Factors in Historical Hatchling Production and Implications for Nesting Hawksbill Sea Turtles (*Eretmochelys imbricata*) on Maui

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Purpose

Hawksbill sea turtles have been protected and researched as they nest on Maui for decades. This small population has not experienced any significant recovery. We examined 22 years of data from 91 nests for trends and effects of natural variables and human impacts on clutch size, incubation time, hatchling success, hatchling production, and nesting population.

Background

Hawksbill sea turtles have been listed as critically endangered across the globe by the IUCN since 1996.[1] The nesting population on Maui represents a portion of the small, isolated population of hawksbills in the Hawaiian Archipelago.[2] Hawai'i Wildlife Fund partnered with state and federal agencies in 1996 to research and protect this population.[3] Since then, this community volunteer-based project has identified and patrolled six nesting beaches along the south coast of Maui, tagged 10 nesting females, and monitored 91 nests. Observations vary each year, without any activity some years but a mean of 1.3 females and 4.2 nests per year over the 22 year period. These nests have led to 9000 live hatchlings, but numbers of females, nests, and hatchlings per year have not increased significantly over this period.

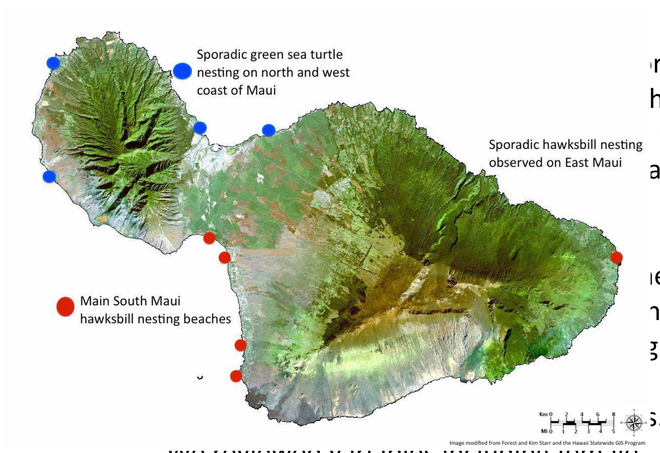

Figure 1. Map of Maui with major hawksbill and green sea turtle nesting areas. Most consistent hawksbill nesting occurs on the south coast of Maui.

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We reviewed variables including female size, age since first nesting observation, date of nest, year of nest, beach conditions, and human intervention to see how they shape hatchling production. By better understanding the threats to this hawksbill population and the variables and the factors in their recovery, we can learn how to best conserve them on Maui and throughout their global range.

Results

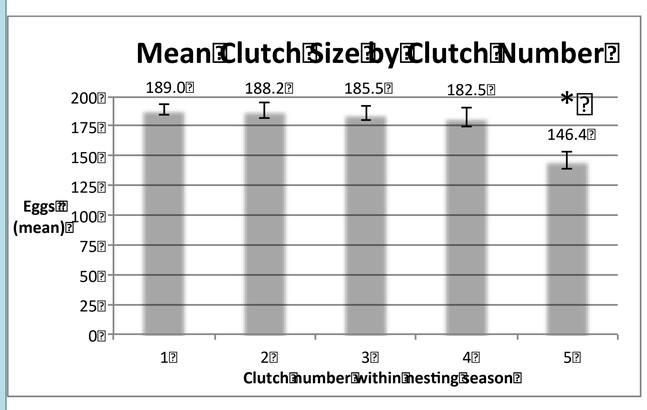

Figure 1. Mean clutch size by clutch number within a nesting season, n=70. Clutch 5 is significantly smaller than all other clutches (p<0.05).

