PIFSC MARINE TURTLE RESEARCH

Focus of Investigations and Activities

1. Pacific Islands sea turtle biology, ecology and life history

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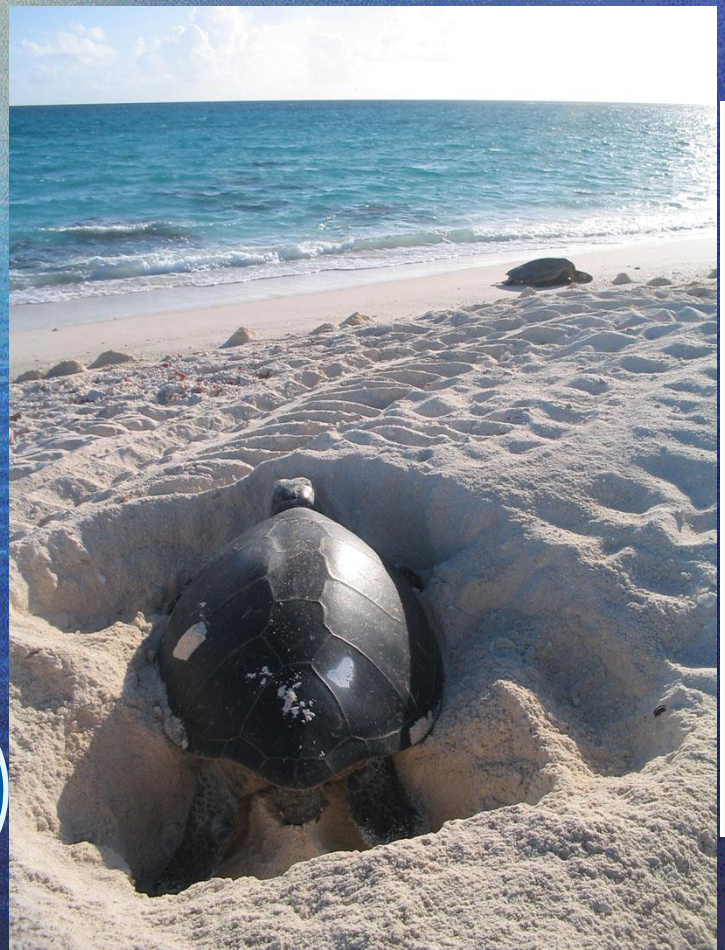
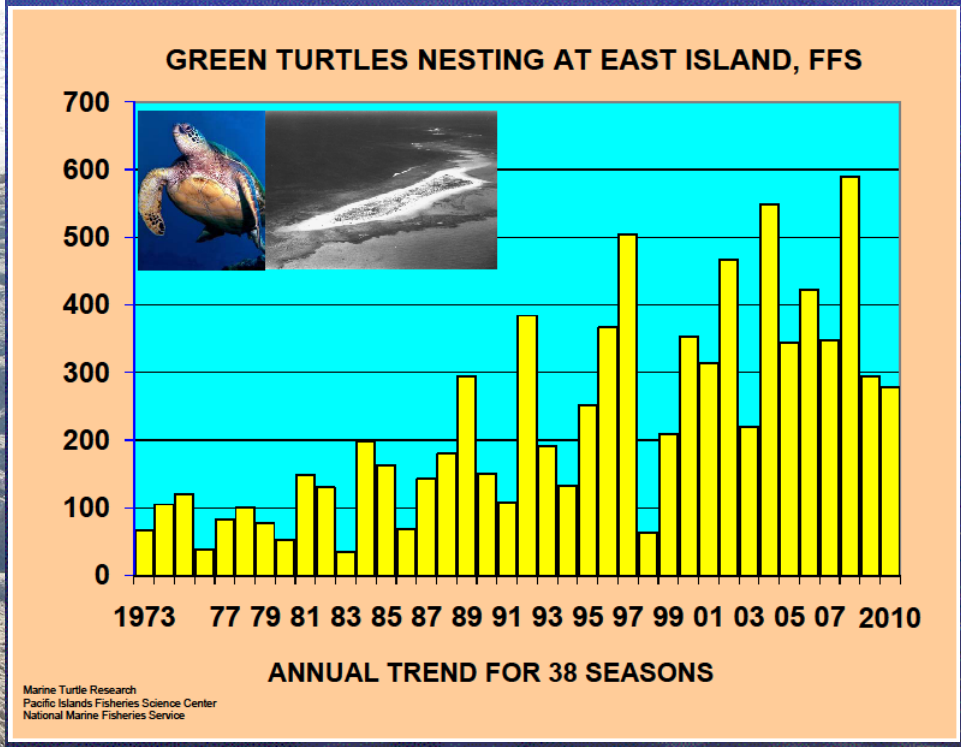
2. Monitoring long term trends at nesting beaches and in foraging areas





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3. Simulation modeling of population dynamics for stock assessment

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4. Health assessments including fibropapilloma disease complex

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5. Stranding, salvage and necropsy research for long term population dynamics data collection

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6. Fishery observer training for pelagic data collection

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7. Research training and capacity building of Pacific islanders and Pacific Rim personnel

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8. Educational outreach using our research results

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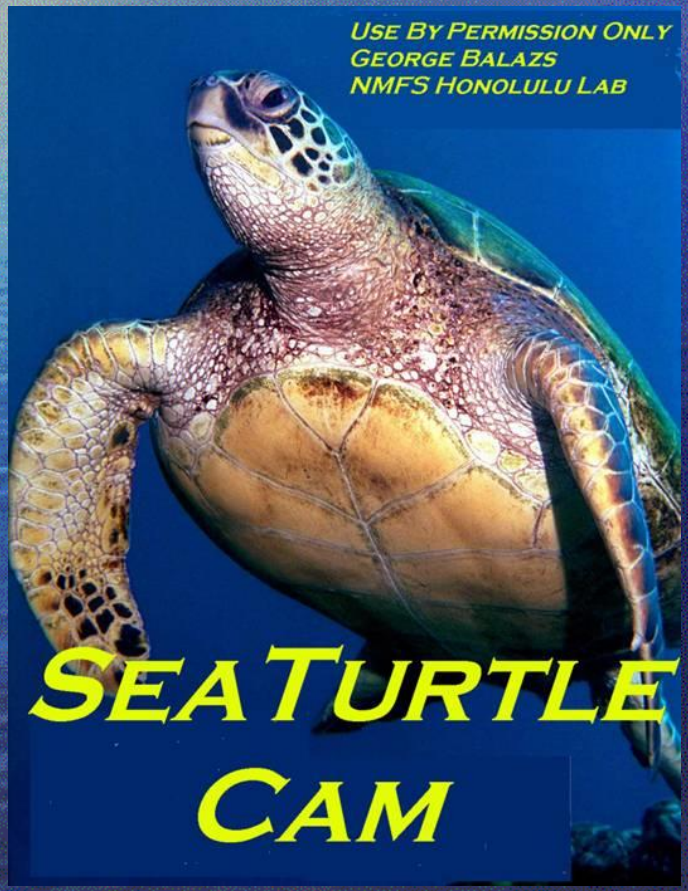
9. "Remote Viewing" for experimental turtle monitoring using hi-tech cameras



