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Seabird Associations with Marine Turtles in the Eastern Pacific Ocean

ROBERT L. PITMAN

Southwest Fisheries Science Center
P.O. Box 271
La Jolla, CA 92038

Abstract.—I analyzed seabird associations with marine turtles observed during 22 research vessel cruises in the eastern tropical Pacific Ocean (ETP) from 1976-1990. Of 3,032 individual turtles sighted, 176 (5.8%) were accompanied by a total of 412 birds of 13 species, with three species of boobies accounting for 63% of the associated birds. The mean number of birds per associated turtle was 2.3 (S.D. = 9.63; range 1-125); single birds occurred with 82% of the associated turtles. Seabirds utilized turtles the same way they used other floating objects on the ocean, i.e., as roosting platforms and to feed on fish that aggregated beneath them. Larger flocks (i.e., > 5 birds) occurred with turtles only when the turtles were associated with flotsam and schools of predatory fish; in each of these cases birds foraged over the fish and appeared to be only incidentally associated with turtles. The olive ridley (*Lepidochelys olivacea*) is by far the most abundant sea turtle of the five species that occur in the ETP and the only species observed with associated birds. Although millions of olive ridleys have been harvested in the ETP over the past several decades, it is still an abundant species and continues to represent a small but contributing resource for foraging seabirds, especially boobies. *Received 6 January 1991, revised 30 April 1993, accepted 16 May 1993.*

Key Words.— eastern Pacific, *Lepidochelys olivacea*, marine turtles, olive ridley, seabird associations.

Colonial Waterbirds 16(2): 194-201, 1993

Seabirds are known to associate commonly with marine vertebrates, including whales, dolphins, pinnipeds and schooling fishes, in order to feed on prey made available when these animals forage near the surface (e.g., Ashmole and Ashmole 1967, Evans 1982, Burger 1988, Harrison *et al.* 1991, Pitman and Ballance 1992). Anecdotal accounts suggest that seabirds also interact with marine turtles, at least in the eastern tropical Pacific Ocean (ETP), where birds, mainly boobies, use turtles as roosting platforms at sea (Oliver 1946, Murphy 1958, Eder 1969, Marquez 1990). In other oceanic areas, references to seabirds interacting with turtles are very rare (e.g., Fritts *et al.* 1983:47-48).

Extant marine turtles comprise two families: *Cheloniidae*, with six "hard-shelled" species, and *Dermochelyidae*, the unique and monospecific leatherback. Cheloniids are cosmopolitan in tropical and warm temperate oceans, where they are largely confined to shallower continental shelf waters. The leatherback is the most pelagic sea turtle, and although it apparently prefers to forage in cool temperate waters, it nests on tropical beaches (Marquez 1990).

Five species of sea turtles occur in the ETP (Pitman 1990). The olive ridley (*Lepidochelys olivacea*) is by far the most abundant and widespread sea turtle in the warmest waters of the eastern Pacific. The loggerhead (*Caretta caretta*) replaces olive ridleys in the cooler water of the California Current off Baja California where it is locally abundant. The green turtle (*Chelonia mydas*, or sometimes referred to as *Chelonia agassizi* in the eastern Pacific) is fairly common near the continental coast or in the immediate vicinity of breeding islands (e.g., Revillagigedos, Galapagos), but very rare on the open ocean. The hawksbill (*Eretmochelys imbricata*) is easily the rarest turtle anywhere in the ETP, especially in pelagic waters. The leatherback (*Dermochelys coriacea*) is also rarely seen on the open ocean despite being readily identifiable.

Although many turtle populations in the ETP have been reduced or extirpated by human activities, some species are still common, or even abundant, in some areas of their range and thus available for interactions with seabirds. I recorded and analyzed bird associations with turtles in the ETP in order to examine the prevalence and nature of these interactions. In this paper, I describe these associations, identify the bases for their occurrence, and comment on their ecological significance.

