SUPPORTING INFORMATION for

Nest initiation and flooding in response to season and semi-lunar spring tides in a ground-nesting shorebird

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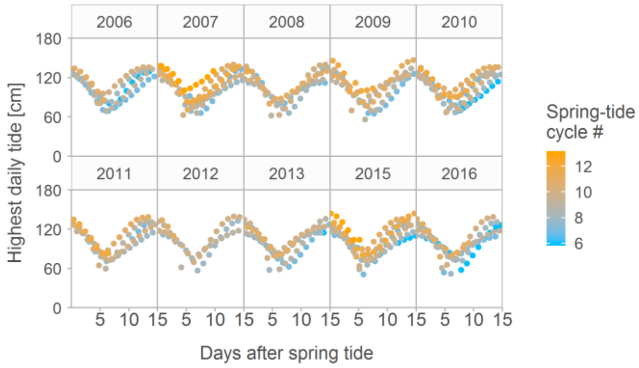

Figure S1 | Changes in the daily highest tides at Ceuta, Mexico. Each point depicts one day, and its color indicates spring tide cycle # (1 refers to the 1st spring tide cycle of the year). Depicted are only spring tide cycles for the breeding season (i.e. period between first and last initiated clutch in a given year). The tide height data were downloaded from mobilegeographics.com (see Methods for details).

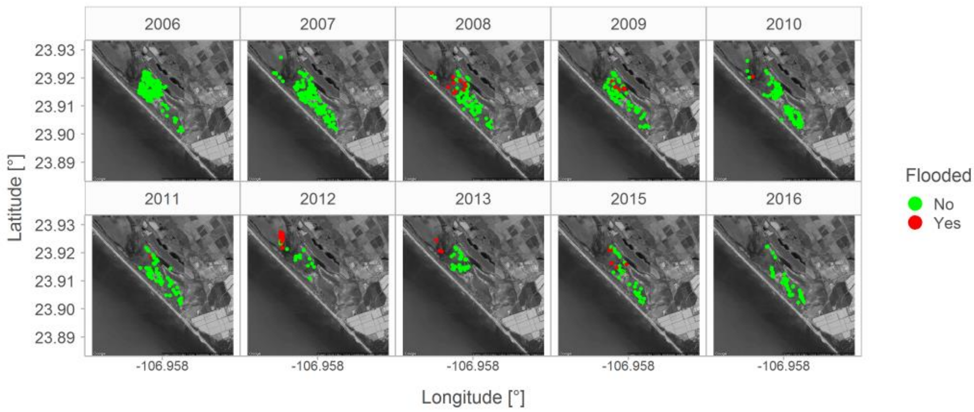

Figure S2 | Spatial variation in Snowy Plover nest locations and flooding across years at Ceuta, Mexico. Each point depicts one nest, its color indicates whether the nest was flooded (red) or not (green). The map was created with 'ggmap' R package (1).

