

## Great Frigatebird (*Fregata minor*) Predation: Not a Factor in Hatchling Green Turtle (*Chelonia mydas*) Survival at French Frigate Shoals, Hawaii

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**Abstract.**—Frigatebirds are known predators of sea turtle hatchlings at several locations worldwide. At certain localities this predation might exacerbate the already endangered status of these marine reptiles. French Frigate Shoals, Hawaii is where over 90% of all Hawaiian green turtle (*Chelonia mydas*) breeding occurs and is the site of a large Great Frigatebird (*Fregata minor*) colony. Frigatebird predation was not a factor in hatchling survival at this location. We found no evidence of green turtle hatchlings in the stomach contents of 200 Great Frigatebirds sampled during peak periods of hatchling emergence in 1988 and 1989. Received 3 June 1991, accepted 21 November 1991.

**Key words.**—*Chelonia mydas*, *Fregata minor*, Great Frigatebird, green turtle, Hawaiian Islands, predation.  
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In 1978, the Hawaiian green turtle (*Chelonia mydas*), with all other sea turtles under United States jurisdiction, was protected under provisions of the U.S. Endangered Species Act and a recovery plan for Hawaiian sea turtles (Balazs *et al.* 1990) was subsequently prepared. Because frigatebirds (*Fregata* spp.) prey on hatchlings in certain other *Chelonia* populations (Hirth 1971, Stancyk 1982), one of the actions recommended in the recovery plan was to investigate the extent of seabird predation on turtle hatchlings. We studied Great Frigatebird (*Fregata minor*) predation on green turtle hatchlings at French Frigate Shoals, Hawaii, where over 90% of all Hawaiian green turtle breeding occurs (Balazs 1980). Adult turtles from throughout the Hawaiian Archipelago migrate to this area to nest (Balazs 1976).

### STUDY AREA AND METHODS

French Frigate Shoals is a crescent-shaped atoll, 16 km in diameter, situated near the midpoint of the Hawaiian Archipelago. The atoll, part of the Hawaiian Islands National Wildlife Refuge, consists of 11 sandy islets and one volcanic pinnacle (for detail, see Amerson 1971).

In 1988 and 1989, we sampled stomach contents of Great Frigatebirds during the peak period of turtle hatchling emergence at French Frigate Shoals. To determine peak hatchling emergence, we monitored green turtle nesting activity on Tern Island by con-

ducting daily surveys of the island. We marked all turtle nests on the island and estimated their hatch dates based on a mean incubation period of 64.5 days (Balazs 1980). To verify the accuracy of the estimated period of peak hatchling emergence, nests were monitored until hatchlings emerged. Periodically, we visited the other islands to confirm that Tern Island data were representative of nesting activity throughout the atoll.

During the peak period of turtle hatchling emergence, we counted the number of Great Frigatebirds on Tern Island. Counts were conducted on windless evenings, when most frigatebirds at French Frigate Shoals roosted on Tern Island, and included adults, juveniles, and nestlings. Adults and juveniles were distinguished by their plumage characteristics. The juvenile category included subadults, immatures, and juveniles, as classified by Harrison (1983). The nestling category included flightless chicks and fledged chicks that were still being fed by their parents.

We captured frigatebirds by hand or with long-handled fish nets. We obtained stomach contents by inducing regurgitation by pumping seawater into the birds' stomachs (Wilson 1984). Stomach contents were emptied into a fine-mesh strainer and examined for evidence of turtle hatchlings. We identified contents to the family level when possible using Tinker (1982). The "unidentified fishes" prey category consists of partially digested fishes that could not be identified.

Because few frigatebird stomachs contained prey in the early morning hours, in 1988 we collected one-third of the samples in each of the following time periods: 1200-1400 h, 1730-1830 h, and 2000-2115 h. In 1989, we collected half of the samples between 1000 and 1200 h and the remainder between 1845 and 1930 h. All stomach content calculations are based upon only those birds which contained food items.

## RESULTS

Turtle nesting occurs on six of the sandy islets with about 90% of the nesting activity occurring on East and Whaleskate islands (Balazs 1980). Most of French Frigate Shoals' Great Frigatebird population nests on Tern Island, where there is a nesting colony of about 700 pairs. Few frigatebirds nest or roost on the other islets. However, frigatebirds from Tern Island feed throughout the atoll and in surrounding waters.

We estimated that 412 and 552 female green turtles nested at French Frigate Shoals during 1988 and 1989, respectively. Based on average clutch size, number of clutches laid per female, hatching success, and emergence success, we estimated that 106,000 hatchlings were available to frigatebirds in 1988 and 163,000 in 1989.

