The greatest lengths of the areas transited underwater by this team were estimated and reported with the dive survey information. Surface waters covering the reefs were transited and searched extensively by three to five support boats at each site. All boat and dive personnel were familiarized with turtle search and reporting objectives and were interviewed by a turtle survey coordinator following each site visit. Turtles observed were identified to species and their approximate locations were marked using Garmin 76S handheld geographic positioning systems. Observation time, turtle activity, size (visually estimated straight carapace length, SCL), and habitat related characteristics were recorded.

Fleshy macroalgae were collected from two survey routes at each isolated reef, with the exception of Supply (one site) and Tatsumi Reefs (no alga collections made), and were identified to species. Coralline algae were lumped into crustose and upright functional groups. Minute turf algae, although present at all sites, were not identifiable in the field and are not considered in this study.

Results

A total of 34 hrs of submerged and 36 hrs of surface surveys were conducted at the seven isolated reefs systems. This included 21 tows and 13 separate dives, with up to five boats used for surface surveys. A total of only three individual green turtles *(Chelonia mydas)* were observed at the seven reefs: one each at Supply Reef, Zealandia Bank and Arakane Reef. No turtles were observed at Stingray Shoals, Pathfinder Reef, Tatsumi Reef or Santa Rosa Reef. Two of the turtles were of juvenile size (< 70 cm SCL), and one was of a larger size where maturity status was difficult to determine (Table 1).

Table 1. Turtle observations at isolated reef systems of the Mariana Archipelago during 25 August to 28 September 2003 surveys.

Site	Date	Reef Area (km^2) within Depth Contour[1] (40 m)	(100 m)	Shallowest Depth (m)	Method	Time (hr:min)	No. Transects	Transect Length (km)	No. Turtles Observed	Species	Estimated Turtle Size SCL (cm)
Stingray Shoals	8/29	0.28	0.67	17	Surface	6:24	(4 boats)	–	0		
					Towed-diver	2:52	4	7.23	0		
					Dive	2:13	2	0.15	0		
Supply Reef	9/1	0.11	0.55	9	Surface	6:59	(5 boats)	–	0		
					Towed-diver	0:27	1	1.16	0		
					Dive	2:10	2	0.13	1	Gn[3]	60
Zealandia Bank	8/25	0.09	1.5	0	Surface	5:47	(5 boats)	–	1[2]	Gn	55
					Dive	2:32	2	0.10	1[2]	Gn	55
Pathfinder Reef	9/14	1.01	1.36	12	Surface	6:58	(4 boats)	–	0		
					Towed-diver	3:48	4	9.73	0		
					Dive	2:32	2	0.15	0		
Arakane Reef	9/15	0.72	1.08	10	Surface	8:40	(4 boats)	–	0		
					Towed-diver	5:12	6	13.80	1	Gn	80
					Dive	2:47	2	0.15	0		
Tatsumi Reef	9/17	3.0	6.6	11	Surface	2:32	(5 boats)	–	0		
					Towed-diver	2:43	3	8.72	0		
Santa Rosa Reef	9/28	25.1	30.7	9	Surface	8:26	(3 boats)	–	0		
					Towed-diver	2:49	3	7.38	0		
					Dive	3:44	3	0.18	0		

[1]Reef areas within 40 m and 100 m depth contours were determined from boat and shipboard measurements, except Tatsumi and Santa Rosa Reefs, which were based on NOAA charts.

[2]The two turtle observations at Zealandia Bank were likely of the same turtle at different times and depths.

[3]Gn = green turtles.

Table 2. Algal species located at CNMI and Guam banks, shoals and isolated reefs. Station numbers where alga were found are presented to indicate commonality on a reef.

