DOES RECREATIONAL DIVING IMPACT HAWKSBILL SEA TURTLE FORAGING BEHAVIOR? RESULTS FROM A MARINE PROTECTED AREA, HONDURAS

Christian T. Hayes[1], Dustin S. Baumbach[2,3], David Juma[5], and Stephen G. Dunbar[2,3,4]

[1]Department of Science and Mathematics, Cedarville University, Cedarville, OH 45314. [2]Protective Turtle Ecology Center for Training, Outreach, and Research, Inc. (ProTECTOR). Colton, CA 92324.

[3]Marine Research Group, Department of Earth and Biological Sciences, Loma Linda University, Loma Linda, CA 92350. [4]Protective Turtle Ecology Center for Training, Outreach, and Research, Inc., Honduras (ProTECTOR - H), Tegucigalpa, Honduras.

[5]School of Public Health, Research Consulting Group, Loma Linda University, Loma Linda, CA 92350.

Introduction

- Little is known about the effects of recreational diving on sea turtle behavior
- **Goal:** to determine if differences in diver behavior alters Hawksbill sea turtle (*Eretmochelys imbricata*) foraging behavior in a marine protected area.
- **Hypothesis**: Hawksbills will engage in less swimming, investigating, and eating behavior when divers are close.

Methods

In-water Observations (Fig. 1)

- Conducted in-water observations in summer 2014
- Recorded turtle behavior observation time and # bouts using underwater paper
- Tested impact of diver (1–4) approach on sea turtle behavior

Analysis

- Ran Spearman's correlations comparing bouts and time
- Conducted repeated measures ANCOVAs comparing behavior before and after diver approach
- Used I^{3}S Pattern to test for repeat observations

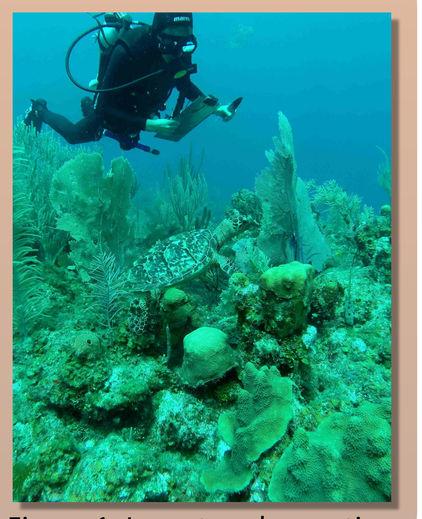

Figure 1. In-water observations

Results

In-water observations

- 1027 min observations (17% total survey time) from 12 June to 2 September (Table 1)
- 61 hawksbills observed at 23 sites with repeat observations (203 min) of 11 turtles (Fig. 2)
- Mean observation time: 13.5 ± 1 min

Analysis (Fig. 3)

- Time for each behavior ↔ # Behavior bouts
- Diver approach ✕ Bouts for each behavior
- Diver approach → Time for each behavior
- Time eating, investigating, and breathing ↓ during diver approach