- Mean clutch size decreases for each clutch laid during a nesting season. For females that laid a 5th clutch of eggs, it was significantly smaller than their previous clutches
- Five is the maximum clutches seen in one season in this population, with one female laying 24 nests in 5 seasons over 16 years, for a total of 4112 eggs
- Clutch size was positively correlated with female size and age since first nesting observation and negatively correlated with date of nesting, but these effects were not significant (p>0.05)

- CCW and CCL both increase with age since first observation for nesting females, but the correlation was not significant (p>0.05)
- Females measured between 80.6 and 97.2 cm long and 74.2 and 88.7 cm wide, with a maximum interval between seasons and age since first observation of 17 years

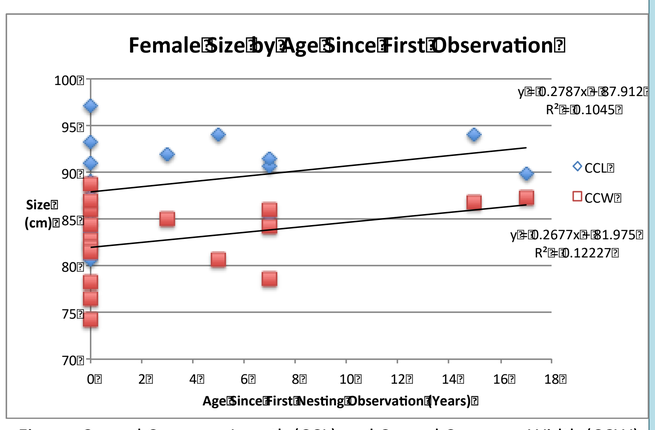

Figure. Curved Carapace Length (CCL) and Curved Carapace Width (CCW) by size since first nesting observation.

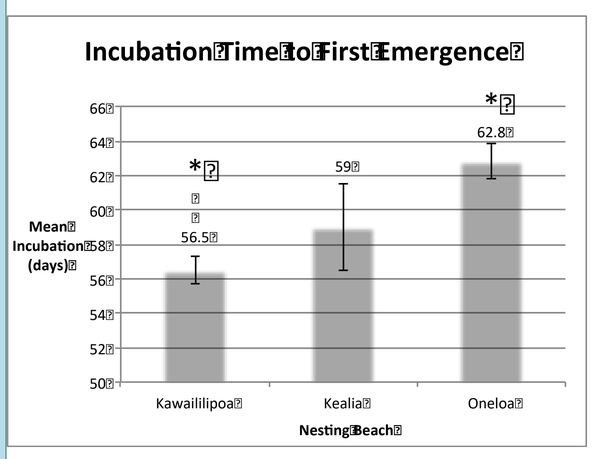

Figure. Mean incubation time to first emergence by nesting beach. Incubation time is significantly difference between Oneloa and Kawaililipoa (p<.05).

- Incubation time varies drastically between the three most common nesting beaches on Maui. Oneloa has significantly longer incubation, including the longest observed incubation of over 70 days, while incubation on Kealia and Kawaililipoa has been as short as 53 days.
- No significant correlation was found between incubation time and date or year, but changing beach temperatures could have long-term effects on resulting incubation time and sex bias
- Nesting females have high site fidelity, so the incubation time and ultimate hatchling success of their clutches are closely tied to the conditions of the nesting beach

Results Continued

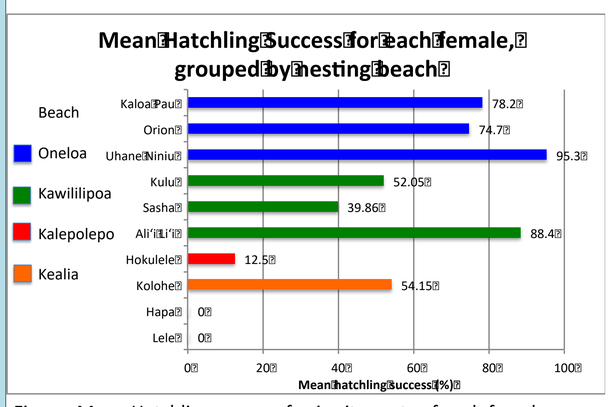

Figure. Mean Hatchling success for *in situ* nests of each female, grouped by primary nesting beach. Significant difference between Oneloa and Kealia and Oneloa and Kawililipoa (p>0.05).