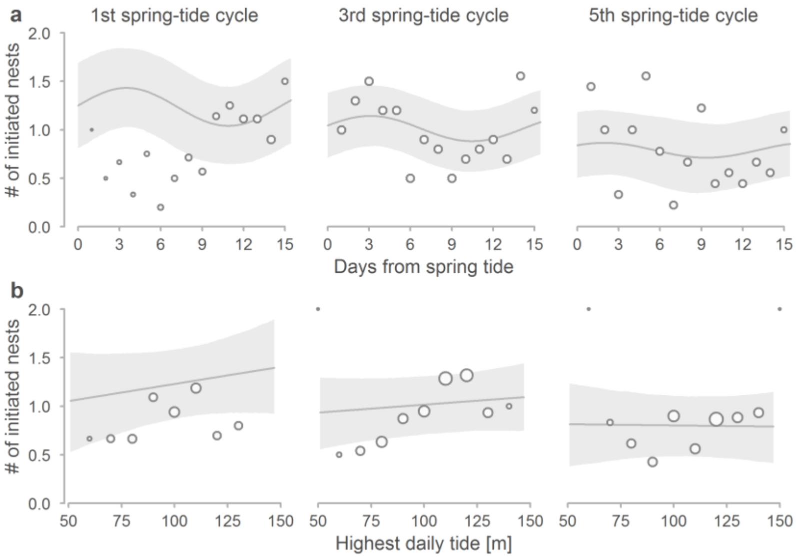

Figure S3 | Changes in the number of initiated Snowy Plover nests across the breeding season. Number of initiated nests over the breeding season (as indicated by spring tide cycle #) and over the spring tide cycle (**a**), or in relation to maximum daily high tide (**b**). Circles represent the mean number of initiated nests within each day of a spring tide cycle (**a**), and for each 10 m tide height interval (**b**). Circle size indicates number of years. The lines and the shaded areas represent model predictions with 95% CI based on a posterior distribution of 5,000 simulated values generated from 'complex Gaussian model' outputs (Table S2 and S3) using first, third and fifth spring tide cycle and the 'sim' function in R (2). *N* = 776 days from ten breeding seasons encompassing 62 spring tide cycles.

Table S1 | Nest initiation according to maximum daily tide height.

Model	Response variable	Effect type	Effect	Estimate	95% CI Lower	Upper
Gaussian complex	# of initiated nests (count)	Fixed	Intercept	0.952	0.647	1.242
			Spring tide cycle number	-0.192	-0.325	-0.061
			Maximum daily tide height	0.033	-0.044	0.113
			Maximum daily tide height × Spring tide cycle	-0.028	-0.107	0.052
		Random (variance)	First or second half : Spring tide cycle : Year (intercept)	9 %		
			Spring tide cycle : Year (intercept)	7 %		
			Year (intercept)	12 %		
			Residual	72 %		
Gaussian simple	# of initiated nests (count)	Fixed	Intercept	0.945	0.65	1.23
			Spring tide cycle number	-0.193	-0.321	-0.063
			Maximum daily tide height	0.036	-0.042	0.113
		Random (variance)	First or second half : Spring tide cycle : Year (intercept)	9 %		
			Spring tide cycle : Year (intercept)	7 %		
			Year (intercept)	12 %		
			Residual	72 %		
Poisson complex	# of initiated nests (count)	Fixed	Intercept	-0.297	-0.586	-0.009
			Spring tide cycle number	-0.237	-0.37	-0.102
			Maximum daily tide height	0.029	-0.055	0.115
			Maximum daily tide height × Spring tide cycle	-0.033	-0.121	0.059
		Random (variance)	Observation (intercept)	13 %		
			First or second half : Spring tide cycle : Year (intercept)	30 %		
			Spring tide cycle : Year (intercept)	19 %		
			Year (intercept)	38 %		
Poisson simple	# of initiated nests (count)	Fixed	Intercept	-0.3	-0.589	-0.032
			Spring tide cycle number	-0.237	-0.378	-0.109
			Maximum daily tide height	0.037	-0.044	0.116
		Random (variance)	Observation (intercept)	13 %		
			First or second half : Spring tide cycle : Year (intercept)	30 %		
			Spring tide cycle : Year (intercept)	19 %		
			Year (intercept)	38 %		

The posterior estimates (medians) of the effect sizes with the 95% CIs derived from a posterior distribution of 5,000 simulated values generated by the 'sim' function in R. Variance components were estimated by the 'lmer' function in R. To account for non-independence of data points 'Year', 'Spring tide cycle number' within year and indication whether the nest was initiated in the 'First or Second half' of the spring tide cycle where fitted as random intercepts. Over-dispersion was modelled by adding 'Observation' level as random intercept. 'Spring tide cycle number' is standardized within the year, so that first spring tide cycle in the given year corresponds to the cycle when the first nest was initiated. 'Day of spring tide cycle' was transformed to radians (2 * number of days after the last spring tide * π / length of the given spring tide cycle [~14.75]) and fitted as sine and cosine of radians. Note that despite violating model assumptions our 'Gaussian model' fits the data better and unlike our 'Binomial model' also accounts for spatial auto-correlation in residuals.
N = 776 days from ten years encompassing 62 spring tide cycles. Note that "Maximum daily tide height" was missing for ten days and we imputed the missing values as the mean of maximum tide heights from previous and next day. Also, excluding these ten days does not change the results.

References

1. Kahle D, Wickham H. Spatial visualization with ggplot2. The R Journal. 2013;5(1):144-61.
2. Gelman A, Su Y. arm: Data analysis using regression and multilevel/hierarchical models [Online]. R package version 1.10-1. 2018.
3. Bates D, Mächler M, Bolker B, Walker S. Fitting Linear Mixed-Effects Models using lme4. 2015. 2015;67(1):48.