

The Influence of “Leave No Trace” Ordinances on Sea Turtle Nesting Success

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WHY IT MATTERS?

- Coastal environments provide critical habitat for threatened species¹, economic and recreational opportunities for human development².
- These services are threatened by rapidly increasing marine debris, including abandoned beach equipment².
- Coastal municipalities have begun enacting “Leave No Trace” or similar ordinances to remove marine debris or prevent its deposition^{3,4}. The cities of Gulf Shores and Orange Beach, Alabama, jointly implemented their ordinances in 2016.

RESEARCH OBJECTIVE: Does a “Leave No Trace” ordinance impact sea turtle nesting success or the frequency of obstructed crawls in Baldwin County, Alabama, USA?



METHODS

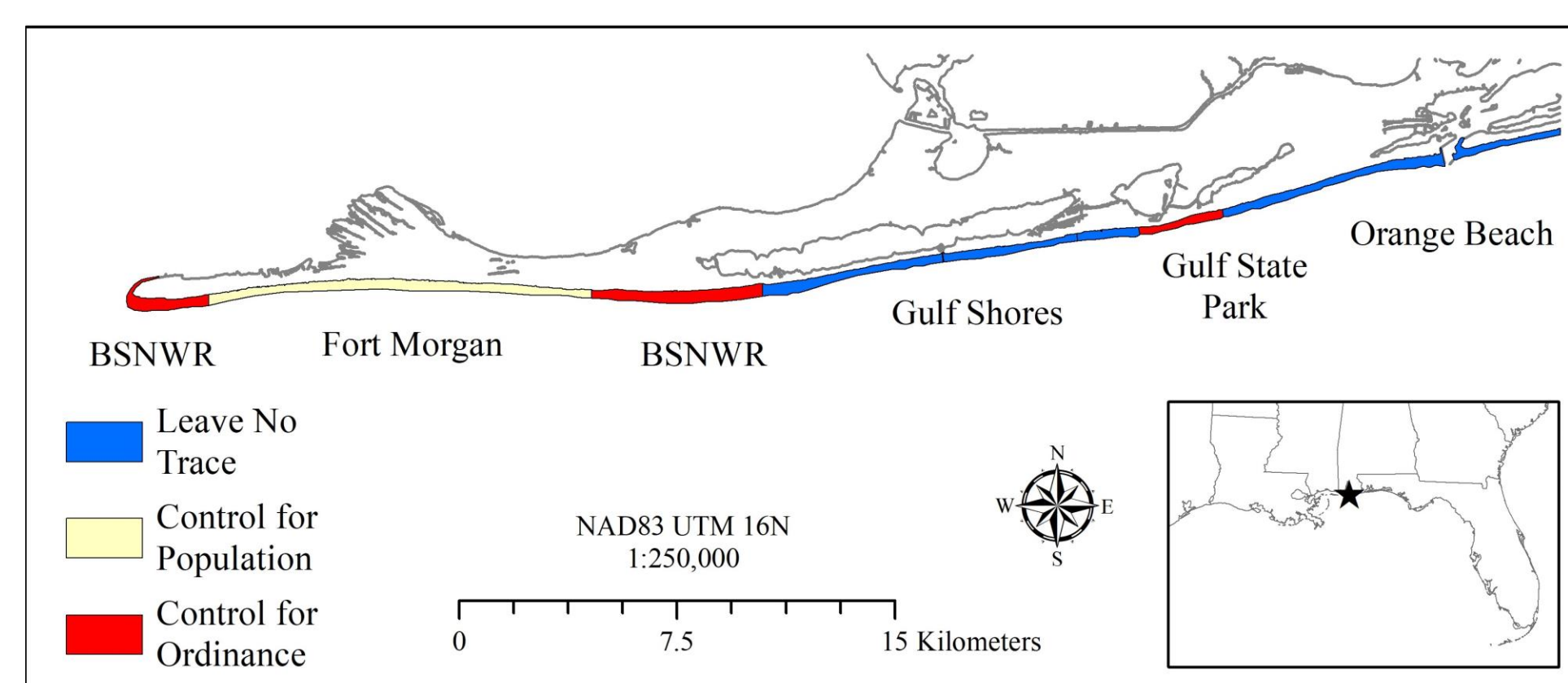


Figure 1. Baldwin County, Alabama, USA beaches. BSNWR: Bon Secour National Wildlife Refuge. Control for Population: has a resident human population but no ordinance. Control for Ordinance: has an ordinance by no resident human population.

- A BACIPS (Before-After Control-Impact Paired Sites) design compared **nesting success** and **the proportion of obstructed crawls** pre- (2011-2015) vs. post-ordinance (2016-2018) at control and treatment sites.
- Binomial generalized linear model (GLM) assessed ...
 - Nesting success $\sim f(\text{treatment group, pre/post-ordinance, interaction with an obstruction, distance to high tide line})$
 - Proportion of obstruction $\sim f(\text{treatment group, pre/post ordinance, distance to high tide line})$

MAIN FINDINGS

Out of 1,679 total crawls and 901 nests across Baldwin County from 2011 to 2018, the “Leave No Trace” ordinance ...

- Did not improve nesting success (Table 1, Figure 1)
- Obstructed crawls decreased by 18% at “Leave No Trace” beaches, increased by 46% at a neighboring non-ordinance beach, relative to pre-ordinance levels (Table 1)
 - The number of obstructions increased after the ordinance (Figure 4)
 - Presence of an obstruction during emergence was not significantly related to nesting success (Figure 2)
- Sea turtle nest site selection is highly variable, and a female turtle may abandon her nesting attempt at any time for reasons beyond obstructions. Improvements in nesting success may not be immediate as enforcement of, and cultural changes associated with, the new ordinance require time.