STUDY AREA AND METHODS

The study site included an open ocean area of more than 20 million km², from California to Peru and west to approximately the longitude of Hawaii (ca. 155°W; Figure 1). Data on turtle sightings were collected opportunistically during 22 dolphin survey cruises that I participated in from 1976 to 1990. During these cruises, one or two observers searched the ocean for dolphin schools during all daylight hours, weather permitting, using mounted 20 or 25x binoculars (see Holt and Sexton 1989 for details of general survey methodology). Vessel speeds averaged 18.5 km h^{-1} with cruise tracks laid out to maximize area covered within the study area. The effort in this study represents approximately 1800 days at sea.

All sightings of turtles, either by the author or reported to the author, were recorded, along with the number and identification of any associated birds. Birds were considered associated with a turtle if they were roosting on it, circling overhead, or sitting on the water within 10 m of it. The data on bird associations were biased by the fact that lone turtles were much less conspicuous than turtles with associated birds, especially if the birds were numerous or conspicuous in their activity.

Turtles were classified as either alive or dead. Floating dead turtles were difficult to distinguish from live turtles and turtles not specifically identified as dead were considered alive. Live turtles were recorded as either solitary or associated with flotsam if they occurred within 10 m of a floating object. Any predatory fish associated with turtles were identified when possible, but most of the turtles were too far from the ship to determine if fish were present or not.

At sea, the distinctive leatherback is easy to recognize, but all the remaining hardshell species of sea turtles can be difficult to identify to species under normal field conditions. Therefore, starting in 1986, as part of a project to study sea turtle distribution in the ETP, I was given the opportunity to divert the ship in order to pass close enough by individual turtles to photograph them at the surface. The photos were later examined to identify individual turtles to species. This provided me with a sample of identified individuals and eventually gave me enough experience with turtle identification to allow me to identify individuals in the field without photographing them.

The olive ridley is by far the most abundant marine turtle in the ETP as shown by nesting beach censuses (e.g., Cliffton *et al.* 1981, Cornelius 1981) and open ocean surveys (Pitman 1990, Au 1991). It was the only hardshell species I identified in the open tropical ocean, where most of my survey effort took place. Therefore, for the purposes of this study, all unidentified hardshell turtles were assumed to be that species.

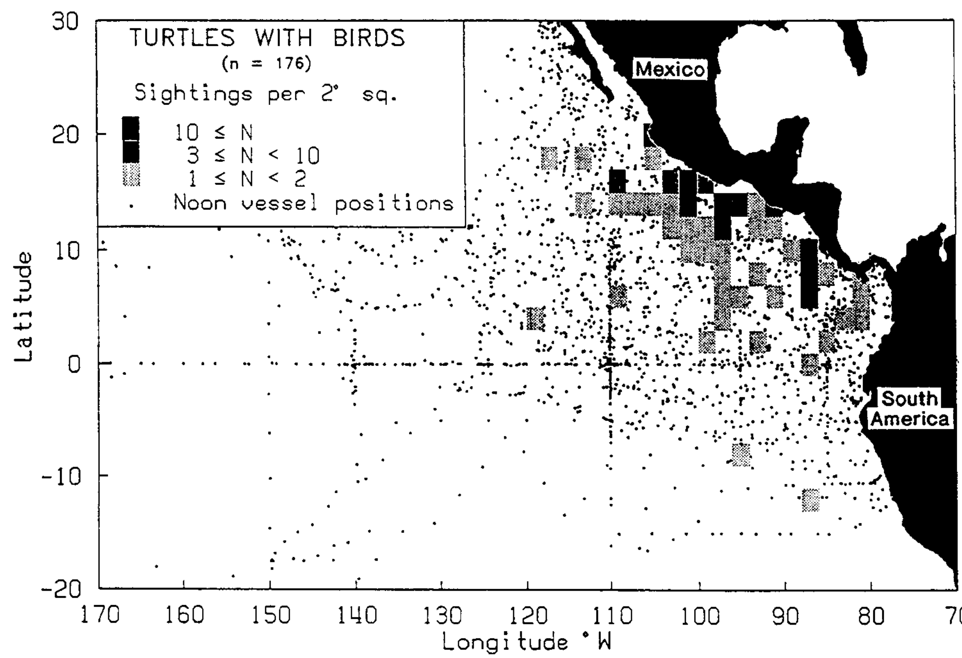

Figure 1. Study area showing locations and numbers of turtles associated with seabirds plotted by 2° area; noon vessel positions are locations where there was survey effort but no birds were seen associated with turtles (see Pitman 1990 for additional details).

