“The most erroneous stories are those we think we know best - and therefore never scrutinize or question.”

-Stephen Jay Gould

Why This Workshop?

Puzzling Important Questions About the Conservation Status of Hawaiian Honu and Their Ecosystem

Signals of Change
Trying to Make Sense of it All

-The Wabnitz 2010 Carrying Capacity Paper

- Slow Growing

-Body Fitness

-Night-to-Day Foraging

-Coming Ashore to Bask

-Expanded Nesting Range

-Novel New Neritic Habitats

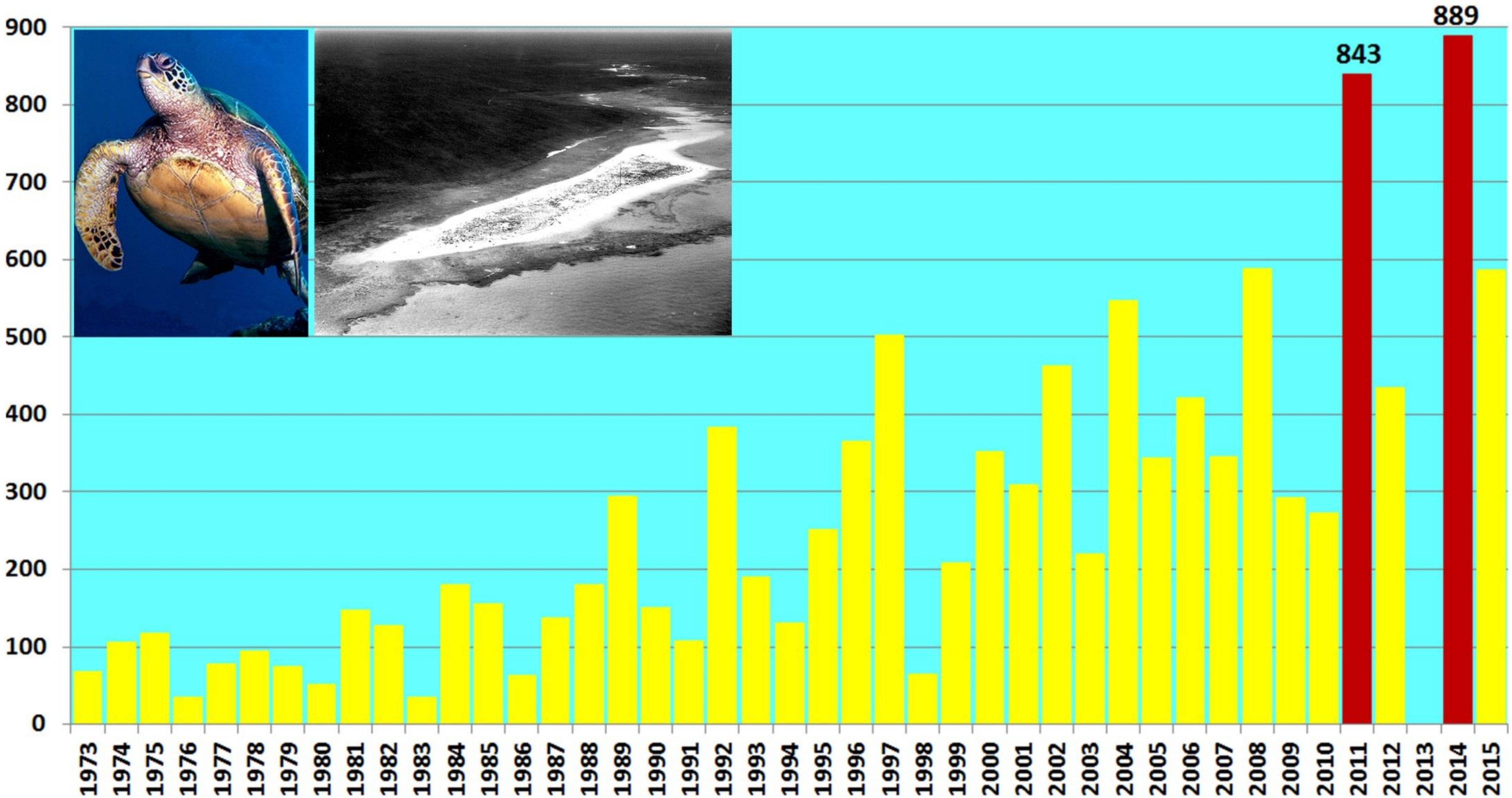
-New Foods

-Hooked and Entangled

-Tiger Sharks and Monk Seal Apex Predators

-Tumor Disease Decline

Green turtles nesting at East Island, French Frigate Shoals, 1973-2015



ANNUAL TREND FOR 42 SEASONS

Pacific Islands Fisheries Science Center
National Marine Fisheries Service

Ecosystem structure and processes at Kaloko Honokōhau, focusing on the role of herbivores, including the green sea turtle *Chelonia mydas*, in reef resilience

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ABSTRACT: The formal protection of the Hawaiian green turtle *Chelonia mydas* in the 1970s has led to significant increases in the number of individuals recorded throughout the archipelago. Reduced growth rates and poor body condition of individuals at a number of foraging sites, including Kaloko-Honokōhau National Historical Park (Kaloko), suggest that some aggregations have reached carrying capacity. To better understand the ecological structure and processes of the reef system at the park, we developed an ecosystem model that synthesized available data on Kaloko for the year 2005 and included 26 groups, spanning the entire trophic web. Model results showed that the combined grazing pressure of the different herbivore functional groups (i.e. reef fish, sea urchins, and green turtles) in Kaloko matched total algal production. Sea urchins exerted the strongest control over algal resources, partly because of their large biomass in park waters. Results confirmed that the Kaloko green turtle aggregation has reached carrying capacity. Green turtles help maintain low algal cover, and thus resilience of reefs in the face of disturbance, and should be explicitly included in studies of ecosystem dynamics on reefs. Our work also provides a 'current-condition' baseline for Kaloko, and a valuable tool for the assessment of the future marine ecosystem impacts of projected urban expansion plans around the park.