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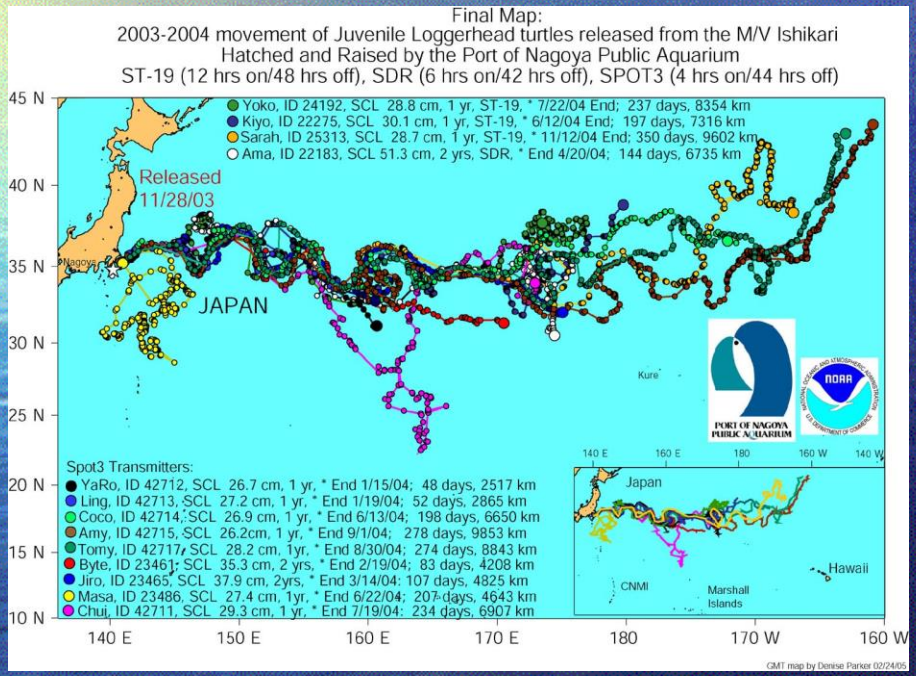
10. Pelagic ecology of Japanese loggerheads for bycatch reduction



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11. Publish findings in peer reviewed journals

Available online at www.sciencedirect.com
SCIENCE DIRECT
ELSEVIER
Biological Conservation 117 (2004) 491–498
BIOLOGICAL CONSERVATION
www.elsevier.com/locate/biocon

Thirty-year recovery trend in the once depleted Hawaiian green sea turtle stock

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Abstract

The green sea turtle is one of the long-lived species that comprise the charismatic marine megafauna. The green turtle has a long history of human exploitation with some stocks extinct. Here we report on a 30-year study of the nesting abundance of the green turtle stock endemic to the Hawaiian Archipelago. We show that there has been a substantial long-term increase in abundance of this once seriously depleted stock following cessation of harvesting since the 1970s. This population increase has occurred in a far shorter period of time than previously thought possible. There was also a distinct 3–4 year periodicity in annual nesting abundance that might be a function of regional environmental stochasticity that synchronises breeding behaviour throughout the Archipelago. This is one of the few reliable long-term population abundance time series for a large long-lived marine species, which are needed for gaining insights into the recovery process of long-lived marine species and long-term ecological processes.

Keywords: Green sea turtle; Abundance; Population recovery; French Frigate Shoals; Hawaii

1. Introduction

The green turtle (*Chelonia mydas*) has a circumtropical distribution with distinct regional population structures (Bowen et al., 1992) and is the most abundant large marine herbivore (Bjorndal, 1997). Globally, the green turtle has been subject to a long history of human exploitation with some stocks now extinct and others in decline (Frazier, 1980; Witzell, 1994). Yet despite being recognized as globally threatened (National Research Council, 1990) there are few reliable assessments of abundance status and trend of any green turtle stock (Chaloupka and Limpus, 2001). Reliable long-term estimates of population abundance trends are needed to support recovery planning (Foin et al., 1998), model sea turtle demography (Chaloupka, 2002) and are essential for developing a better understanding of long-term ecological processes (Inchausti and Halley, 2001).

For sea turtles, such population abundance estimates are based preferably on foraging ground capture–mark–recapture programs that can provide more detailed sex- and age-class-specific demographic information (Limpus and Chaloupka, 1997; Chaloupka and Limpus, 2001, 2002). However, capture–mark–recapture programs in the marine environment for large and highly mobile species such as sea turtles are very difficult and expensive to conduct and so are rarely undertaken (Limpus and Chaloupka, 1997; Bjorndal et al., 2000). Nearly all assessments of sea turtle population abundance have been based on trawl based catch-per-unit-effort estimation, aerial survey based density estimation or, more commonly, by monitoring the number of females that come ashore each year to nest at stock-specific rookeries (see review in Chaloupka and Limpus, 2001).

Monitoring beach nesting is by far the easiest and least expensive means to assess green turtle population abundance but short-term surveys (<10 years) are inadequate for several reasons (Chaloupka and Limpus, 2001). Most notably because green turtles are long-lived (Limpus and Chaloupka, 1997; Zug et al., 2002) and females skip several nesting seasons due to nutritional constraints (Bjorndal, 1997). Hence, long-term nesting beach surveys are essential if this form of assessment of

