1 Methods for standardized indices of abundance

1.1 Stock definition for CPUE analysis

Porbeagle not found in north so removed hemi Mako + blue south and north stocks (see Clarke 2011... or other refs)

1.2 Selection of cells within shark distribution

Looked at range of SST where positive catches occured, selected cells where median falls within this range

1.3 Procedure for model selection

Variable name	Symbol	Explanation	% records present
Year	β_Y	Require to estimate year effect	100
Month	β_M	Captures seasonal variability	100
Observer program	β_O	Country hosting the observer program	100
Vessel flag	β_F	Note: correlated with observer program	100
Hooks-beween-floats	β_{HBF}	Indicator of catchability for surface-dwelling species	
Shark bait			
Number of shark lines			
Lighsticks			
Shark target		Sharks explicitly defined as targets?	
SST	SST	Moon frac	

1.3.1 Note on interactions between year and observer program

1.4 Notes on the use of error distributions

Error distributions for by-catch species have been discussed at length in previous publications as these data are notoriously hard to model properly due to the high proportion of zeroes (**?**). We achieved significant improvements in model diagnostics by allowing multiple parameters in the error distribution to be fit. This is because often accounting for the large amount of zeroes in shark CPUE catch data comes at the expense of modelling large catch events, since the dispersion is assumed to be constant for all factors. This is especially a problem when the mean of the distribution is close to zero or one, as in those instances the probability of getting large events if mostly controlled by the dispersion parameter (unlike when the mean is larger and the tail is not as pronounced). However, whenever conditions are good for sharks or targeting takes place, larger catch events can happen and not modelling them properly means we are missing important drivers. Typically, this can seen as a bump in the right-hand side of qqnorm plots.

Because flag and observer programs are highly correlated, we used observer program as an explanatory categorical variable as it tended to explain a higher proportion of the data when used on its own than flag. We also explored adding an interaction between year and observer program, as for some species of less mobile sharks we could expect to see local trends in annual abundance that are reflected in the observer program data. We checked for the relevance of including interactions early in the model selection process, and proceeded with an interaction for the remaining of the model selection if the AIC score when interactions are allowed is at least 50 lower than with additive effects only.

Hooks-between-floats on its own explains little variation, probably because it only matters when looked at within specific levels of other factors (see Fig ... – panel observers).

1.5 Model structure by species

Species	Model μ	model dispersion	% deviance explained
South mako: program + hbp2 + yy + mm	program code + month		
North mako:			
South Blue shark:			
North Blue shark:			
Thresher:			
Hammerheads:			
Oceanic whitetip:			
Silky:			
Porbeagle:			

1.6 Model diagnostics

Used quantile residuals.