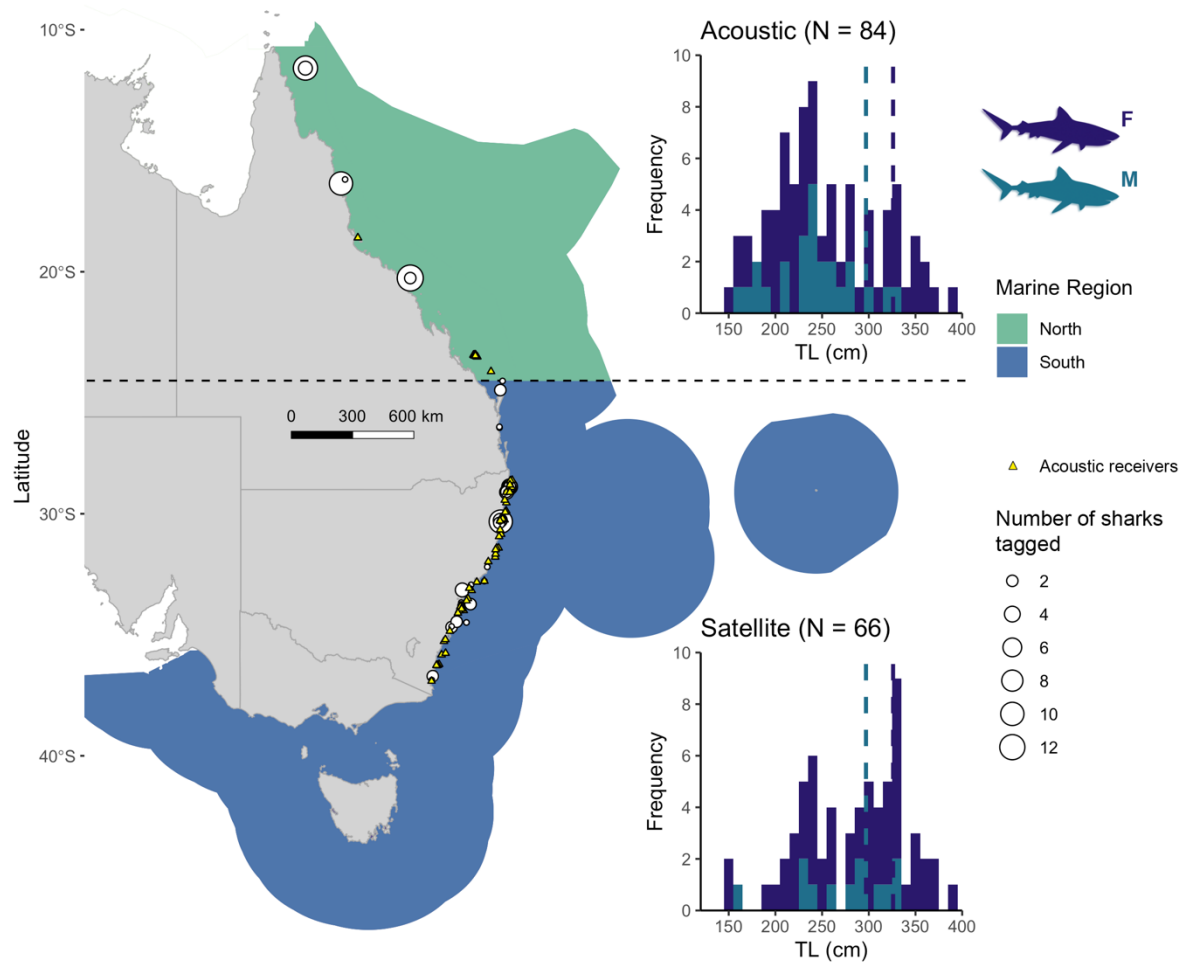
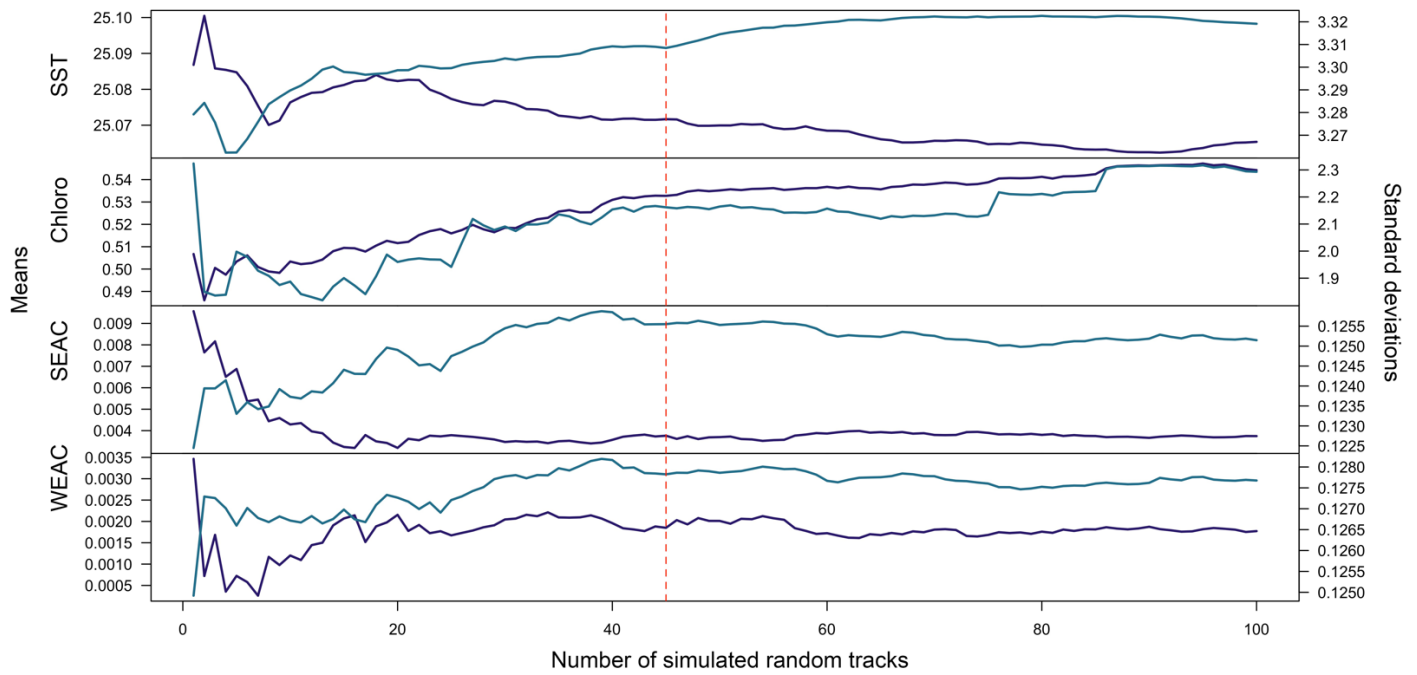