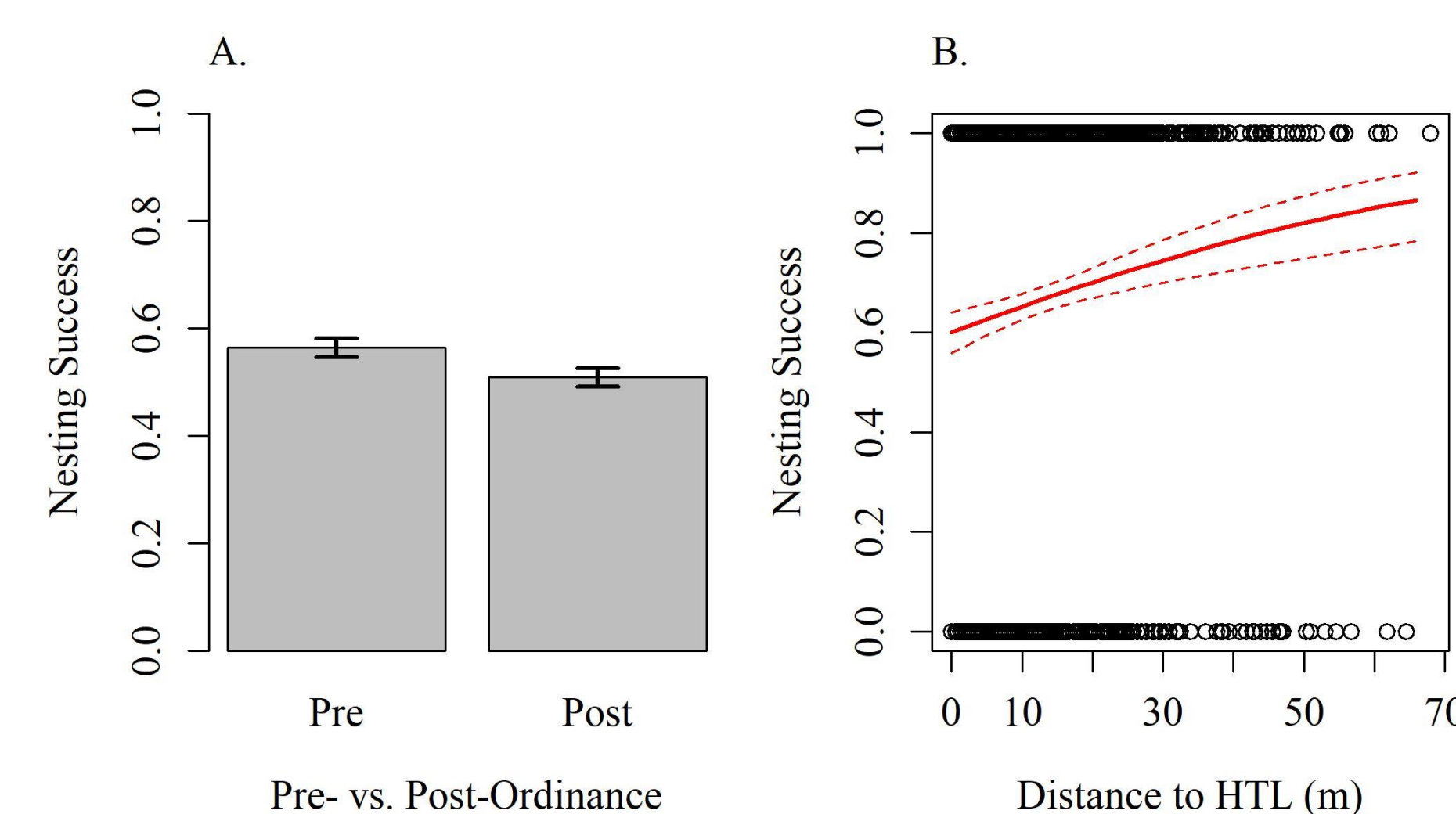


Figure 2. (A) Nesting success (± 1 SE) pre/post-ordinance, and (B) distance to the high tide line (with 95% confidence interval). Treatment group, interaction with an obstruction, and the interaction between pre/post-ordinance and treatment group were not significant, so were not plotted.

Table 1. Mean nesting success and percent obstructed crawls (\pm SE) before (2011-2015) and after (2016-2018) implementation of the “Leave No Trace” ordinance by treatment group. Superscripts indicate statistical significance within pre/post-ordinance implementation (letters) and within treatment group (numbers).

	Leave No Trace	Control for Ordinance	Control for Population
Nesting Success	57.7% ($\pm 2.7\%$) ¹	58.5% ($\pm 3.2\%$)	53.2% ($\pm 3.0\%$)
Pre-ordinance			
Nesting Success	48.7% ($\pm 2.5\%$) ²	51.7% ($\pm 3.2\%$)	54.3% ($\pm 3.4\%$)
Post-ordinance			
Obstructed Crawls	22.1% ($\pm 2.3\%$) ^a	8.1% ($\pm 1.8\%$) ^b	16.7% ($\pm 2.3\%$) ^{a,3}
Pre-ordinance			
Obstructed Crawls	18.1% ($\pm 1.9\%$) ^c	5.1% ($\pm 2.9\%$) ^d	24.3% ($\pm 3.0\%$) ^{c,4}
Post ordinance			