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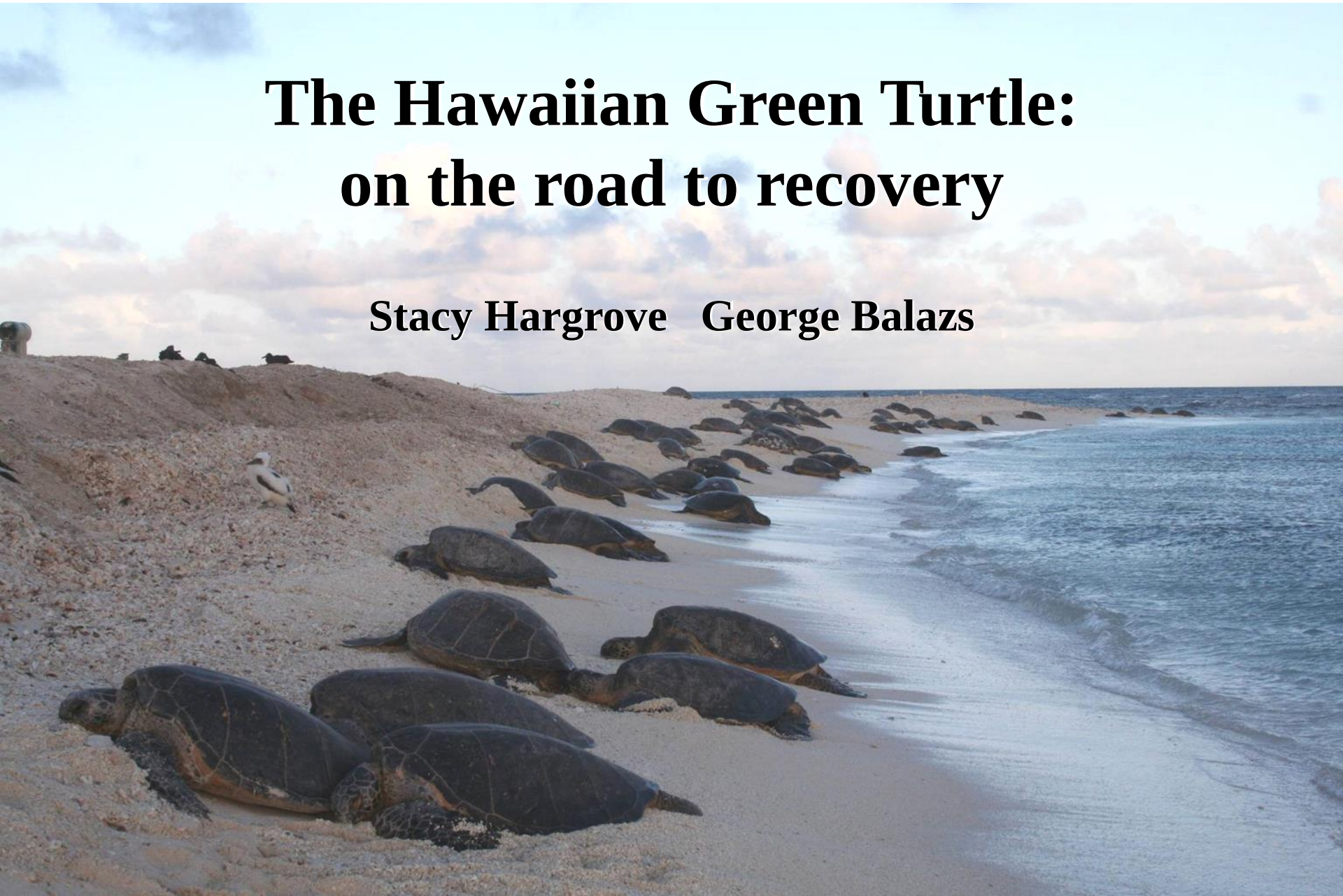
The Hawaiian Green Turtle: on the road to recovery

Stacy Hargrove George Balazs



"…it appears that Hawaii has one of the few *Chelonia* populations in which protection is not complicated by international migrations…With both the feeding pastures and breeding grounds under the jurisdiction of a single country, one would hope to find a healthy population that has not undergone ecologic decline. Unfortunately, Hawaii's green turtles have nevertheless experienced serious losses…"

~ Defenders of Wildlife, 1975

History

- Hawaiian Islands Bird Reservation established by T. Roosevelt in 1909 – changed name to HINWR in 1940
- Nesting habitat destruction at FFS thru 1960s
- Females and eggs harvested until 1959 – USFWS permanently assigned to FFS in 1964
- Annual surveys of nesting females - 1973
- Harvested on foraging grounds until 1974; home consumption still allowed
- ESA listed 1978

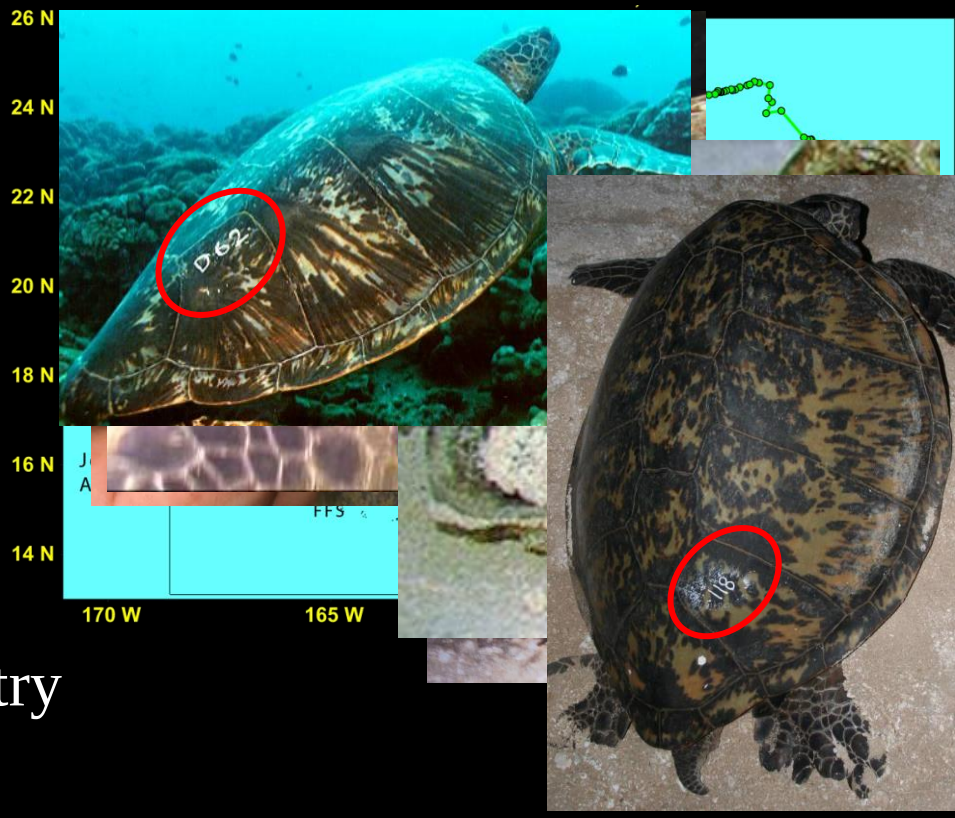
How many green turtles are there in Hawaii?