Comparison of data from our Tern Island turtle nest monitoring with observations of nesting activity on the other islets showed that hatchling emergence phenologies on all the islets were similar; turtle hatchlings emerged between early July and late December. Hatchling emergence peaked in September in both years.

During peak turtle hatchling emergence, numbers of Great Frigatebirds at French Frigate Shoals varied greatly between the two years. In 1988, about 15,000 frigatebirds, mostly adult females and immatures, roosted on Tern Island. The following year only about 4,000 frigatebirds were present. In both years, juvenile birds accounted for about half of the frigatebird population.

Between 12 and 28 September 1988, we analyzed stomach contents of 150 Great Frigatebirds (50 each of adults, juveniles, and nestlings). Stomach contents of another 50 nestlings were analyzed between 16 and 18 September 1989. No turtle hatchlings were found in any of the frigatebird stomachs sampled. We found prey items in 110 (73.3%) of the 150 birds sampled in 1988 (Table 1) and in 34 (68.0%) of the 50 frigatebird nestlings sampled in 1989. In 1988, the Fan-tail Filefish (*Pervagor pilosoma*) was the most important prey. No filefish were found in the 1989 samples, when flying fish and squids each contributed 38.2% of the 144 food items iden-

tified. The remaining 23.6% items were unidentified fishes.

## DISCUSSION

Turtle hatchlings emerge predominantly at night (Balazs 1980). After entering the water, they rapidly swim out to sea. Although little is known about the behavior of hatchlings at sea, they are probably restricted to the surface zone where they feed on macroplankton (Hirth 1971).

Because of their inability to take off from water, Great Frigatebirds feed by snatching prey from surface waters (Harrison *et al.* 1983) and by pirating food from other seabirds; however, pirating has been shown to be less significant than once thought (Nelson 1975, Schreiber and Hensley 1976). Most frigatebird feeding activity takes place in the daylight hours (Schreiber and Clapp 1987), and Nelson (1975) reported that Great Frigatebirds are reluctant to take food from land (except chicks of other seabirds). These factors limit the opportunity for frigatebirds to take turtle hatchlings during their nocturnal postemergence dash to the sea. We have not observed Great Frigatebirds attempting to take turtle hatchlings from land, not even when misdirected hatchlings are still wandering around the interior of the island after sunrise.

Although nestling frigatebirds do not capture prey themselves, we sampled the contents of their stomachs. Adults, needing to supply food to ravenous nestlings, may be more opportunistic in their prey selection, taking a wider variety of prey items. Therefore, stomach contents of nestlings needed to be examined. If parental food requirements do not alter prey selection, prey items fed to the nestlings should be representative of the adults' diet.

Turtle hatchlings should be available to frigatebirds in the waters surrounding the atoll. However, we found no evidence of turtle hatchlings in the stomach contents of the 200 Great Frigatebirds that we sampled. Harrison *et al.* (1983) found no green turtle hatchlings in 284 Great Frigatebird regurgitations collected throughout the northwestern Hawaiian Islands during all months except December and January.

Table 1. Stomach contents of adult, juvenile, and nestling Great Frigatebirds collected at Tern Island, French Frigate Shoals, during September 1988.

Prey	Adults (40 birds)		Juveniles (36 birds)		Nestlings (34 birds)		Combined (110 birds)	
	N(%) <sup>1</sup>	% Occur. <sup>2</sup>	N(%)	% Occur.	N(%)	% Occur.	N(%)	% Occur.
Fishes	220(97.8)	100.0	135(97.8)	97.2	186(76.9)	88.2	541(89.4)	95.5
Filefish (Monacanthidae)	194(86.2)	77.5	108(78.3)	75.0	110(45.5)	44.1	412(68.1)	66.4
Flying Fish (Exocoetidae)	6( 2.7)	5.0	20(14.5)	16.7	56(23.1)	35.3	82(13.6)	18.2
Tuna (Scombridae)	3( 1.3)	2.5	1( 0.7)	2.8	-	-	4( 0.7)	1.8
Unidentified	17( 7.6)	20.0	6( 4.3)	8.3	20( 8.3)	26.5	43( 7.1)	18.2
Squid	5( 2.2)	5.0	3( 2.2)	5.6	56(23.1)	38.2	64(10.6)	15.5

<sup>1</sup>N = number of food items in the category (% of the total number of food items).

<sup>2</sup>% Occurrence = the percentage of birds that contained that prey type.

Balazs (1980) found no evidence of turtle hatchlings in fecal matter at Great Frigatebird nesting and roosting sites at French Frigate Shoals. Therefore, we conclude that Great Frigatebird predation in the vicinity of French Frigate Shoals is not a factor in green turtle hatchling survival.

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