KEY WORDS: Marine turtles · Ecosystem-based management · Ecopath · Coral reef · Herbivory · Phase shift · Nutrient enrichment · Kona coast · Hawaii

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G. H. Balazs · M. Chaloupka

Spatial and temporal variability in somatic growth of green sea turtles (*Chelonia mydas*) resident in the Hawaiian Archipelago

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Abstract The somatic growth dynamics of green turtles (*Chelonia mydas*) resident in five separate foraging grounds within the Hawaiian Archipelago were assessed using a robust non-parametric regression modelling approach. The foraging grounds range from coral reef habitats at the north-western end of the archipelago, to coastal habitats around the main islands at the south-eastern end of the archipelago. Pelagic juveniles recruit to these neritic foraging grounds from ca. 35 cm SCL or 5 kg (~6 years of age), but grow at foraging-ground-specific rates, which results in quite different size- and age-specific growth rate functions. Growth rates were estimated for the five populations as change in straight carapace length (cm SCL $year^{-1}$) and, for two of the populations, also as change in body mass (kg $year^{-1}$). Expected growth rates varied from ca. 0–2.5 cm SCL $year^{-1}$, depending on the foraging-ground population, which is indicative of slow growth and decades to sexual maturity, since expected size of first-time nesters is ≥80 cm SCL. The expected size-specific growth rate functions for four populations sampled in the south-eastern archipelago displayed a non-monotonic function, with an immature growth spurt at ca. 50–53 cm SCL (~18–23 kg) or ca. 13–19 years of age. The growth spurt for the Midway atoll population in the north-western archipelago occurs at a much larger size (ca. 65 cm SCL or 36 kg), because of slower immature growth rates that might be due to a limited food stock and cooler sea surface temperature. Expected age-at-maturity was estimated to be ca. 35–40 years for the four populations sampled at the south-eastern end of the archipelago, but it might well be > 50 years for the Midway population. The Hawaiian stock comprises mainly the same mtDNA haplotype, with no differences in mtDNA stock composition between foraging-ground populations, so that the geographic variability in somatic growth rates within the archipelago is more likely due to local environmental factors rather than genetic factors. Significant temporal variability was also evident, with expected growth rates declining over the last 10–20 years, while green turtle abundance within the archipelago has increased significantly since the mid-1970s. This inverse relationship between somatic growth rates and population abundance suggests a density-dependent effect on somatic growth dynamics that has also been reported recently for a Caribbean green turtle stock. The Hawaiian green turtle stock is characterised by slow growth rates displaying significant spatial and temporal variation and an immature growth spurt. This is consistent with similar findings for a Great Barrier Reef green turtle stock that also comprises many foraging-ground populations spanning a wide geographic range.

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Introduction

The green sea turtle (*Chelonia mydas*) is a threatened marine turtle species with a broad pan-tropical distribution and distinct regional population substructures (Bowen et al. 1992). Green turtles are the most abundant large, long-lived marine herbivores (Bjorndal 1997) and have a long history of human exploitation for meat and eggs (Parsons 1962; Frazier 1980; Witzell 1994). Many green turtle stocks in the Pacific region are in serious decline (Seminoff 2002), with the populations resident in Great Barrier Reef and Hawaiian waters representing some of the few remaining stocks with apparently viable