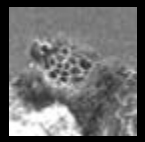
Population Abundance Estimates

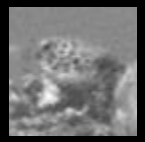
- Trawl-based CPUE estimation
- Aerial survey-based density estimation
- Capture-mark-recapture on foraging grounds
  - – Difficult & expensive
- Count nesting females
  - – Easiest & least expensive

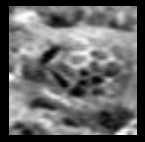
Connecting the Foraging Grounds and Nesting Beaches

- mtDNA
- ID Individuals
  - Tags
  - Mototool
  - Head Scales
- Satellite Telemetry



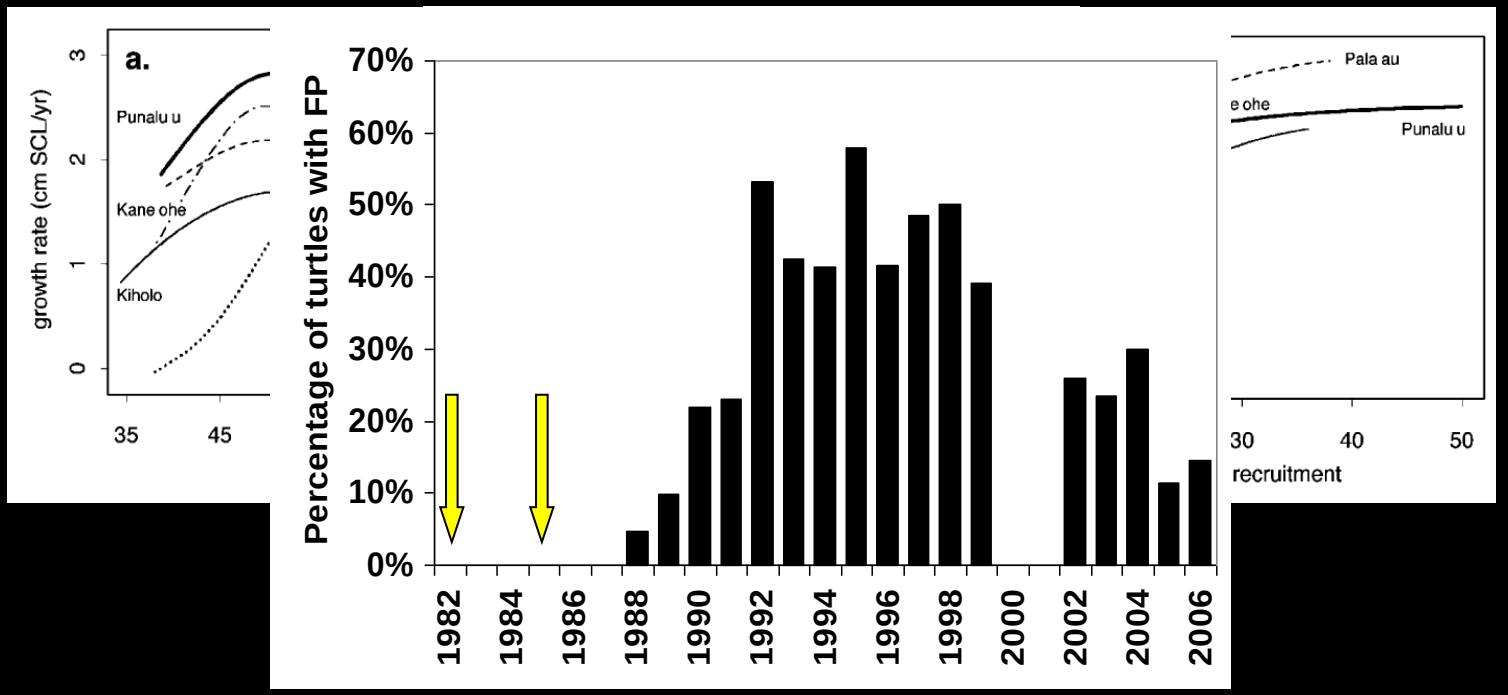






Annual records for Tutu U521	
1990	First sighted at the Turtle House. Tagged female. Tumors on both eyes and one tumor near tag on right front flipper. Overall Tumor Score Light
1991	**Nesting, French Frigate Shoals**. 6/2/91, 6/18/91, 7/4/91, 7/16/91, 7/29/91, 8/13/91
1992	Resighted at the Turtle House. All tumors improved. ***First Honokowai regression case.***
1993	Resighted at the Turtle House. Read one tag for the first time. Regression continues.
1994	**Nesting, French Frigate Shoals**. 6/25/94. Resighted at Honokowai on 8/25/94. Eye tumors completely gone. Tumor on right front flipper barely noticeable. Regression continues.
1995	Resighted on second dive. Accepted our presence easily. Regression complete, no visible tumors. New tags read July 15. She is turtle U521 (left rear tag).
1996	**Nesting, French Frigate Shoals**. 6/15/96, 7/2/96
1997	Resighted quickly as fourth turtle of the summer. Regression holds.
1998	Resighted July 3rd dive. Several white blemishes on neck and shoulders. Fear of FP relapse!
1999	**Nesting, French Frigate Shoals.** 6/8/99, 6/23/99. Resighted at Honokowai on 8/27/99.

Results of foraging ground studies



- 25-35 yr generation period
- Declining somatic growth rates over time
- Incidence of FP peaked during past 20 years

Population Abundance Estimates

- Trawl-based CPUE estimation
- Aerial survey-based density estimation
- Capture-mark-recapture on foraging grounds
  - Difficult & expensive
- Count nesting females
  - Easiest & least expensive
    (but not easy or inexpensive)

Horvitz-Thompson type estimator

$$N_i = n_i/p_i$$

where:

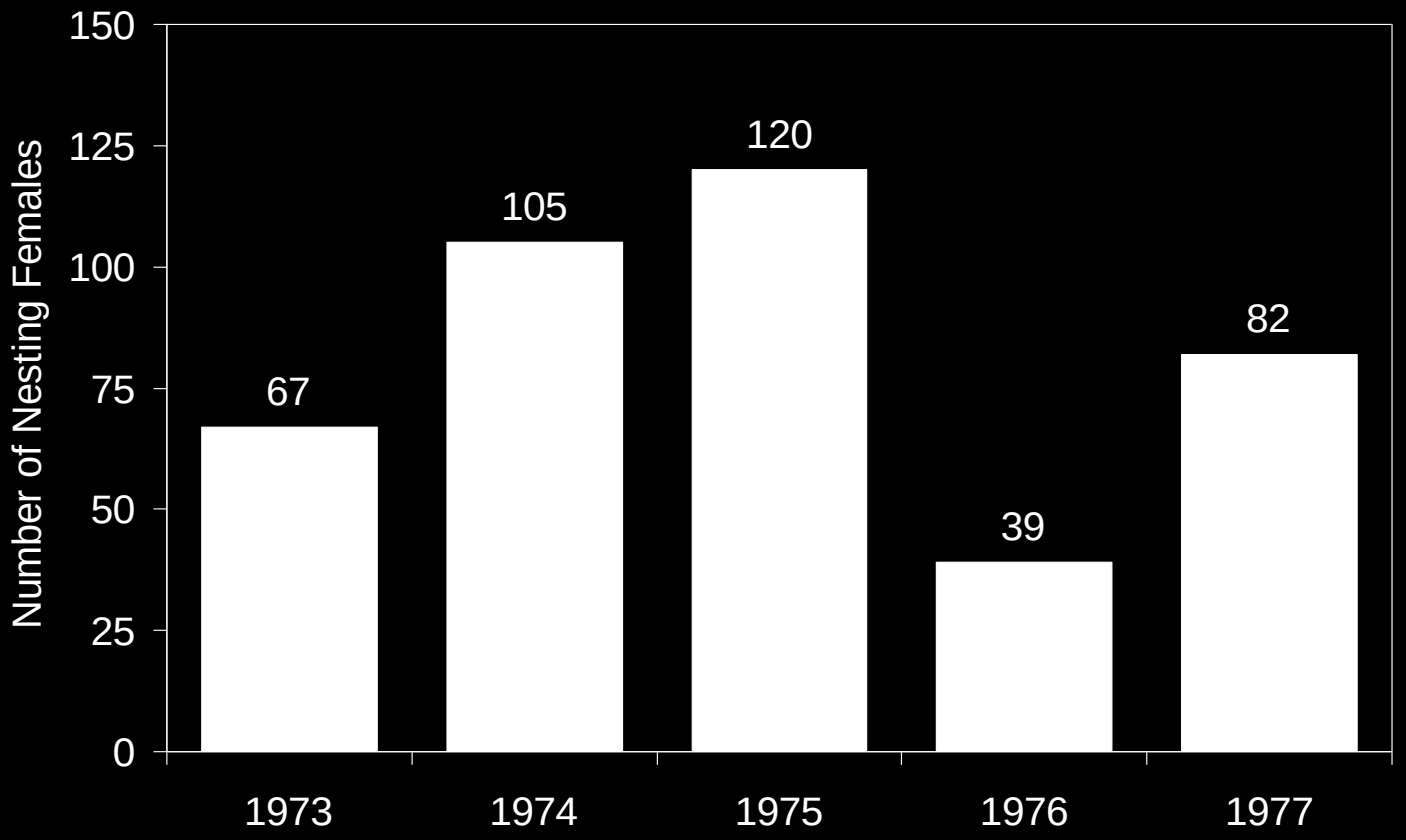
N_i = estimated number of female nesters in the *i*th year

n_i = number of uniquely identified female nesters recorded for the *i*th year

p_i = probability of sighting a female that emerges and nests at least once during the *i*th year

(Wetherall et al. 1998)

Green Turtles Nesting at East Island, FFS: Before ESA Protection



Early results

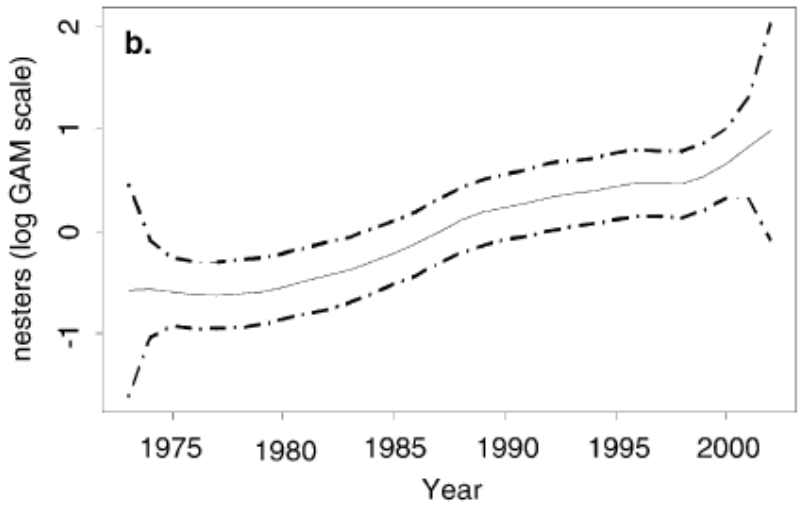
- FFS accounts for >90% of all nesting within the Hawaiian Archipelago
- East Island accounts for 50% of all nesting at FFS
- Strong island fidelity within the regional rookery
- Hawaiian green turtles are an isolated reproductive stock; later confirmed with genetics

Green Turtles Nesting at East Island, FFS (1973-2007)

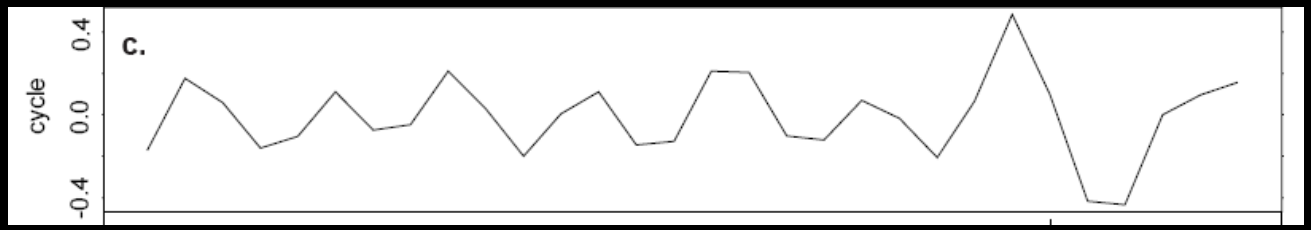
Results

The estimated long-term trend in Horvitz-Thompson nester abundance derived using a Bayesian nonparametric regression model (Fahrmeir and Lang, 2001), which was fitted to the Horvitz-Thompson nester series. Solid curve is the posterior mean annual nester abundance derived from the model with a Bayesian 95% credible region shown by dashed curves (posterior 2.5th-97.5th quantiles).