Table 1. Number of occurrences and mean number of birds (±SD) for seabirds occurring with different categories of sea turtles in the eastern Pacific. Bird species are arranged by functional groups (see text).

	Turtle Categories									
	All turtles with birds associated (N = 176)		Live turtles no flotsam (N = 149)		Dead Turtles (N = 12)		Turtles with flotsam (N = 10)		Turtles with flotsam and predatory fish (N = 5)	
Bird species	N	mean ± SD	N	mean ± SD	N	mean ± SD	N	mean ± SD	N	mean ± SD
A.										
Booby species *Sula* spp.	25	1.2 ± 0.7	25	1.2 ± 0.7	–	–	–	–	–	–
Masked Booby *S. dactylatra*	79	1.3 ± 0.8	61	1.2 ± 0.7	8	1.0 ± 0.0	7	2.0 ± 1.1	3	1.0 ± 0.0
Red-footed Booby *S. sula*	38	1.8 ± 2.3	30	1.2 ± 0.5	2	1.0 ± 0.0	4	2.2 ± 0.8	2	11.0 ± 1.0
Brown Booby *S. leucogaster*	31	1.4 ± 1.6	24	1.0 ± 0.0	4	1.8 ± 1.0	2	1.5 ± 0.5	1	10.0 ± 0.0
Black Tern *Chlidonias niger*	8	1.0 ± 0.0	8	1.0 ± 0.0	–	–	–	–	–	–
B.										
Wedge-tailed Shearwater *Puffinus pacificus*	3	29.7 ± 47.9	1	3.0	–	–	1	1.0	1	85.0
Frigatebird species *Fregata* spp.	6	4.2 ± 3.2	–	–	1	4.0	–	–	5	4.2 ± 3.2
Sooty Tern *Sterna fuscata*	3	10.7 ± 8.1	–	–	–	–	–	–	3	10.7 ± 6.6
C.										
Jaeger species *Stercorarius* sp.	1	1.0	–	–	–	–	–	–	1	1.0
Parasitic Long-tailed Jaeger *S. parasiticus/longicaudus*	1	1.0	1	1.0	–	–	–	–	–	–

Swallow-tailed Gull *Creagrus furcatus*	1	1.0	–	–	–	–	–	–	1	1.0
Tern species *Sterna* sp.	1	1.0	1	1.0	–	–	–	–	–	–
Artic Tern *S. paradisaea*	1	1.0	1	1.0	–	–	–	–	–	–
Bridled Tern *S. anaethetus*	1	1.0	1	1.0	–	–	–	–	–	–
White Tern *Gygis alba*	1	1.0	–	–	–	–	–	–	1	1.0
Noddy species *Anous* sp.	1	7.0	–	–	–	–	–	–	1	7.0
Black Noddy *A. tenuirostris*	1	1.0	1	1.0	–	–	–	–	–	–
D.										
All birds	176	2.3 ± 9.6	149	1.2 ± 0.7	12	1.7 ± 1.4	10	2.7 ± 1.4	5	36.6 ± 44.8
Number of bird species	176	1.1 ± 0.6	149	1.0 ± 0.2	12	1.2 ± 0.4	10	1.4 ± 0.5	5	3.8 ± 1.6

RESULTS

A total of 3,032 individual turtles were sighted, including 277 (9.1%) olive ridleys, 42 (1.4%) loggerheads, 31 (1.0%) leatherbacks, 22 (0.7%) greens, 1 hawksbill, and 2,659 (87.7%) unidentified hardshell turtles. Of these, 176 individual turtles (5.8%) had associated birds (Table 1). Birds were associated with 37 olive ridleys and 139 unidentified hardshell turtles; no other turtle species was observed with birds. There was an overall mean of 2.3 birds/associated-turtle (SD = 9.6), ranging from 1 to 125, with a mode of 1. The mean number of bird species associated with individual turtles was 1.1 (SD = 0.6), with a range of 1-6. Although seabirds associated with marine turtles throughout much of the ETP (Fig. 1), associations were more common closer to the coast of the Americas, where turtles were more abundant (Pitman 1990).