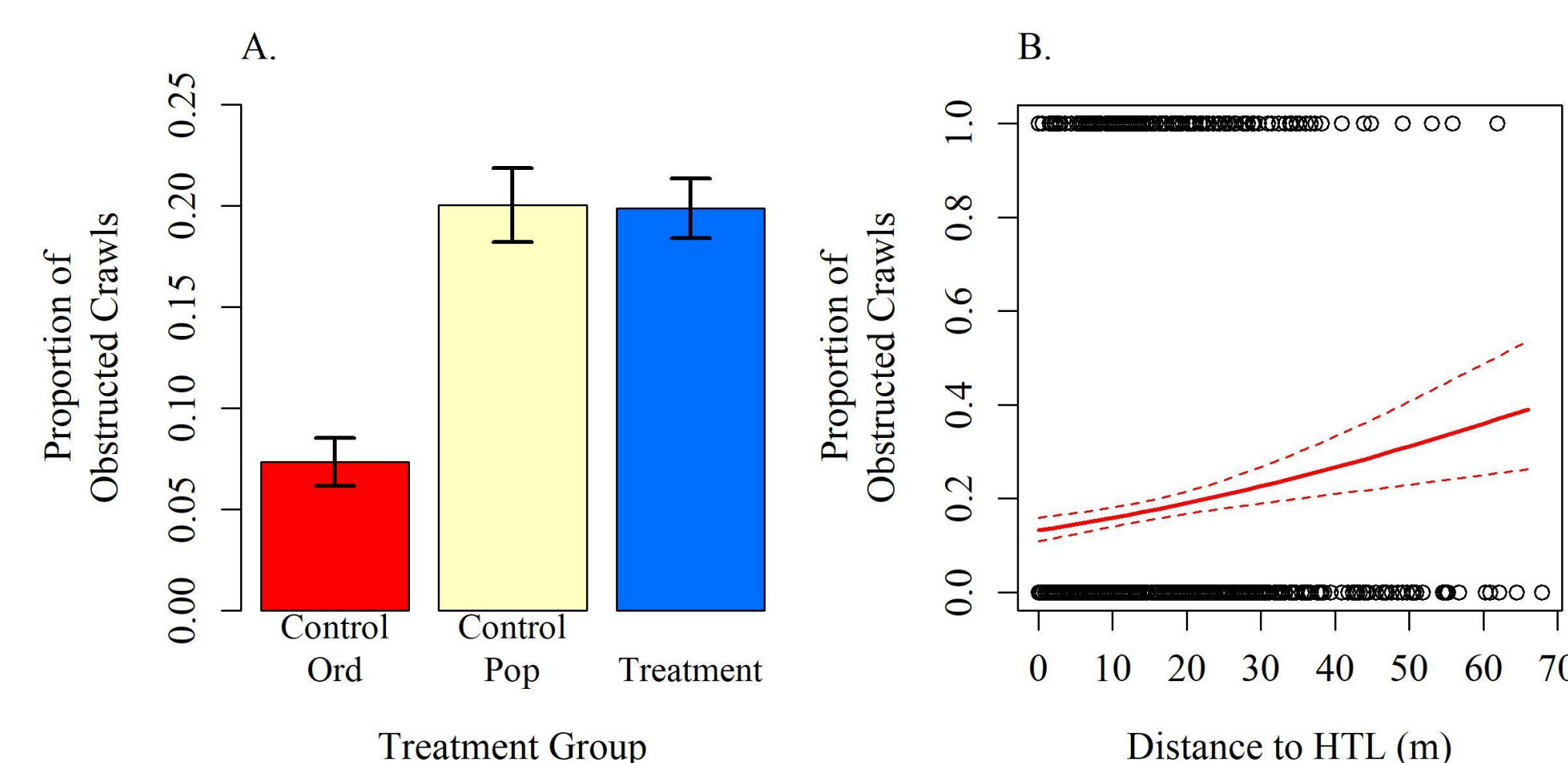


Figure 3. (A) Proportion of obstructed crawls by treatment group (± 1 SE), (B) and distance to the high tide line (with 95% confidence interval). Pre/post-ordinance timing and the interaction between pre/post-ordinance and treatment group were not significant, so were not plotted.