(Balazs and Chaloupka 2006)



- Near-linear increase in annual nester abundance over the last 30+ years (~ 5.7% pa)



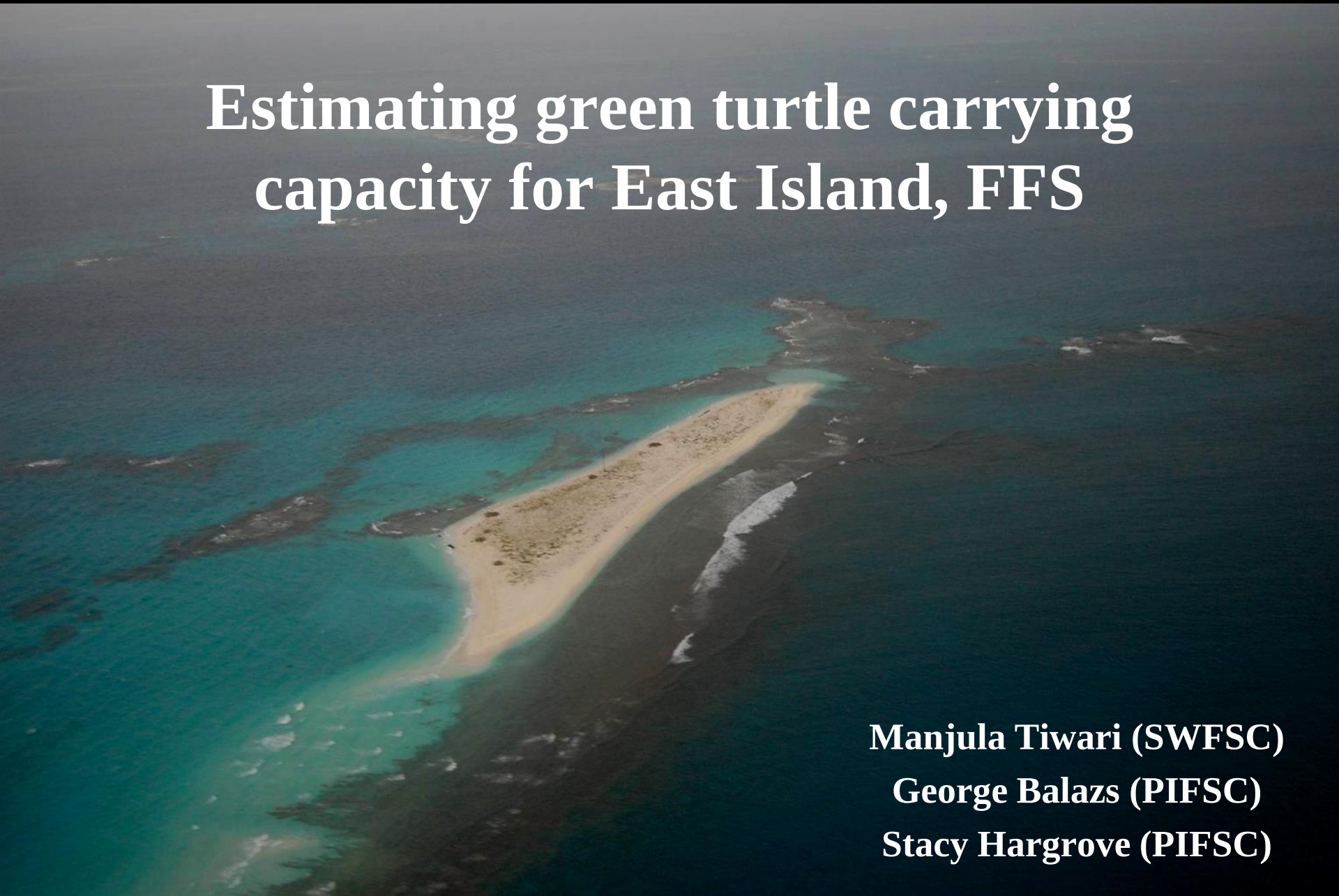
- Substantial fluctuations in the number of annual nesters