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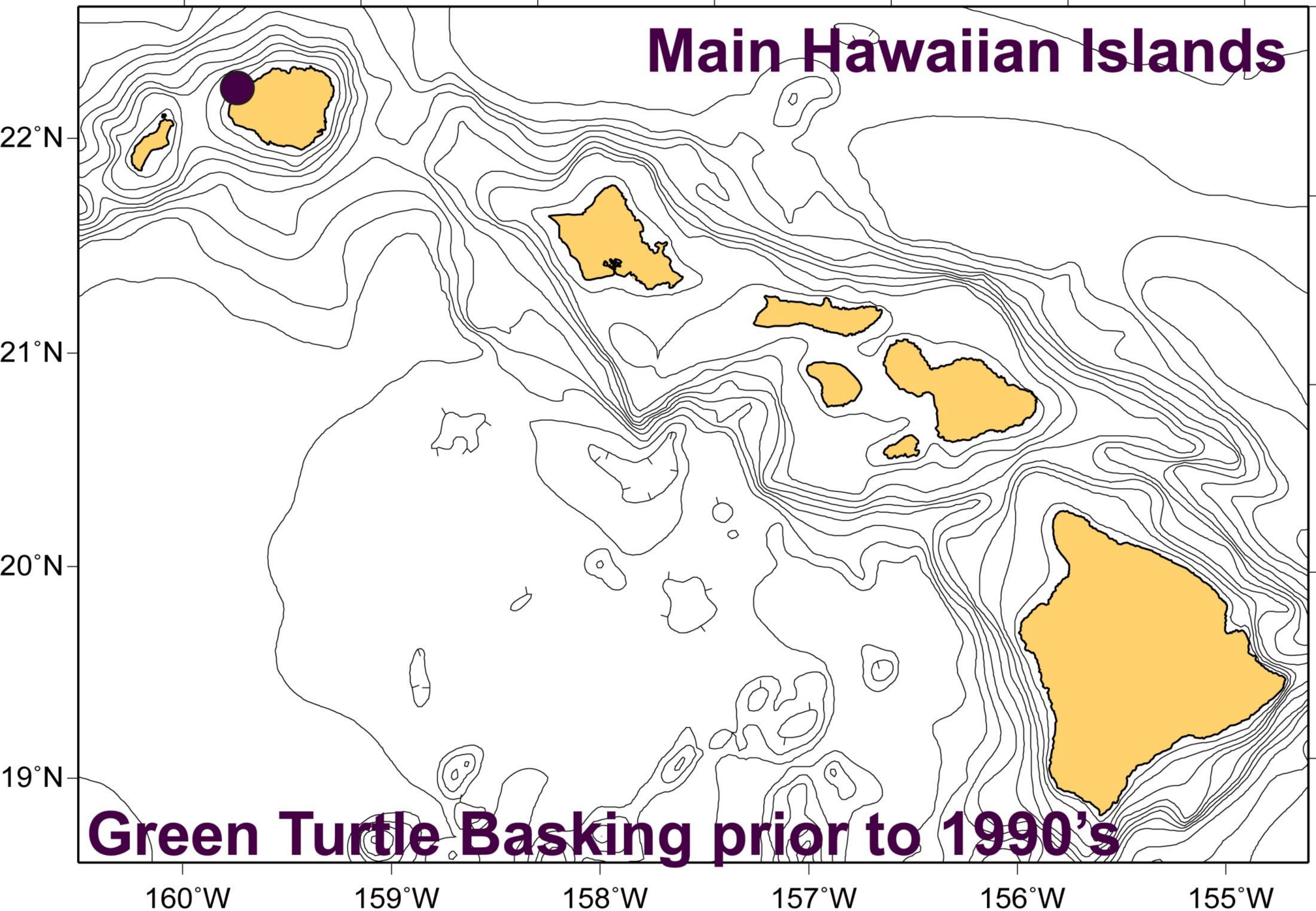
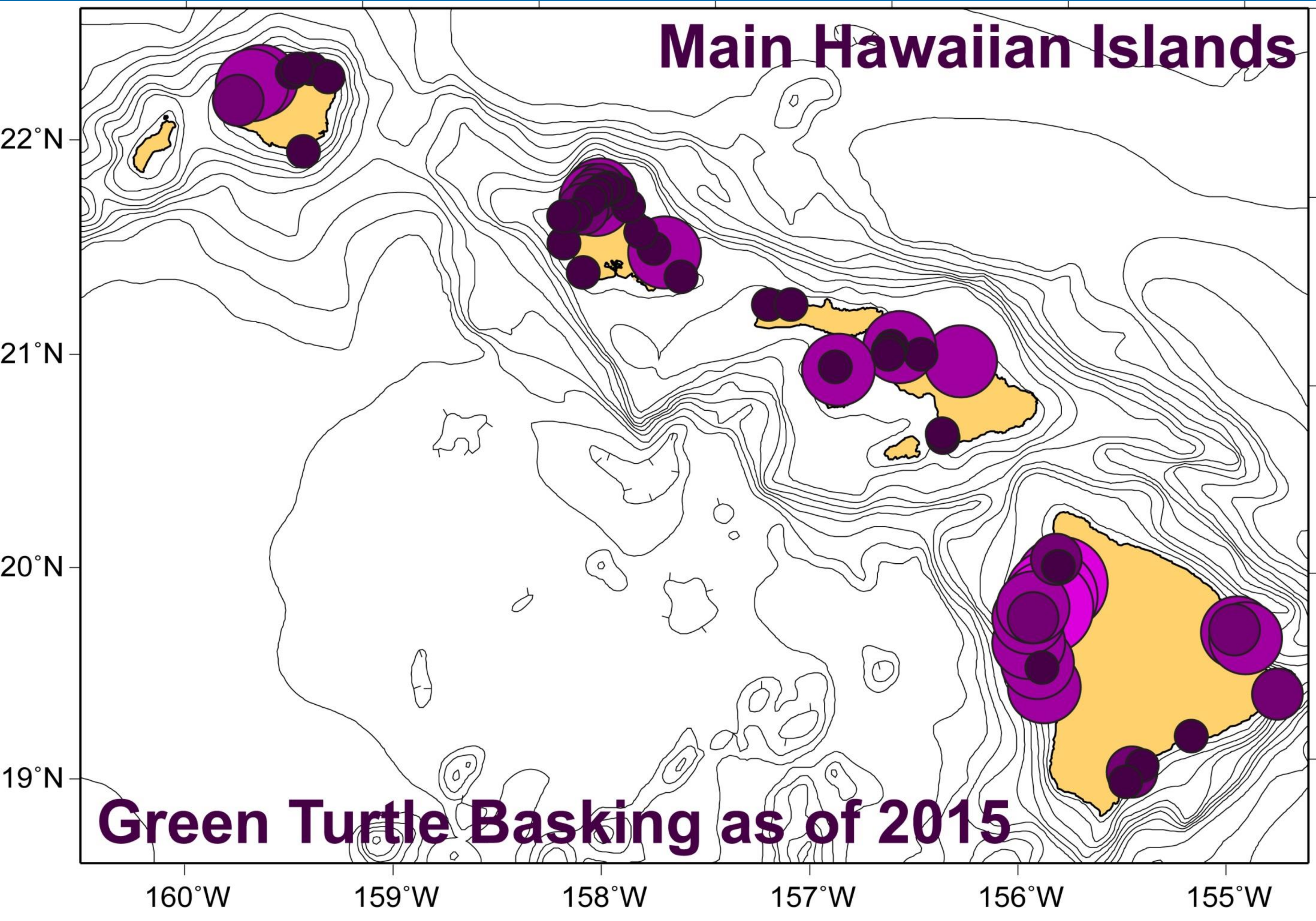