A total of 412 individual birds of 13 species were associated with turtles (Table 1). Boobies, induding Brown (*Sula leucogaster*), Red-footed (*S. sula*) and Masked (*S. dactylatra*), were by far the most commonly associated species: they accounted for 63% of the individual birds that occurred with turtles and they were present with 91% of the turtles that had associated birds.

Bird species associated with turtles comprised three general categories. The first included the species which were associated with turtles most often, but typically in small numbers (mean < 2 birds/associated-turtle) (Table 1a). These included all three booby species and the Black Tern (*Chlidonias niger*). Olive ridleys often basked at the surface and these birds were most often seen perching on their exposed carapaces. There was room for only one bird at a time to stand on top of the small, rounded portion of a turtle's exposed carapace, and single birds were present in 82% of the cases.

The second group of turtle-associated birds was comprised of species that occurred less frequently with turtles, but in larger numbers per turtle when they did. These species were Wedge-tailed Shearwaters (*Puffinus pacificus*), frigatebirds (*Fregata* spp.) and Sooty Terns (*Sterna fuscata*) (Table 1b). This group was further distinguished by the fact that none of these birds were ever seen roosting on turtles, and 94% of all the individuals of these species that occurred with turtles did so when both flotsam and schools of predatory fish were also present. The third category was comprised of species that were recorded only once with turtles, and usually with only one bird present (Table 1c).

Although not statistically significant, there was a trend of increasing number of associated birds and number of bird species from solitary turtles, to dead turtles, to turtles associated with flotsam (Table 1d). Every bird species recorded with turtles more than once, except Black Tern, was more numerous when turtles were associated with flotsam (Table 1a,b,c). Compared with other turtle categories, turtles associated with flotsam and tunas had the largest and most diverse bird flocks with significantly more individual birds (Single Factor ANOVA, $F = 34.2$, $P < 0.001$) and species of birds (Single Factor ANOVA, $F = 101.7$, $P < 0.001$). The five largest flocks associated with turtles, including all flocks of over five birds, were associated with flotsam that had predatory fish schools underneath.

Two general categories of schooling fishes associated with turtles, which provided different foraging opportunities for birds: small baitfish and larger schooling predators. Schools of small baitfish were often seen swimming near turtles that the ship passed close by. The species identified included flotsam fish (*Psenes cyanophrys*), pilotfish (*Naucrates ductor*), pelagic triggerfish (*Canthidermis maculatus*), tripletail (*Lobotes surinamensis*), and numerous others. These fishes seemed to be seeking protection because they often responded to the vessel, and predatory fish, by forming tight schools directly underneath the turtle. The same behavior was observed when the ship passed by flotsam with baitfish associated.

Birds, especially boobies, were observed preying upon these fish. On calm days when turtles were present, it was fairly common to see a flying booby change course to approach a turtle at the surface. The booby would either land on the turtle or on the water close by, plunge into the water next to it, or circle overhead once or twice and continue on its way. Boobies fed most often around turtles by plunge-diving within 2 m of them; on several occasions I saw boobies catch fish this way. Although plunge-diving was the most common foraging behavior, birds were also able to use other foraging methods to catch fish associated with turtles. For example, on two separate occasions I saw a single booby land next to a turtle, stick its head in the water, under the turtle, and pull out a fish which it swallowed. Another time I saw three Wedge-tailed Shearwaters making shallow dives directly undeneath a turtle, but it was impossible to tell if they were successful in catching fish.

The second category of fish that associated with turtles usually occurred when turtles were associated with flotsam and was comprised of larger schooling predators that included mainly tunas. (At these sites, we caught yellowfin tuna [*Thunnus albacares*], skipjack [*Katsuwonus pelamis*], black skipjack [*Euthynnus lineatus*], mahi mahi [*Coryphaena hippurus*] and wahoo [*Acanthocybium solandri*]). The birds in these flocks (mainly shearwaters, terns, frigatebirds, and also boobies) focused on the feeding activity of the foraging fish and fed on prey scattered by them.

The only other kind of foraging interaction I observed between birds and turtles at sea involved a single Parasitic or Long-tailed Jaeger (*Stercorarius parasiticus* or *S. longicaudus*) sitting on the water next to an olive ridley and picking at epibionts along the edge of the carapace (probably taking either commensal crabs or soft barnacles). This behavior was observed only once.