# Forecasting intraspecific changes in distribution of a wide-ranging marine predator under climate change

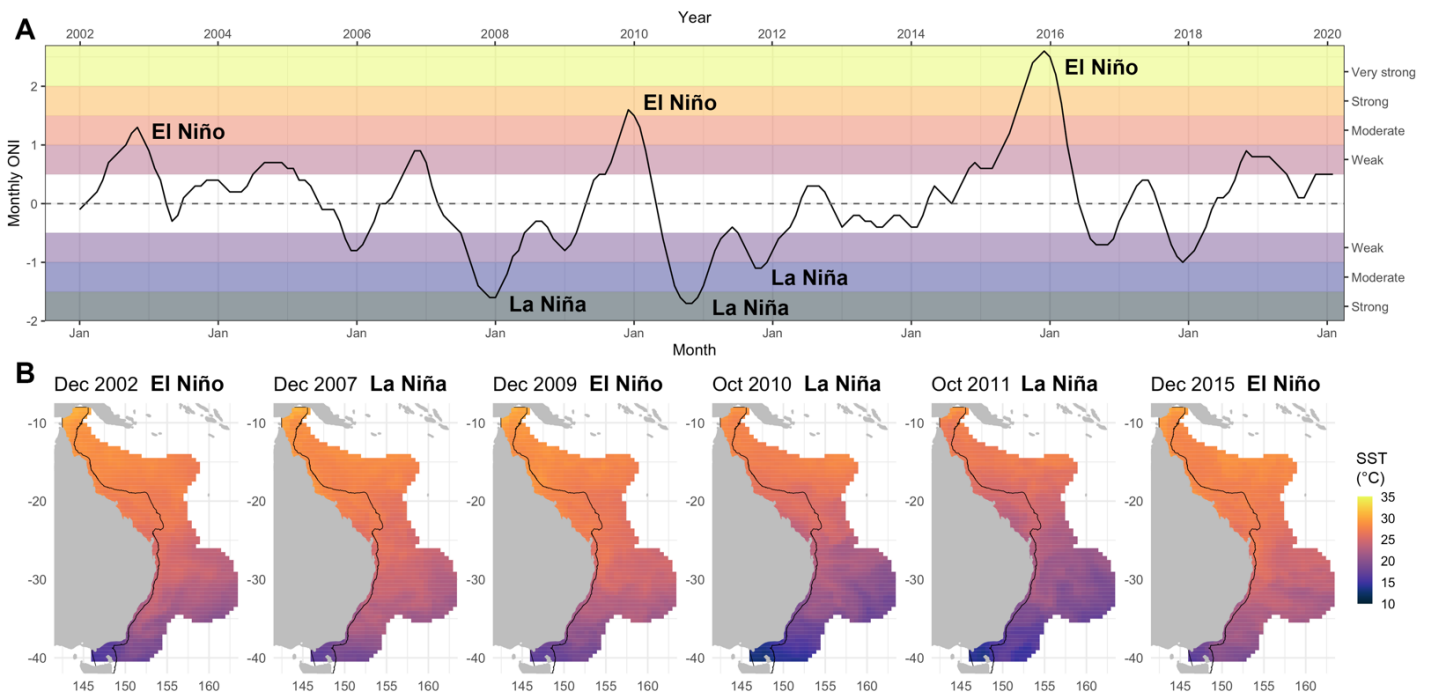
*Yuri Niella, Paul Butcher, Bonnie Holmes, Adam Barnett, Robert Harcourt*