Alga	Stingray Shoals	Supply Reef	Zealandia Bank	Pathfinder Reef	Arakane Reef	Santa Rosa Reef	Listed *C. mydas* Food Source[1]
Chlorophyta							
Avrainvillea nigricans						1, 2	
Boodlea composita						2	
Boodlea vanbosseae					1		
Caulerpa peltata				1			
Caulerpa urvilleana						1, 2	✓
Caulerpa sp.						2	?[2]
Chlorodesmis sp.				1, 2	1		
Dictyosphaeria cavernosa					2	1, 2	✓
Dictyosphaeria versluysii		1	1, 2	1	1	1, 2	✓
Halimeda cylindracea						1, 2	
Halimeda taenicola			1, 2	1, 2	1, 2	2	
Halimeda spp.			1, 2		1, 2	2	?
Microdictyon okamurai					1, 2	1, 2	
Neomeris sp.				1, 2		1	
Rhipidosiphon javensis					2		
Rhipilia sinuosa			1		2		
Udotea argentea						1, 2	
Ventricaria ventricosa		1	1, 2	1, 2	2		
Phaeophyta							
Lobophora variegata		1					
Rhodophyta							
crustose coralline		1		1, 2	1, 2	1	
gelid						1, 2	?
Laurencia sp.	1, 2			1			?
Liagora ceranoides						1	
non-geniculate branched coralline						1	
Peyssonnelia rubra				2			
Cyanophyta		1	1, 2	1, 2	1, 2	2	
Total No.							
26	1	5	6	10	12	17	3 to 7

[1]Species listed as food for green turtles by Hirth (1997).

[2]? = Listed as green turtle food by Hirth (1997), but species may differ.

Algal collections from six of the seven reef systems revealed 26 macroalgal species, with an increase in diversity from north to south (Table 2). The number of observed species was positively correlated with reef area ($\log_{10}$ transformed) within the 40 m contour (Pearsons r = 0.845, P = 0.034). Green algae accounted for 69% of total species recorded, with species of the calcified genus *Halimeda* being among the most dominant algae at all sites except for Stingray Shoals. When compared to lists of plants known to be eaten by green turtles, only three

(12%) of the species found represented known food sources (Hirth 1997), with limited abundance in areas observed (P. Vroom pers. obs.). However, unidentified species in four recorded genera may also be utilized. Edible algal species were identified on reefs where green turtles were observed (Table 2).

Discussion

This study is the first we know of to survey for turtles at banks, shoals and other isolated reefs within the Mariana Archipelago and is a part of ongoing efforts to ascertain the abundance and distribution of resident turtles throughout the CNMI (Pultz et al. 1999, Belt Collins Hawaii & Marine Research Consultants 2000, Kolinski et al. 2001, 2004, in prep., Ilo & Manglona 2001, 2002, Belt Collins Hawaii 2003, The Environmental Company 2004) and the Territory of Guam (Davis et al. unpubl. data, Kolinski et al. unpubl. data). The seven sites are likely to be representative of shallow (< 40 m) isolated reef systems throughout the archipelago. The absence or limited number of turtle sightings is consistent with reports by fishers visiting these and other isolated reefs in the region (Larry Ilo, CNMI Division of Fish & Wildlife, pers. comm., Gerry Davis, Guam Division of Aquatic & Wildlife Resources, pers. comm.).

Surveys to date have highlighted the numerical dominance of green turtles within Mariana waters (Pritchard 1982, Wiles et al. 1995, Pultz et al. 1999, Belt Collins Hawaii & Marine Research Consultants 2000, Ilo & Manglona 2001, 2002, Kolinski et al. 2001, 2004, in prep., Belt Collins Hawaii 2003, The Environmental Company 2004). Green turtles were the only species encountered in this study. The limited numbers or absence of green turtles at these isolated reef systems may be due to a number of factors including: a long history of hunting and egg gathering at Indo-West Pacific breeding rookeries; low probability of turtles transitioning from the post-hatchling pelagic phase encountering small isolated reefs for benthic recruitment; inadequate habitat and forage resources; increased exposure to predation by sharks, and; increased energetic effort required to remain over a small isolated reef during high ocean wave and current events. Observations of low diversity and abundance of listed (Hirth 1997) green turtle food resources within the limited areas surveyed suggest that, while green turtles appear to be supported in low numbers at certain isolated reefs, perhaps for transitory periods of time, overall resources may be inadequate to support large resident populations.

Although the full contribution of isolated reef systems to turtle population status and dynamics remains unknown, these systems do not presently appear to support large turtle numbers on a resident basis in the Mariana region. This information has obvious implications when attempting to project turtle population sizes for the CNMI (Kolinski et al. 2004, in prep.), and Territory of Guam (Davis et al. unpubl. data, Kolinski et al. unpubl. data). Unless a seasonal component exists, these low numbers suggest that interactions between sea turtles and bottom-fishing activities in these areas are likely to be rare. Research, management

and recovery efforts might best be focused around island areas where turtles are known to occur in larger numbers and impacts are likely to be identified and subsequently addressed.

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