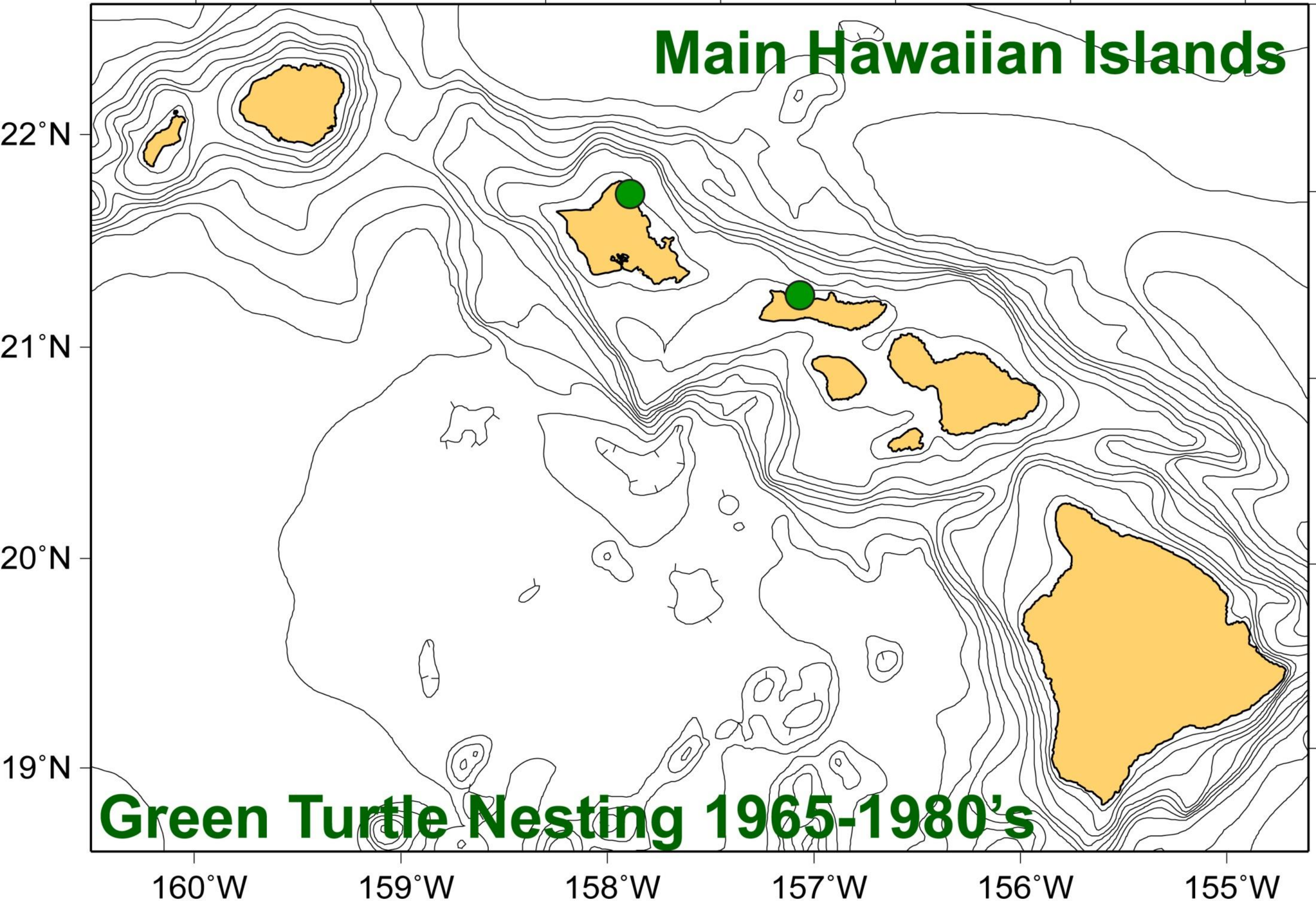
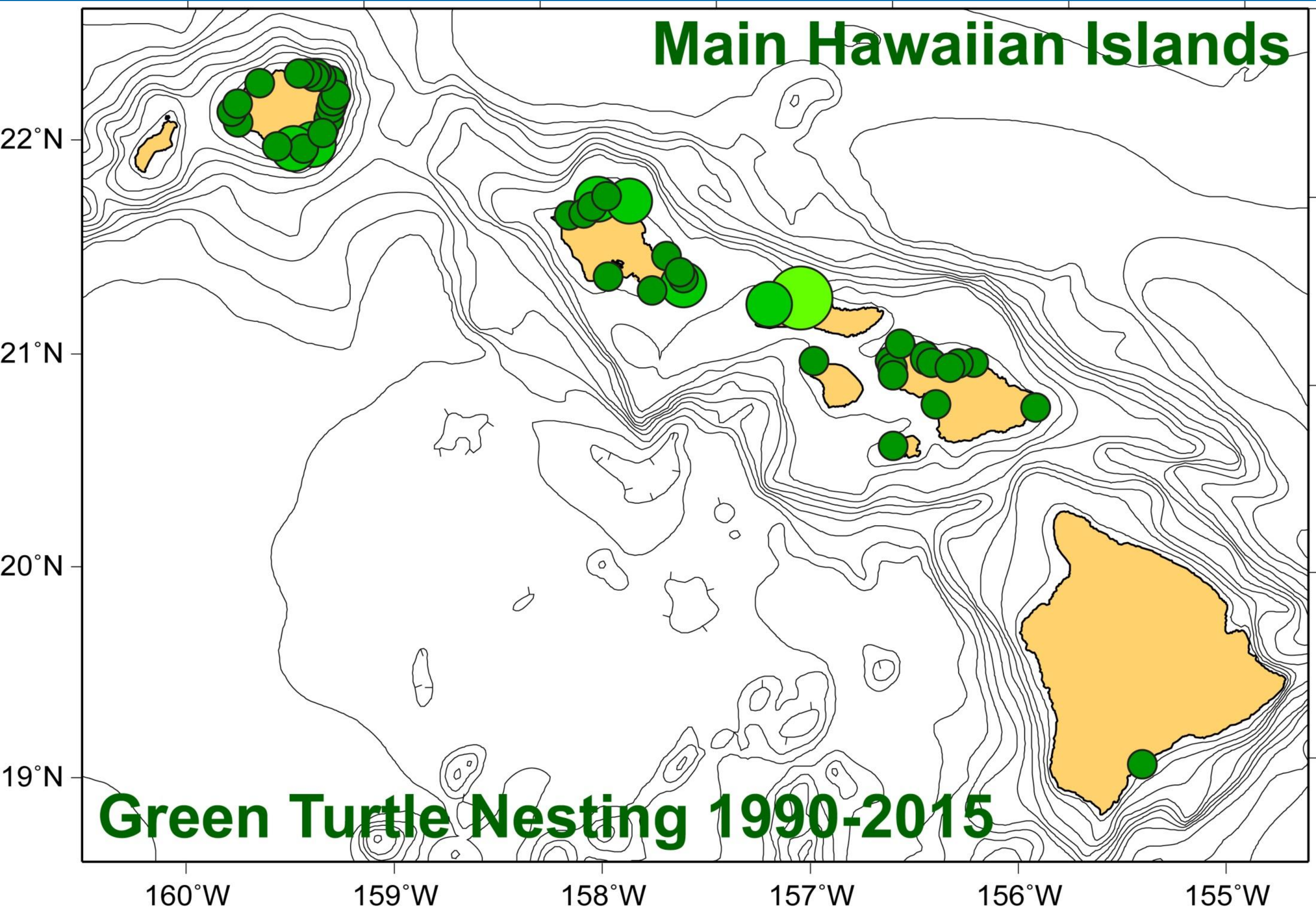
Changing Behaviors