- Success varies dramatically by female, from averaging over 95% success to some females that have never had a successful hatchling despite laying 4 or more clutches
- Hatchling success is also closely tied to beach choice and environmental conditions, so it can be difficult to determine if unsuccessful clutches are due to the female or the beach
- There was no significant correlation observed with female age since first nesting observation, clutch number, or date, although success tends to be lower later in the nesting season

- There has been a significant increase in hatchling success since monitoring began in 1996
- One explanation for this trend could include increased community awareness, volunteer support, and protection of nesting hawksbills through education and research
- Recent years have had some of the highest hatchling success, with year means over 75% in 2011, 2012, 2016, and 2017

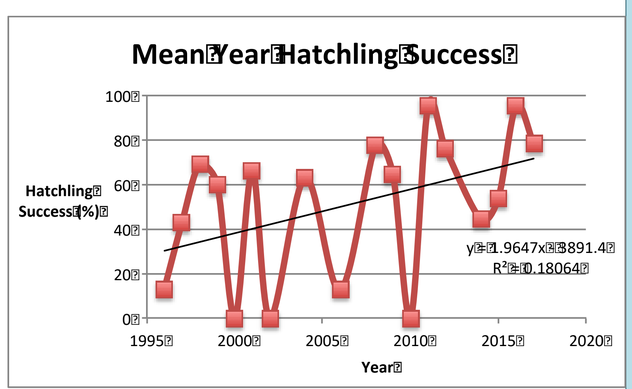

Figure. Mean hatchling success per year, with a significant increase since 1996 (p<0.05).

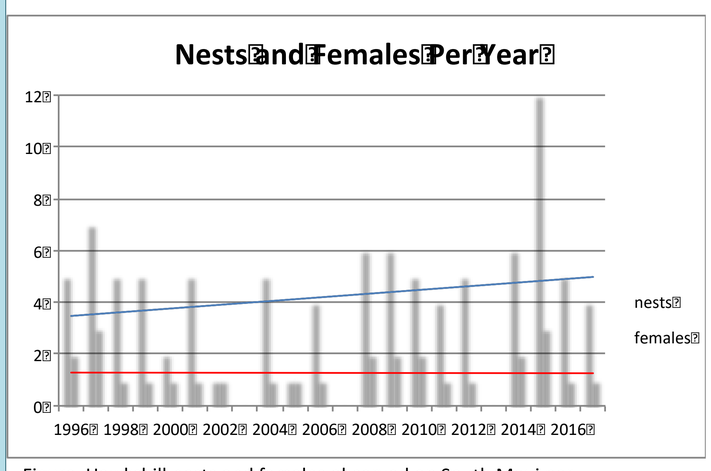

Figure. Hawksbill nests and females observed on South Maui per year, 1996-2017. Increasing trend is not significant (p>0.05).

- There has been no significant change in females, nests, eggs, or hatchlings per year since 1996
- However, numbers of nests, eggs, and hatchlings may be beginning to increase along with hatchling success, as seen above

Conclusion

Data from the Hawksbill Sea Turtle Recovery Project revealed several trends from the last 22 years of research. Female age and size does not have a significant effect on clutch size or hatchling survival. However, we have seen females lay up to 5 viable clutches over multiple nesting seasons, for thousands of total eggs from one individual. The incubation time and success of these clutches depends largely on the nesting beach, its associated threats, and volunteer protection. As this project continues, we encounter and resolve new obstacles, finding solutions through partnerships and community awareness. Hawksbill sea turtles are faced with invasive predators, pollution, habitat loss, beach development, and global warming, but have shown resilience and longevity. Although there has not been a significant increase in this population yet on Maui, continued dedication and conservation can prevent their loss and enable their recovery.

Acknowledgements

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References:
1. Mortimer J.A., Donnelly M. (2008). Eretmochelys imbricata, 2008 IUCN Red List of Threatened Species. Retrieved from www.iucnredlist.org
2. Parker D.M., Balazs G.H., King C., Katahira L., Gilmartin W. (2009). Short-range movements of post-nesting hawksbill turtles (Eretmochelys imbricata) from nesting to foraging areas within the Hawaiian Islands. *Pac Sci* 63:371-382.
3. Mangel J.C., Bernard H., Canja S., Hau S., Smith K., Williams S. (2000). Summary of Hawksbill Turtles (Eretmochelys Imbricata) Nesting on Maui, Hawaii from 1991 to 1996. Kalb, H.J. and T. Wibbels, compilers. Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. U.S. Dept. Commerce. NOAA Tech. Memo. NMFS-SEFSC-443, 291 p.

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