**Figure S1.** Map of the east coast of Australia showing the positions of acoustic receivers and the tiger shark tagging locations, including the North and South Marine Regions, and histograms of total length (TL) distribution of sharks tagged with acoustic (upper) and satellite (lower) transmitters by sex. Vertical dashed lines in histograms represent sex-specific maturation sizes for tiger sharks in eastern Australia. The horizontal dashed line represents the coast centroid location (latitude 24.5°S) used to divide the North and South Regions considered in the present study.



**Figure S2.** Variation of mean (dark line) and standard deviation (light line) of the environmental variables as a function of the number of simulated random tracks. The final value of 45 random tracks (dashed red line) was chosen as it stabilized all environmental variables.



**Figure S3.** Monthly distribution (a) of the Oceanic Niño Index (ONI) with horizontal bands representing the corresponding intensity of events. Geographical distribution within the Australian marine regions (b) of the mean sea surface temperature (SST) during peaked El Niño/La Niña months during the study period, with contour lines depicting the 1,000-m isobath used as the spatial resolution for the modelling approach.

## *1. Shark location processing*

GPE3 software (Wildlife Computers) was used to generate raw tracks from light-level data of PSAT tags, and a Kalman Filter was applied to the corresponding processed geolocations and location errors. A correlated random-walk state-space model using a 5 m/s speed filter to avoid unrealistic swimming behaviour was applied to both PSAT and SPOT data, with location estimates reduced to standard sampling intervals of 24 hours using the *foieGras* R package (Jonsen et al. 2020). A bathymetric correction was performed with locations over land moved to the nearest in-water location within the corresponding location errors. False detections were identified and excluded from the acoustic tracking dataset. These comprised either any acoustic detections of the tracked transmitters which occurred prior to the release of a tagged shark, or single/few detections which would correspond to biologically not plausible movements (e.g., hundreds to thousands of kilometres in one day/a couple of days).

One of the main differences between satellite and acoustic telemetry data is that in the latter the animal positions are restricted to the deployment locations of the acoustic receivers (Harcourt et al. 2019). To merge acoustic and satellite data and remove potential bias in the analysis from multiple daily detections of the same individual, the acoustic dataset was standardised to only include a single daily location for each tracked shark. These single daily acoustic locations were obtained using centre of activity calculations (Simpfendorfer et al. 2002). For double-tagged sharks, these processed acoustic locations were added to the satellite tracks. If the centre of activity location was placed within the error of a satellite position on a particular day, the acoustic position was used, and the satellite excluded as the latter are usually less accurate. If the acoustic location was outside of the satellite error, the midpoint of a straight line between the two positions was considered to be representative of that day's position.