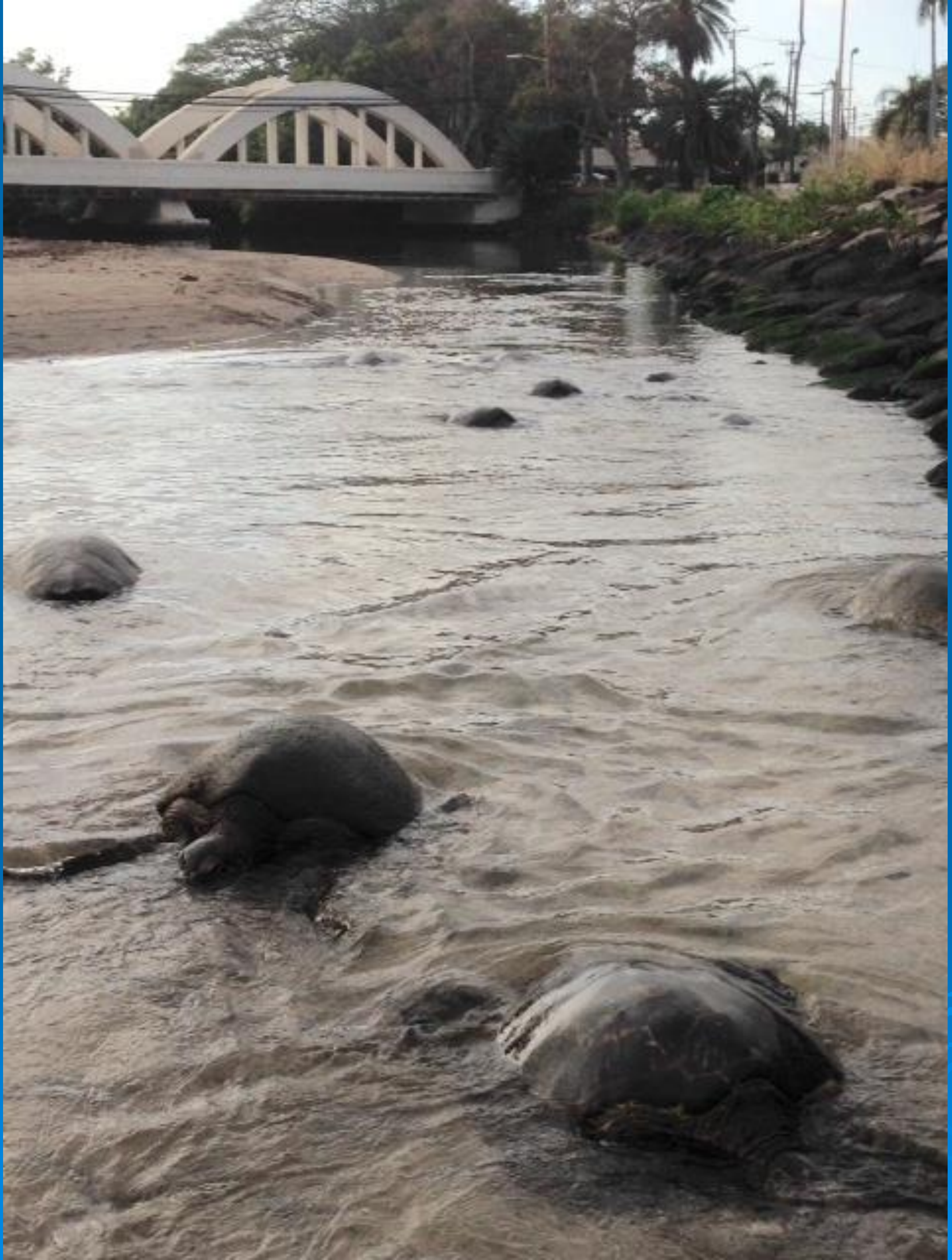

TM 88


Main Hawaiian Islands
Green Turtle Basking prior to 1990's
22°N
21°N
20°N
19°N
160°W
159°W
158°W
157°W
156°W
155°W


Main Hawaiian Islands
Green Turtle Basking as of 2015
22°N
21°N
20°N
19°N
160°W
159°W
158°W
157°W
156°W
155°W


Main Hawaiian Islands
Green Turtle Nesting 1965-1980's
22°N
21°N
20°N
19°N
160°W
159°W
158°W
157°W
156°W
155°W


Main Hawaiian Islands
Green Turtle Nesting 1990-2015
22°N
21°N
20°N
19°N
160°W
159°W
158°W
157°W
156°W
155°W



Update as of 6/13/2011:

2008-2011 movement of Anahulu river green turtle, “RT”, ID 23081

ST-24 6/24 SCL: 59.4 cm

Date deployed: 10/10/2008 Days transmitting: 976 days

Nonnative Seashore Paspalum, *Paspalum vaginatum* (Poaceae), Consumed by Hawaiian Green Sea Turtles (*Chelonia mydas*): Evidence for Nutritional Benefits[1]

Karla J. McDermid,[2,4] James A. Lefebvre,[2] and George H. Balazs[3]

Abstract: The Hawaiian green turtle, *Chelonia mydas* Linnaeus, is a marine herbivore known to feed on sea grasses and seaweeds. On the east side of the island of Hawai'i, at high tide, green turtles have been observed feeding on a terrestrial, salt-tolerant turfgrass: seashore paspalum, *Paspalum vaginatum* Swartz, first introduced to the Hawaiian Islands in the 1930s. The role of this grass in green turtle nutrition is unknown. *Paspalum vaginatum* samples were collected at Keaukaha Beach Park, Hilo, and analyzed for nutritional composition (percentage water, percentage ash, caloric value, C:N ratio, percentage protein, and percentage lignin). In addition, two red seaweeds, *Pterocladiella capillacea* (Gmelin) Santelices & Hommersand, a common food source for green turtles, and *Ahnfeltiopsis concinna* (J. Agardh) Silva & DeCew, an abundant high-intertidal species sometimes consumed by turtles, were analyzed for comparison. In contrast to the two seaweed species, *Paspalum vaginatum* contained approximately half the ash; 300–1,500 more calories/g ash-free dry weight; three to four times greater total protein; and 3–19 times higher lignin content. Green turtles in Hawai'i may opportunistically consume *P. vaginatum* because of its local abundance and/or its high protein and caloric content. In foraging areas where native macroalgal species have declined and/or turtle carrying capacity has been reached, green turtles may exploit new foods, such as seashore paspalum, and perhaps mitigate decline in somatic growth rates and body condition.

