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**Supplementary material**

# Inferring trends and linkages between shark abundance and shark bites on humans for shark-hazard mitigation

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**Table S1. Generalised additive model (GAM) and zero-inflated generalised additive model (ZIGAM) comparisons for the abundance of potentially dangerous sharks and for the frequency of shark bites off the Metropolitan Region of Recife**

Included are the response variables (Resp.), where PDSs corresponds to potentially dangerous sharks, Tiger and Bull correspond to species-specific analyses of tiger and bull sharks respectively, TSB corresponds to the total number of shark bites, and FSB corresponds to fatal shark bites only; the predictor variables (Predict.), where SMPR corresponds to the activity of the Shark Monitoring Program of Recife; and the approximated logarithmic marginal likelihoods (logE), the Akaike's information criterion (AIC), the AIC differences ΔAIC = (AIC – min(AIC)), and the rounded Akaike weights (AICw) of the respective models

| Variable | Predict. | logE | | AIC | | ΔAIC | | AICw | |
|---|---|---|---|---|---|---|---|---|---|
| Resp. | | GAM | ZIGAM | GAM | ZIGAM | GAM | ZIGAM | GAM | ZIGAM |
| PDSs | Year | –222.0 | –221.7 | 516.2 | 441.7 | 74.5 | 0 | <0.0001 | 0.9999 |
| PDSs | Month | –225.1 | –224.8 | 514.3 | 441.5 | 72.8 | 0 | <0.0001 | 0.9999 |
| PDSs | Fishing site | –316.2 | –315.9 | 622.8 | 546.1 | 76.7 | 0 | <0.0001 | 0.9999 |
| Tiger | Year | –462.0 | –461.6 | 1029.2 | 979.2 | 50.0 | 0 | <0.0001 | 0.9999 |
| Tiger | Month | –469.1 | –468.3 | 1031.4 | 980.3 | 51.1 | 0 | <0.0001 | 0.9999 |
| Tiger | Fishing site | –476.0 | –475.5 | 1033.6 | 991.1 | 42.5 | 0 | <0.0001 | 0.9999 |
| Bull | Year | –235.2 | –234.5 | 520.2 | 468.8 | 51.4 | 0 | <0.0001 | 0.9999 |
| Bull | Month | –245.0 | –244.6 | 530.1 | 489.0 | 41.1 | 0 | <0.0001 | 0.9999 |
| Bull | Fishing site | –249.9 | –249.0 | 541.3 | 491.8 | 49.5 | 0 | <0.0001 | 0.9999 |
| TSB[A] | SMPR | –41.0 | –40.3 | 120.4 | 79.6 | 40.8 | 0 | <0.0001 | 0.9999 |
| TSB[A] | Month | –35.3 | –34.9 | 118.1 | 78.1 | 40.0 | 0 | <0.0001 | 0.9999 |

[A]The dataset comprised all shark bites for the period between June 1992 to December 2015.

**Table S2. Stepwise variable selection procedure of the spatiotemporal predictors for the zero-inflated generalised additive model of potentially dangerous shark abundance**

Included are the explained percentage of null deviance (Dev.exp.), the approximated logarithmic marginal likelihood (logE), the Akaike's information criterion (AIC), the AIC differences (ΔAIC = (AIC – min(AIC)), and the rounded Akaike weights (AICw) of each candidate model. The final model is identified in bold

| Model | Dev.exp (%) | logE | AIC | ΔAIC | AICw |
|---|---|---|---|---|---|
| Null | 0.0 | –380.11 | 381.33 | 26.97 | 0.0001 |
| Year | 3.7 | –378.52 | 378.90 | 24.54 | 0.0001 |
| Month | 6.6 | –370.82 | 358.01 | 3.65 | 0.0690 |
| Fishing site | 3.9 | –376.10 | 371.10 | 16.74 | 0.0001 |
| Month + Fishing site | 11.3 | –368.33 | 354.57 | 0.21 | 0.3859 |
| Month + Year | 10.8 | –369.01 | 356.97 | 2.61 | 0.1162 |
| **Month + Fishing site + Year** | **13.0** | **–367.19** | **354.36** | **0.00** | 0.4286 |

**Table S3. Stepwise variable selection procedure for the zero-inflated generalised additive model of tiger shark occurrence**

Included are the explained percentage of null deviance (Dev.exp.), the approximated logarithmic marginal likelihood (logE), the Akaike's information criterion (AIC), the AIC differences (ΔAIC = (AIC – min(AIC)), and the rounded Akaike weights (AICw) of each candidate model. The final model is identified in bold

| Model | Dev.exp. (%) | logE | AIC | ΔAIC | AICw |
|---|---|---|---|---|---|
| Null | 0.0 | –480.62 | 269.89 | 29.31 | 0.0001 |
| Year | 4.6 | –462.12 | 254.74 | 14.16 | 0.0007 |
| Month | 5.1 | –460.97 | 253.14 | 12.56 | 0.0013 |
| Fishing site | 1.0 | –472.66 | 263.97 | 23.39 | 0.0001 |
| Month + Year | 9.3 | –451.05 | 242.91 | 2.33 | 0.2362 |
| Month + Fishing site | 6.1 | –463.28 | 250.86 | 10.28 | 0.0044 |
| **Month + Year + Fishing site** | **10.2** | **–449.90** | **240.58** | **0.00** | 0.7572 |