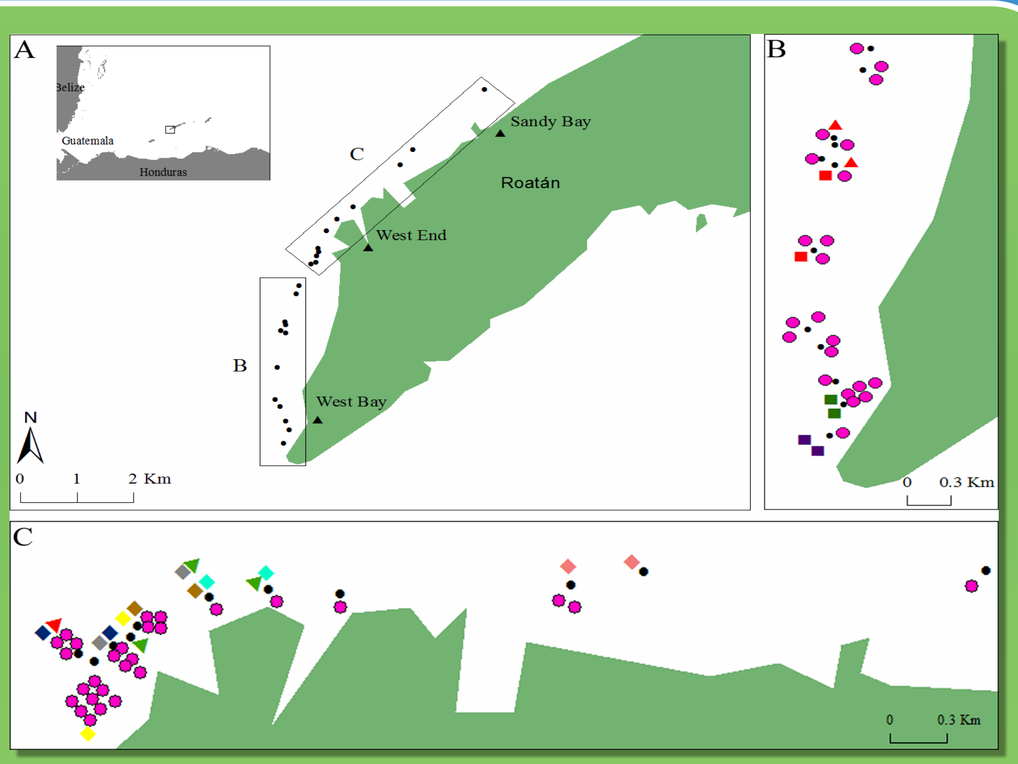

Figure 2. In water observation of 61 hawksbills in the RMP. Black dots: dive sites. Pink circles: single observations. Colored dots: repeat observations (Source: Hayes et al. in press).

Table 1. Behavior times for hawksbill activities

Behavior	Mean time ± S.E.	Range (min)	Percent time
Swimming	7.8 ± 0.7	0.0 – 25.5	57.9
Eating	2.2 ± 0.5	0.0 – 15.9	16.5
Investigating	2.2 ± 0.4	0.0 – 12.8	16.3
Breathing	0.5 ± 0.1	0.0 – 3.6	4.0

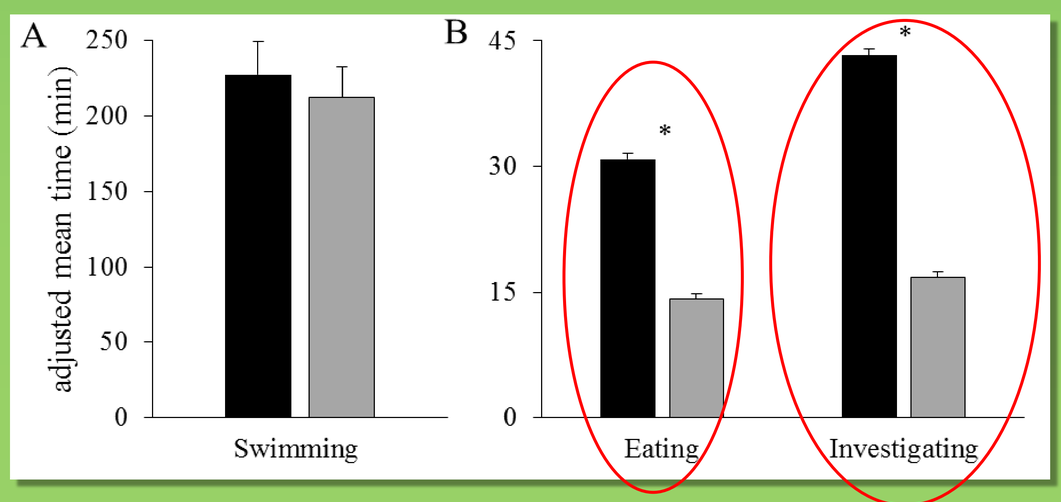

Figure 3. Adjusted mean time (min) + 1 SE turtles engaged in swimming, eating, and investigating behaviors (Source: Hayes et al., in press).

Conclusions

- **Outcome:** Hawksbills spent less time eating, investigating, and breathing during diver approach.
- **Hypothesis**: Hawksbills in the RMP may be habituated to divers and interested in diver activity leading them to alter foraging behavior.
- **Implications:** If changes in turtle foraging behavior are detrimental to sea turtle health (Meadows, 2004), increases in recreational diving may lead to changes in turtle growth and fecundity.

References

Baeza, L., Hayes, C. T., Wright, M., Salinas, L. A., and Dunbar, S.G. 2015. Photo recognition for in-water identification of hawksbills in a marine protected area of Honduras. Page 250 in Y. Kaska, B. Sönmez, O.Türkecan, and Ç. Sezgin, editors. Book of abstracts of the 35th annual symposium on sea turtle biology and conservation. Denizli, Turkey; MARCAT press.

Dunbar, S. G, Salinas, L. A., and Stevenson, L. 2008. In-water observations of recently released juvenile hawksbills. Marine Turtle Newsletter 121:5-9.

Hayes, C. T., Baumbach, D.S., Juma, D., and Dunbar, S. G. (in press). Impacts of recreational diving on hawksbill sea turtle (Eretmochelys imbricata) behaviour in a marine protected area. Journal of Sustainable Tourism.

Meadows, D. 2004. Behavior of green sea turtles in the presence and absence of recreational snorkellers. Marine Turtle Newsletter 103:1-4.

Acknowledgements

This research was funded by ProTECTOR and Loma Linda University. We would like to thank Stephen G. Dunbar for his advice throughout the editing process, Giacomo Palavincini, Nic Bach and the Roatán Marine Park for providing us with equipment and transportation, Ed Santos and Lance PompevMeerdervoort for help with ArcGIS, West End Divers, Coconut Tree Divers, and Splash Inn for providing us with dives, and the many volunteers who helped us collect data.