Of turtles and trees: Nutritional analysis of tree heliotrope (*Heliotropium foertherianum*) leaves consumed by green turtles (*Chelonia mydas*) in Hawai'i*

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Abstract— Fallen, senescent leaves of tree heliotrope (*Heliotropium foertherianum*), a ubiquitous shoreline tree from the Indian Ocean, tropical Asia, Australia, and the western and central Pacific, are a novel food item for green turtles (*Chelonia mydas*) in Hawai'i. Leaves were collected in two seasons and analyzed for proximate nutrients, including dry matter, ash, crude fat, crude protein, carbon:nitrogen (C:N) ratio, gross energy, as well as dietary fibers (ADF and NDF), lignin, and total phenol content. The senescent leaves showed a high C:N ratio, and measurable phenolic compounds, but were low in protein ($\bar{x}$ = 5.5%) and fat ($\bar{x}$ = 2.2%) based on dry weight. Gross energy averaged > 4500 Kcal/kg ash-free dry weight; therefore, *H. foertherianum* could provide more calories than other marine food sources for Hawaiian green turtles. Green turtles elsewhere within the broad geographic range of tree heliotrope's distribution may also consume senescent leaves that fall into coastal waters.

Observations of a rapid decline in invasive macroalgal cover linked to green turtle grazing in a Hawaiian marine reserve*

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Abstract— The persistent, non-native invasive alga *Gracilaria salicornia* has dominated the protected waters surrounding Moku o Lo'e, Kāne'ohe Bay since its introduction in 1978; however, a sudden decline in abundance (75%) occurred within a 30-day survey period. The consisent environmental conditions during the survey period, dominance of *G. salicornia* despite the presence of abundant herbivorous fish populations, and multiple observations of physical grazing by the green turtle, *Chelonia mydas*, on *G. salicornia* support our conclusion that *C. mydas* was the primary driver of the rapid decline of a persistent invasive macroalgae within a Hawaiian marine reserve. These findings highlight the need for high herbivore functional diversity with species-specific differences in dietary preference and feeding strategy, which should more efficiently suppress the growth and spread of any given macroalga and indirectly benefit coral reefs.

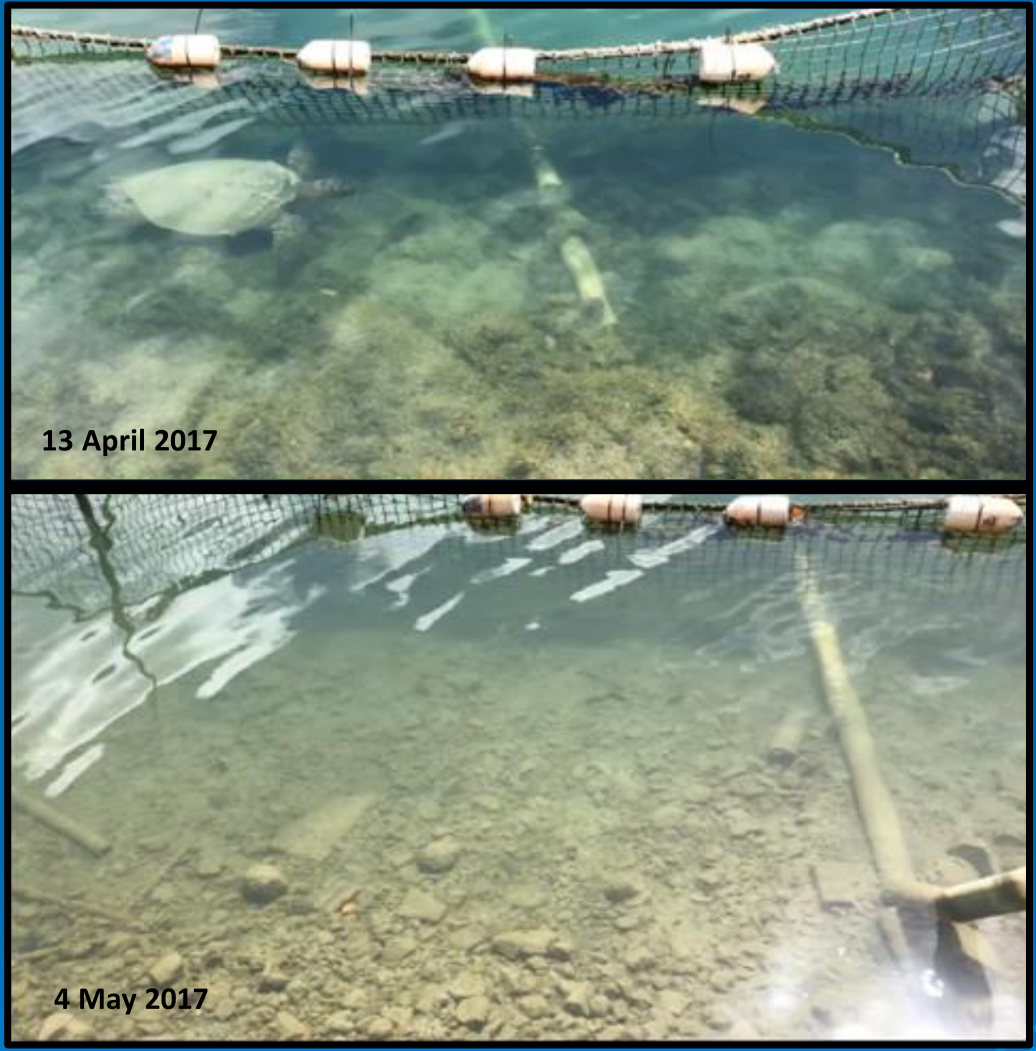
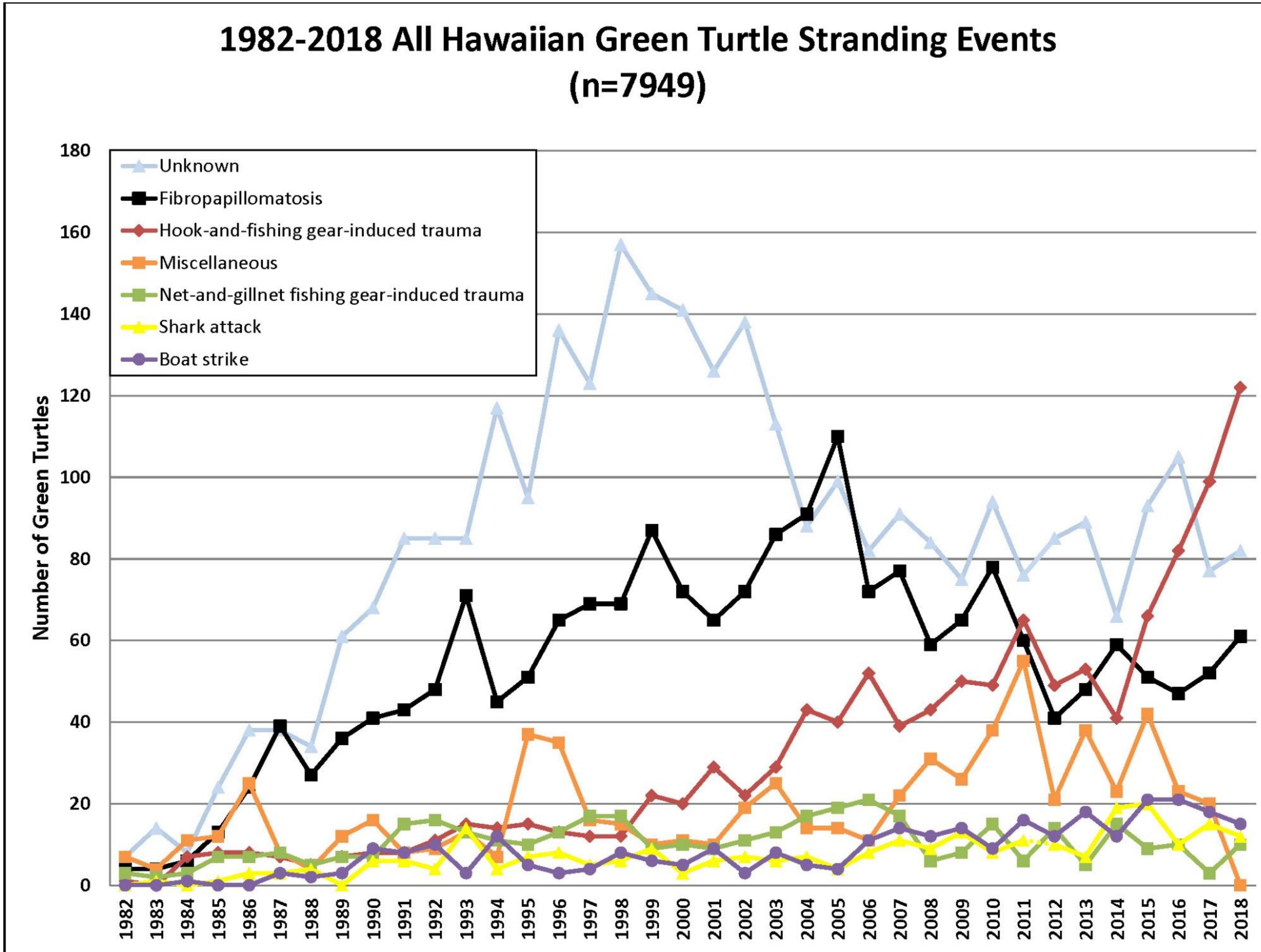