## *2.1. Juvenile shark movements*

### *2.1.1. Juvenile females*

Sharks tagged in the Great Barrier Reef Marine Park tended to remain in the northern region though some individuals swam towards Papua New Guinea or the Solomon Islands, with the furthest movement a straight-line distance of 2,138 km from the Great Barrier Reef, October 2015 towards Tonga, February 2016 (Fig. 1a). Juvenile females tagged in the Temperate East Marine Region usually moved further, both into the northern region but also towards oceanic areas including to Papua New Guinea and New Caledonia (Fig. 1a).

### *2.1.2. Juvenile males*

Juvenile males tagged in the Great Barrier Reef Marine Park remained north of the coast centroid, some moving towards Papua New Guinea (Fig. 1b). Juvenile males tagged in the Temperate East Marine Region generally travelled further, with one moving towards New Caledonia (Fig. 1b).

## *2.2. Adult shark movements*

### *2.2.1. Adult females*

Adult females tagged in the Great Barrier Reef Marine Park remained in the north (Fig. 1c). Most sharks remained within Australian coastal waters, but one individual moved into the Gulf of Carpentaria, and another travelled north towards Papua New Guinea (Fig. 1c). Adult females tagged in the Temperate East Marine Region generally dispersed further than sharks tagged north of the coast centroid and moved both north and south into the South East Marine Region, using waters as far south as the Bass Strait (Fig. 1c) between the months of February and April when SSTs ranged between 17.8 and 20.5°C.

**Table S1.** Tagging and tracking metadata on the 115 tiger sharks analysed in the present study, including information on tagging date, location, sex, total length (TL; cm), types of transmitters deployed (Acoustic, SPOT and PSAT), total number of tracking days, maximum distances travelled away from tagging locations, and biological class.