**Table S4. Stepwise variable selection procedure for the zero-inflated generalised additive model of bull shark occurrence**

Included are the explained percentage of null deviance (Dev.exp.), the approximated logarithmic marginal likelihood (logE), the Akaike's information criterion (AIC), the AIC differences (ΔAIC = (AIC – min(AIC)), and the rounded Akaike weights (AICw) of each candidate model. The final model is identified in bold

| Model | Dev.exp. (%) | logE | AIC | ΔAIC | AICw |
|---|---|---|---|---|---|
| Null | 0.0 | –252.28 | 1002.41 | 13.72 | 0.0006 |
| Year | 1.2 | –234.56 | 992.28 | 3.59 | 0.0799 |
| Month | 0.8 | –244.68 | 995.49 | 6.80 | 0.0161 |
| Fishing site | 0.2 | –249.02 | 1000.05 | 11.36 | 0.0016 |
| **Year + Month** | **2.1** | **–232.16** | **988.69** | **0.00** | **0.4805** |
| Year + Fishing site | 1.3 | –233.95 | 992.85 | 4.16 | 0.0600 |
| Year + Month + Fishing site | 2.0 | –232.76 | 989.26 | 0.57 | 0.3613 |

**Table S5. Stepwise variable selection procedure for the zero-inflated generalised additive model of shark-bite frequency**

Included are the explained percentage of null deviance (Dev.exp.), the approximated logarithmic marginal likelihood (logE), the Akaike's information criterion (AIC), the AIC differences (ΔAIC = (AIC – min(AIC)), and the rounded Akaike weights (AICw) of each candidate model. The final model is identified in bold

| Model | Dev.exp. (%) | logE | AIC | ΔAIC | AICw |
|---|---|---|---|---|---|
| Null | 0.0 | –244.01 | 443.16 | 5.15 | 0.0431 |
| SMPR | 2.1 | –242.13 | 441.92 | 3.91 | 0.0800 |
| Month | 9.6 | –239.96 | 439.20 | 1.19 | 0.3117 |
| **Month + SMPR** | **12.9** | **–237.68** | **438.01** | **0.00** | **0.5652** |

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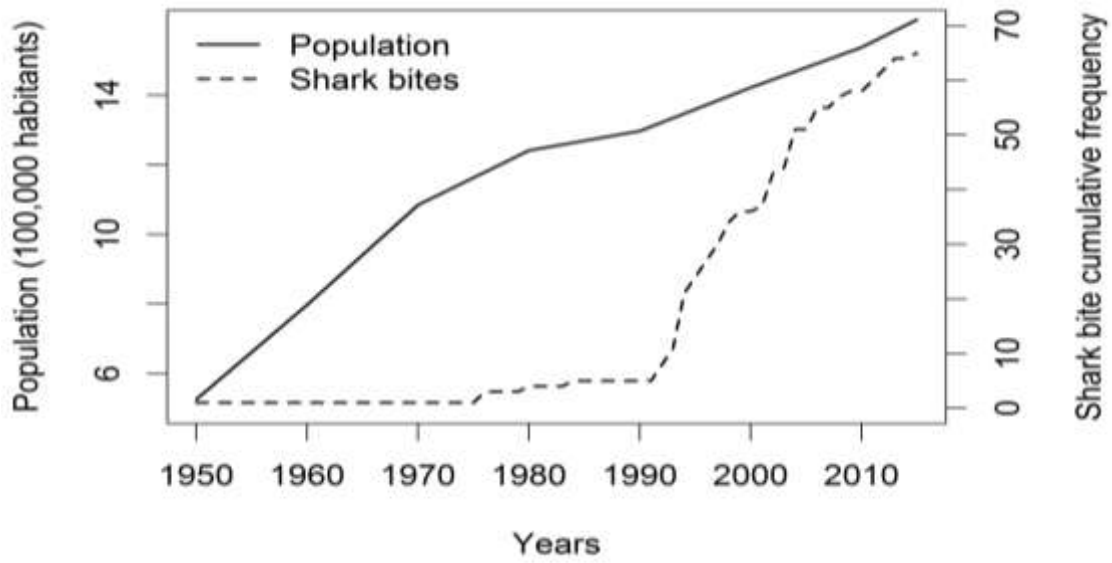


**Fig. S1.** Yearly cumulative frequency of shark bites reported off the Metropolitan Region of Recife, in comparison with the cumulative frequency of the local population, between 1950 and 2015. Population data were obtained from Instituto Brasileiro de Geografia e Estatística, IBGE (http://cidades.ibge.gov.br/xtras/perfil.php?codmun=261160, accessed 31 December 2015), whereas shark-bite data were obtained from the Shark Attack International File and from the State Committee for the Monitoring of Incidents with Sharks, CEMIT (http://www.portaisgoverno.pe.gov.br/c/document_library/get_file?uuid = 2bdd9987-d469-4679-b652-ba7a2556e3c2&groupId = 124015, accessed 31 December 2015).