Figure 5. Back lagoon of Moku o Lo‘e, Kāne‘ohe Bay, O‘ahu, Hawai‘i adjacent to a fenced enclosure on 13 April 2017 (top) and same area 21 days later on 4 May 2017 (bottom). Photo by KD Bahr.



1982-2018 All Hawaiian Green Turtle Stranding Events
(n=7949)
Unknown
Fibropapillomatosis
Hook-and-fishing gear-induced trauma
Miscellaneous
Net-and-gillnet fishing gear-induced trauma
Shark attack
Boat strike
Number of Green Turtles
0
20
40
60
80
100
120
140
160
180
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
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2018

The stomach content of a Mediterranean Monk Seal (*Monachus monachus*): finding of Green Turtle (*Chelonia mydas*) remains

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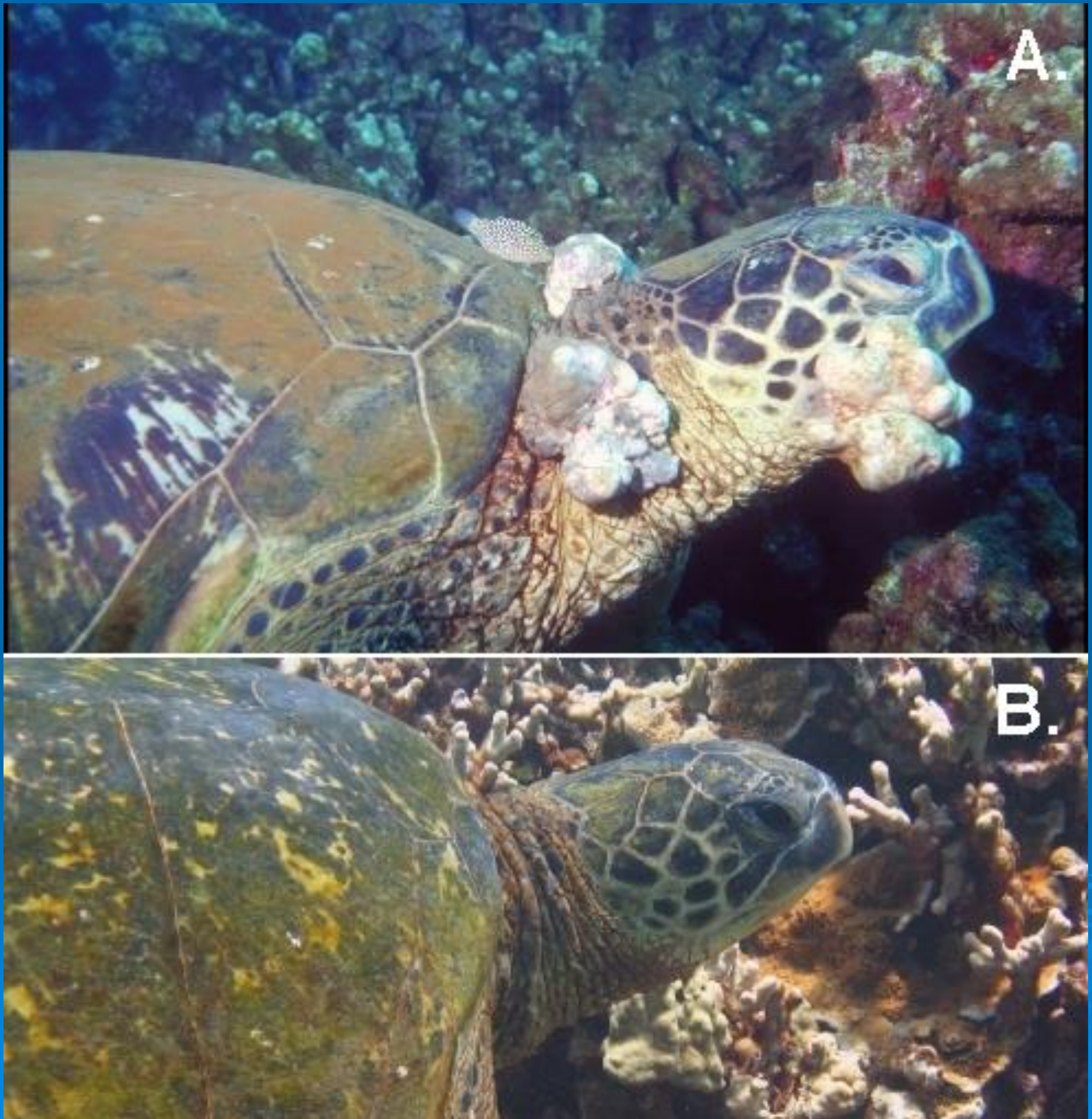
(Received 7 March 2016; accepted 29 May 2016)