Balazs and Chaloupka – 2004, 2006

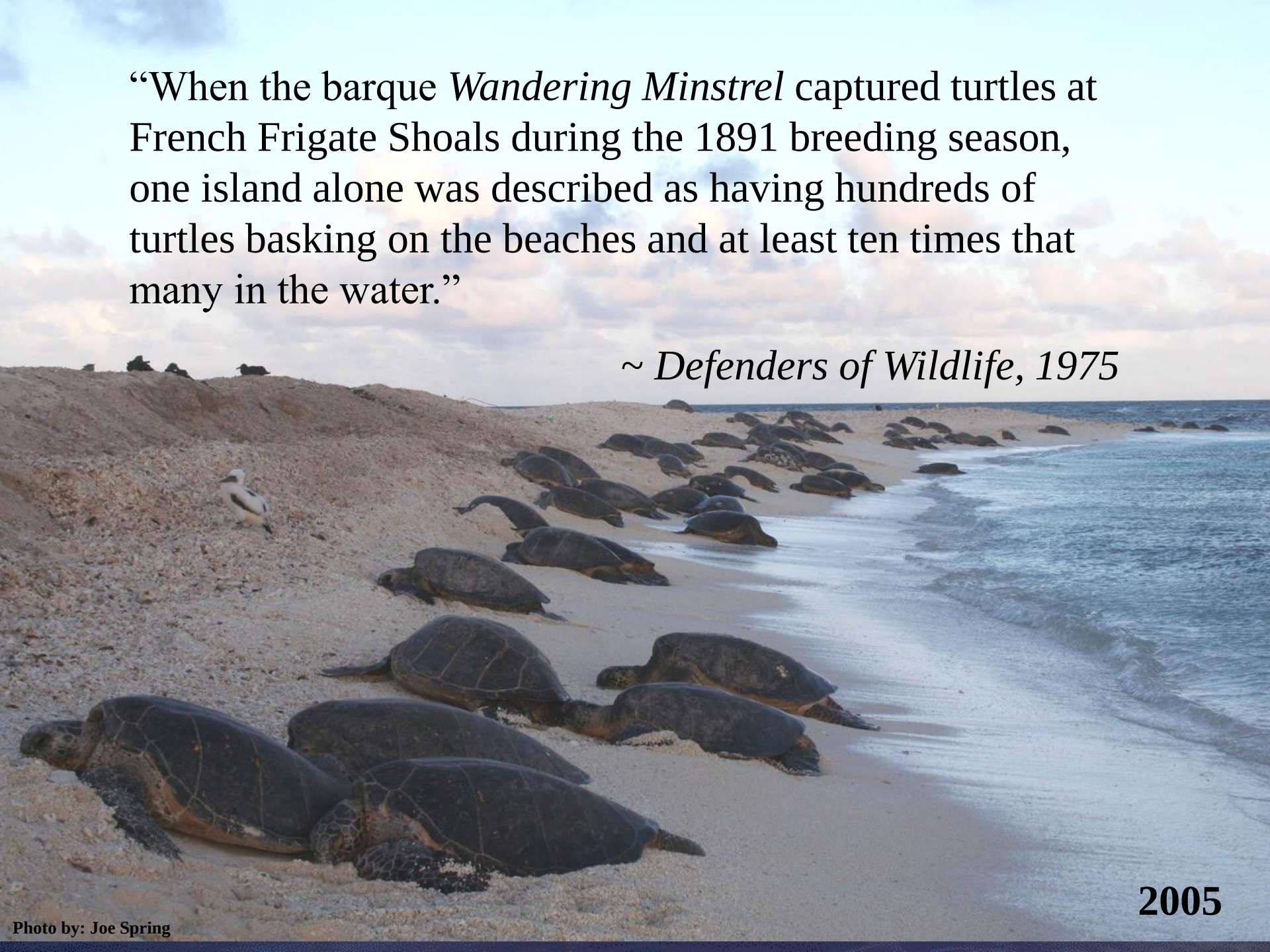
Future Research

- Continue monitoring nesting population at index site
- Survey other islands for nesting and basking activity
- Assess reproductive/hatching success
- Assess sex ratios of hatchlings
- Estimate hatchling predation rates in near shore waters
- Conduct multi-year saturation surveys to recalibrate Horvitz-Thompson parameters (repeat every 10 yrs)
- Initiate a beach carrying capacity study at East Island
- Continue use of and upgrade satellite-linked remote viewing and thermal imaging cameras at East Island, FFS

Estimating green turtle carrying capacity for East Island, FFS



Manjula Tiwari (SWFSC)
George Balazs (PIFSC)
Stacy Hargrove (PIFSC)



"When the barque *Wandering Minstrel* captured turtles at French Frigate Shoals during the 1891 breeding season, one island alone was described as having hundreds of turtles basking on the beaches and at least ten times that many in the water."

~ Defenders of Wildlife, 1975

2005

Photo by: Joe Spring

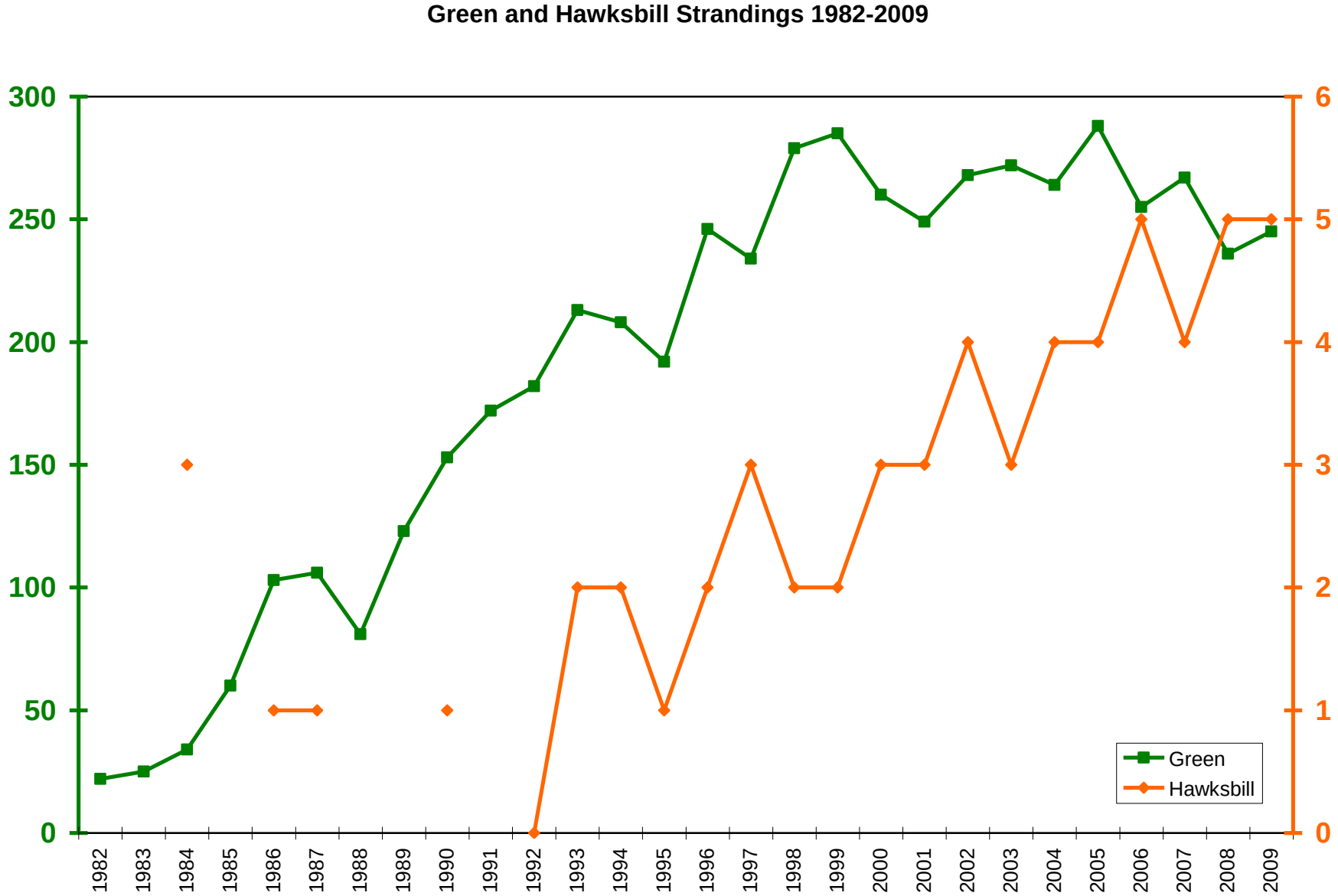
Hawksbill Stranding Update 2009

Marine Turtle Research Program

Stacy Hargrove

Summary of Marine Turtle Strandings in Hawaii (1982-2009)

- 5432 total strandings
  - 5322 (98.0% - *Chelonia mydas)*
    - +14 hatchlings
  - 60 (1.1 % - *Eretmochelys imbricata*)
    - +23 hatchlings
  - 37 (*Lepidochelys olivacea*)
  - 5 (*Dermochelys coriacea*)
  - 2 (*Caretta caretta*)
  - 6 (undetermined species)