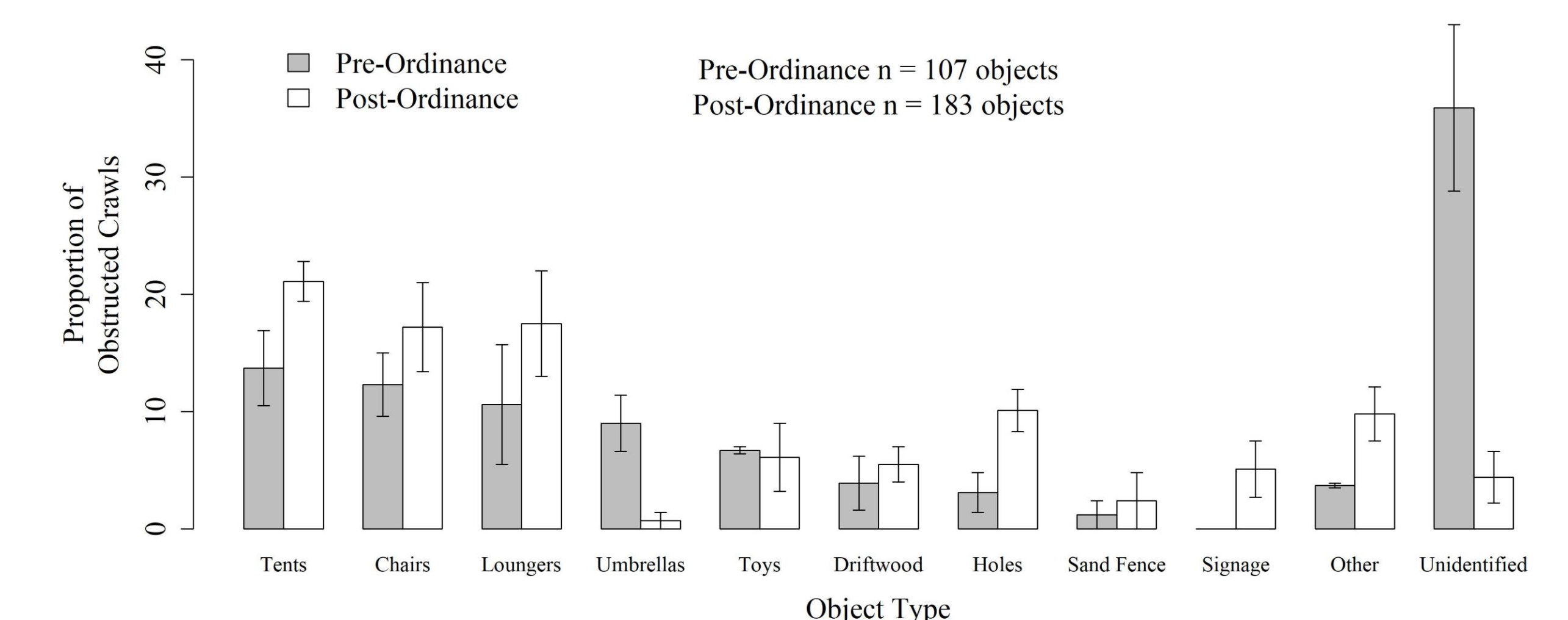


Figure 4. Relative contribution of common beach objects to obstruction of crawls pre- and post-ordinance implementation (\pm SE) across the complete study area. Interpreting trend in any one object class should be done with caution due to the large “Unidentified” category pre-ordinance implementation.

REFERENCES

- NMFS, USFWS (2008) Recovery plan for the northwest Atlantic population of the loggerhead sea turtle (*Caretta caretta*), second revision. National Marine Fisheries Service, Silver Spring, MD.
- Defeo et al. (2009) Threats to sandy beach ecosystems: a review. Estuarine Coastal and Shelf Science 81: 1-12.
- City of Gulf Shores Ordinance 6-1§6-13 “Leave Only Footprints Program”.
- City of Orange Beach Ordinance 30-6§30-158 Beach and Dune Protection and Preservation.

ACKNOWLEDGEMENTS