The stomach contents of an adult Mediterranean Monk Seal (*Monachus monachus*) found stranded on the Turkish eastern Mediterranean coast near Antalya in May 2013 were analysed. In total, 69 individual food items were counted and nine taxa were identified to species or family level. Of the identified taxa, Sparidae was the most highly represented family of prey fish, and one cephalopod species, *Octopus vulgaris,* was found. *Ariosoma balearicum* and *Argyrosomus regius* were encountered for the first time in the diet of a Monk Seal in the Mediterranean. Several body parts (three heads, six forelimbs, neck bones and fractured upper forelimb bones) of Green Turtles (*Chelonia mydas*) were also identified, which is the first record of this species in the Monk Seal's diet.

Keywords: Mediterranean Monk Seal; stomach content; Green Turtle; eastern Mediterranean


A.
B.

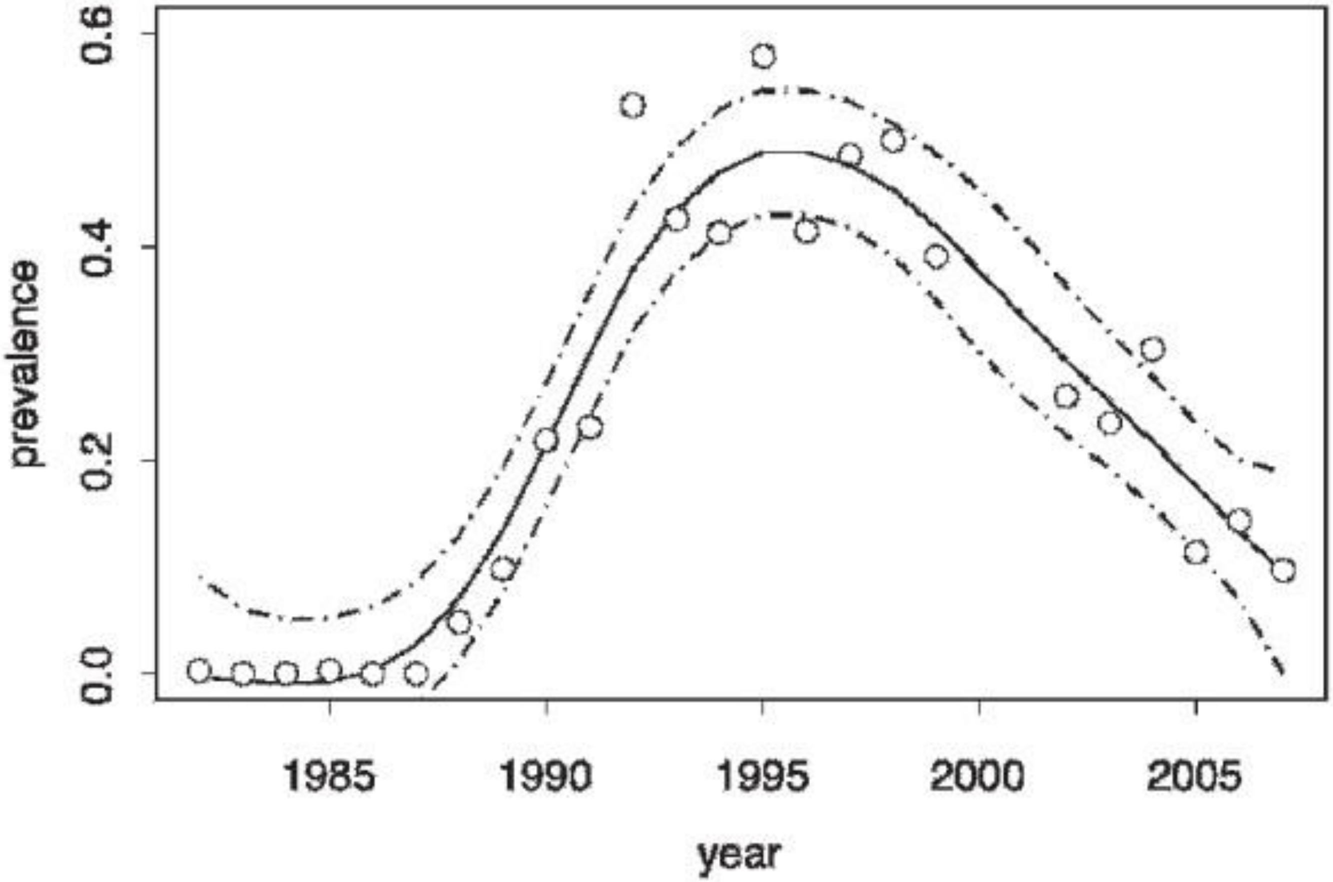


FIGURE 2. Epidemic curve with three phases: 1) rapid increasing phase (1988–1991), 2) peak phase (1992–1998), 3) slow decline phase from 1999 onward. Solid curve=smoothing spline fit, dashed curves=95% Bayesian confidence intervals, dots =apparent prevalence estimates.

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