Green and Hawksbill Strandings 1982-2009
300
250
200
150
100
50
0
6
5
4
3
2
1
0
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
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1998
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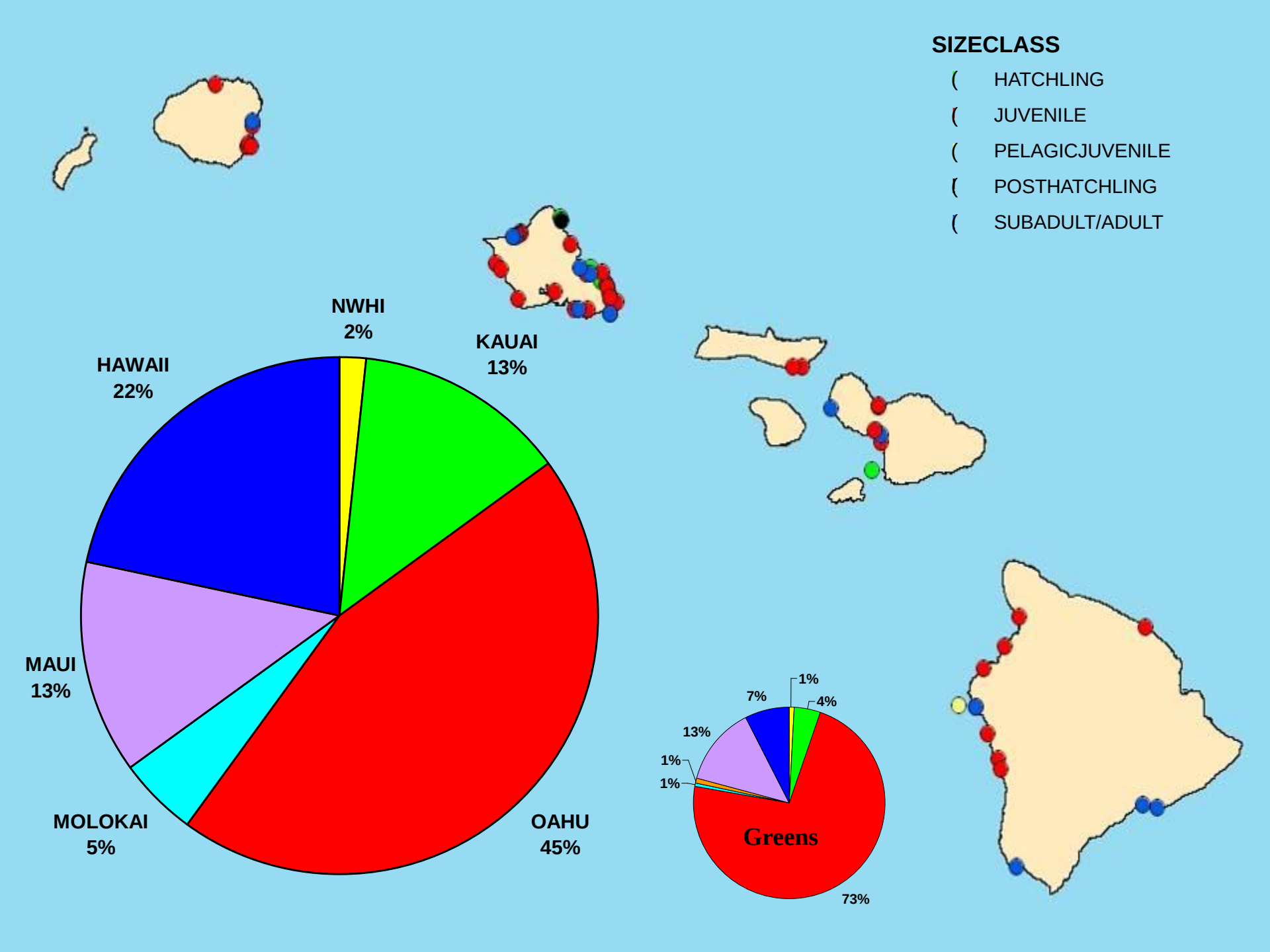
2002
2003
2004
2005
2006
2007
2008
2009
Green
Hawksbill


SIZECLASS
HATCHLING
JUVENILE
PELAGICJUVENILE
POSTHATCHLING
SUBADULT/ADULT
NWHI
2%
KAUAI
13%
HAWAII
22%
MAUI
13%
MOLOKAI
5%
OAHU
45%
1%
7%
4%
13%
1%
1%
Greens
73%

July 28, 2009

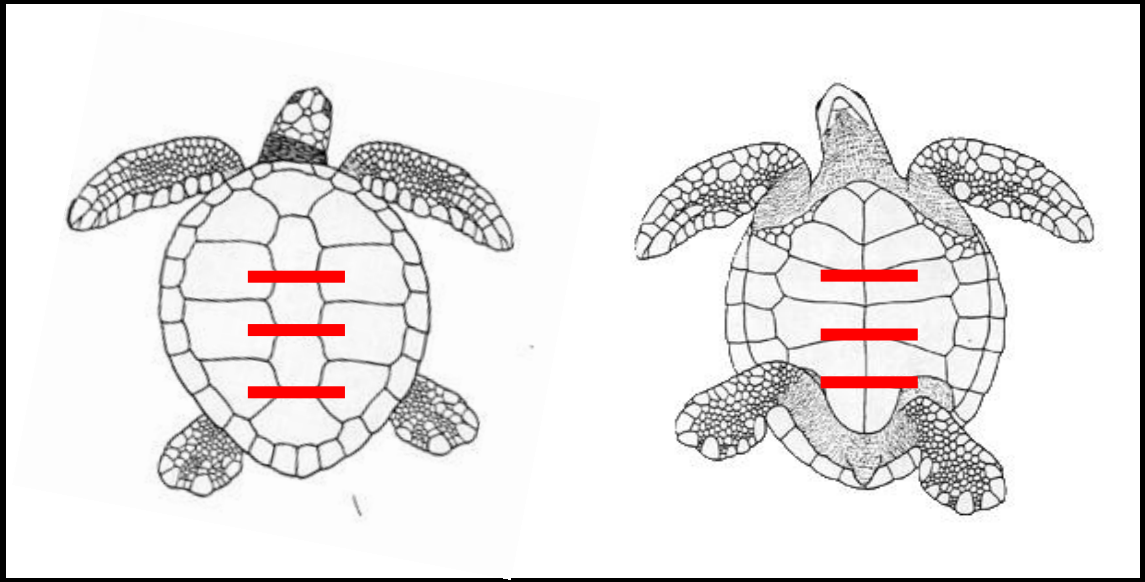
“As I expected, we did not find any honu when we got to the Turtle House. There was, however, one turtle waiting to greet us: a hawksbill, the first one we’ve sighted this summer. Quite a large one too, one of the biggest we’ve seen, and not one familiar to us.”

An Alternate Method for Assessing Body Condition of Hawaiian Green Turtles

Stacy Kubis, Thierry Work, Shawn Murakawa, George Balazs

PIFSC Marine Turtle Research Program

Methods: Volume Calculations



Body Condition Field Scores

Robust – Normal

Mild Emaciation

Moderate Emaciation

Severe Emaciation

Discussion

- Declining growth rates over time coupled with poorer body condition at Kona sites
- Virtually no FP on the Kona coast – otherwise healthy animals are maturing slower and the contribution of animals from these sites to the nesting population may be reduced
- Foraging grounds may be reaching their carrying capacity – or are turtles simply surviving and not thriving?