DISCUSSION

The only species of sea turtle that seabirds were seen associated with in the eastern Pacific was the olive ridley. This was probably because it was by far the most abundant species in the study area (Pitman 1990), and also because of its habit, possibly unique among sea turtles, of regularly basking at the surface (Marquez 1990; pers. obs.).

ETP seabirds used sea turtles the same way they used other floating objects and the same way Atlantic seabirds use patches of *Sargassum* i.e., as roosts and to feed on fish that aggregate underneath them (Haney 1986).

Roosting

Most bird-associated turtles were accompanied by single birds, nearly all of which were roosting on turtles floating at the surface. One reason for this roosting behavior may be that seabirds sitting on the water, especially in the tropics, are vulnerable to attacks from sharks (e.g., Nelson 1978:921, Schreiber and Chovan 1986). Roosting on floating objects reduces this threat, and many seabirds in the ETP, especially boobies, will roost on any floating object large enough to support them (pers. obs.), including sea turtles. Haney (1986) also suggested that birds such as the Black Tern may seek out dry roosts for resting and preening because their plumages are less water-resistant.

Feeding

Unlike large schooling fish and mammals that drive prey to the surface making it available to birds (e.g., Au and Pitman 1986), turtles provided feeding opportunities for birds mainly by acting as passive fish aggregators, or FADs (Fish Aggregation Devices; see, for example, Rountree 1989). On the open ocean, small fishes are often attracted to floating objects (Hunter and Mitchell 1966, Gooding and Magnuson 1967), including turtles (Gooding and Magnuson 1967, Balazs 1981, this study). These fish seek out floating objects and form resident schools, presumably for protection and feeding. Many tropical seabirds, especially boobies, are attracted to floating objects on the open ocean where they prey upon these associated fishes (Haney 1986; pers. obs.).

Floating objects often attracted a second fish assemblage composed of larger, schooling, predatory fishes, which were observed with turtles only when the turtles associated with flotsam. Associations between birds and turtles in these cases were probably largely coincidental, because both turtles and predatory fish such as tuna are independently attracted to flotsam (Greenblatt 1978, Pitman 1990), and birds appeared to be mainly attracted to the feeding activities of the tuna.

The ability of floating FADs (including turtles) to attract fish (and therefore birds) is related to characteristics of the object, with larger, more stationary objects being more attractive (Tsukagoe 1981, Rountree 1989). This may explain the trend of increasing bird numbers and species associated with live turtles, dead turtles and turtles associated with flotsam, respectively.

Although the percentage of turtles with associated birds and the number of birds per associated turtle were both quite small, by dint of sheer numbers alone the olive ridley probably represents a more important resource for ETP seabirds than my small sample (3000) of turtle sightings suggests. For example, Richard and Hughes (1972) reported that two separate nesting beaches in Costa Rica each had over 100,000 olive ridleys aggregated offshore during peak nesting periods. And Cliffton *et al.* (1981) estimated that there was a minimum of 10,000,000 olive ridleys in Mexican waters prior to 1950, when commercial exploitation began. Populations of these magnitudes suggest a resource that is, or possibly was, of more than passing importance for ETP seabirds.

Several of the largest olive ridley rookeries in the eastern Pacific have been decimated by commercial harvests that, until recently, annually took hundreds of thousands of adult turtles and millions of eggs (Cliffton *et al.* 1981, Green and Ortiz-Crespo 1981). Carr (1972) estimated that more than one million olive ridleys were landed in Mexico in 1968 alone. Loss of marine turtles on this scale, regrettable in its own right, has undoubtedly reduced some of the options for foraging seabirds in the ETP. Recent bans on commercial sea turtle harvesting in the ETP by the two main countries involved, Mexico and Ecuador (Aridjis 1990, Frazier and Salas 1982), should benefit both marine birds and turtles.

ACKNOWLEDGMENTS

Sallie Beavers, Jim Cotton, Gary Friedrichsen, Scott Sinclair, and numerous other NMFS observers helped collect the sightings data; their assistance is gratefully acknowledged. David Au, Lisa Ballance, Jack Frazier and an anonymous reviewer provided useful comments on an earlier draft of this paper.

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