| Date       | Latitude | Longitude | Sex | TL  | Acoustic | SPOT  | PSAT  | Days | Distance | Class    |
|------------|----------|-----------|-----|-----|----------|-------|-------|------|----------|----------|
| 21/01/2012 | -33.147  | 151.376   | F   | 150 | FALSE    | TRUE  | TRUE  | 26   | 730.71   | Juvenile |
| 06/04/2019 | -36.708  | 149.996   | F   | 150 | TRUE     | FALSE | FALSE | 285  | 331.78   | Juvenile |
| 10/04/2010 | -33.732  | 151.764   | F   | 152 | FALSE    | TRUE  | TRUE  | 13   | 205.34   | Juvenile |
| 16/09/2017 | -30.320  | 153.150   | F   | 159 | TRUE     | FALSE | FALSE | 112  | 90.79    | Juvenile |
| 25/04/2019 | -30.322  | 153.180   | F   | 160 | TRUE     | FALSE | FALSE | 40   | 140.85   | Juvenile |
| 07/03/2019 | -36.718  | 149.992   | F   | 168 | TRUE     | FALSE | FALSE | 269  | 932.52   | Juvenile |
| 16/11/2017 | -30.362  | 153.120   | F   | 174 | TRUE     | FALSE | FALSE | 12   | 171.88   | Juvenile |
| 13/02/2018 | -30.287  | 153.203   | F   | 188 | TRUE     | TRUE  | TRUE  | 281  | 857.85   | Juvenile |
| 03/03/2018 | -34.647  | 150.875   | F   | 192 | TRUE     | FALSE | FALSE | 10   | 133.70   | Juvenile |
| 09/09/2018 | -28.885  | 153.595   | F   | 192 | TRUE     | FALSE | FALSE | 209  | 878.70   | Juvenile |
| 18/11/2007 | -35.054  | 151.066   | F   | 200 | FALSE    | TRUE  | TRUE  | 47   | 459.54   | Juvenile |
| 15/04/2019 | -29.096  | 153.444   | F   | 201 | TRUE     | FALSE | FALSE | 281  | 843.44   | Juvenile |
| 15/11/2017 | -30.272  | 153.154   | F   | 203 | TRUE     | FALSE | FALSE | 4    | 165.06   | Juvenile |
| 15/04/2019 | -29.107  | 153.450   | F   | 203 | TRUE     | FALSE | FALSE | 77   | 31.92    | Juvenile |
| 18/06/2018 | -29.113  | 153.457   | F   | 204 | TRUE     | FALSE | FALSE | 137  | 122.35   | Juvenile |
| 27/04/2012 | -34.492  | 151.572   | F   | 210 | FALSE    | TRUE  | FALSE | 107  | 1118.01  | Juvenile |
| 12/02/2015 | -16.353  | 145.697   | F   | 210 | TRUE     | TRUE  | FALSE | 194  | 28.43    | Juvenile |
| 29/11/2017 | -30.285  | 153.141   | F   | 210 | TRUE     | FALSE | FALSE | 324  | 715.33   | Juvenile |
| 10/01/2018 | -30.271  | 153.158   | F   | 212 | TRUE     | FALSE | FALSE | 4    | 6.80     | Juvenile |
| 28/01/2018 | -30.380  | 153.110   | F   | 212 | TRUE     | FALSE | FALSE | 56   | 144.53   | Juvenile |
| 02/03/2018 | -34.684  | 150.876   | F   | 212 | TRUE     | FALSE | FALSE | 328  | 545.37   | Juvenile |
| 29/03/2019 | -30.323  | 153.180   | F   | 216 | TRUE     | TRUE  | TRUE  | 298  | 895.84   | Juvenile |
| 09/02/2018 | -32.195  | 152.548   | F   | 219 | TRUE     | FALSE | FALSE | 370  | 492.50   | Juvenile |
| 29/01/2018 | -30.274  | 153.155   | F   | 221 | TRUE     | FALSE | FALSE | 7    | 95.45    | Juvenile |
| 30/01/2018 | -30.318  | 153.153   | F   | 221 | TRUE     | TRUE  | FALSE | 329  | 435.72   | Juvenile |
| 24/04/2019 | -28.813  | 153.614   | F   | 223 | TRUE     | TRUE  | TRUE  | 26   | 356.08   | Juvenile |
| 23/01/2019 | -28.855  | 153.613   | F   | 226 | TRUE     | FALSE | TRUE  | 5    | 24.91    | Juvenile |
| 30/05/2017 | -30.331  | 153.138   | F   | 227 | TRUE     | TRUE  | FALSE | 948  | 788.07   | Juvenile |
| 17/05/2019 | -29.112  | 153.457   | F   | 227 | TRUE     | FALSE | FALSE | 44   | 14.26    | Juvenile |
| 14/05/2019 | -30.318  | 153.145   | F   | 228 | TRUE     | TRUE  | TRUE  | 200  | 559.29   | Juvenile |
| 19/11/2019 | -33.798  | 151.303   | F   | 230 | TRUE     | FALSE | FALSE | 18   | 16.46    | Juvenile |
| 23/10/2018 | -16.353  | 145.697   | F   | 231 | FALSE    | TRUE  | FALSE | 476  | 105.40   | Juvenile |
| 08/05/2019 | -30.237  | 153.185   | F   | 236 | TRUE     | TRUE  | TRUE  | 233  | 2394.83  | Juvenile |
| 22/10/2018 | -16.353  | 145.697   | F   | 240 | FALSE    | TRUE  | FALSE | 509  | 780.79   | Juvenile |
| 29/03/2017 | -29.115  | 153.459   | F   | 241 | TRUE     | FALSE | FALSE | 182  | 60.99    | Juvenile |
| 13/02/2018 | -30.318  | 153.190   | F   | 242 | TRUE     | TRUE  | TRUE  | 533  | 603.53   | Juvenile |
| 18/12/2018 | -20.259  | 148.941   | F   | 242 | TRUE     | TRUE  | FALSE | 247  | 322.78   | Juvenile |
| 27/03/2012 | -34.459  | 151.114   | F   | 245 | FALSE    | TRUE  | TRUE  | 27   | 1001.29  | Juvenile |

|            |         |         |   |     |       |       |       |      |         |          |
|------------|---------|---------|---|-----|-------|-------|-------|------|---------|----------|
| 08/04/2012 | -34.816 | 151.102 | F | 250 | FALSE | TRUE  | FALSE | 285  | 1262.34 | Juvenile |
| 29/03/2019 | -30.315 | 153.173 | F | 251 | TRUE  | TRUE  | TRUE  | 61   | 1029.18 | Juvenile |
| 24/07/2011 | -24.512 | 153.264 | F | 260 | FALSE | TRUE  | TRUE  | 7    | 2.77    | Juvenile |
| 12/08/2015 | -16.353 | 145.697 | F | 260 | TRUE  | TRUE  | FALSE | 84   | 103.61  | Juvenile |
| 06/11/2019 | -32.936 | 151.790 | F | 260 | TRUE  | FALSE | FALSE | 71   | 116.94  | Juvenile |
| 07/02/2019 | -28.853 | 153.615 | F | 261 | TRUE  | FALSE | FALSE | 161  | 236.55  | Juvenile |
| 23/10/2018 | -16.353 | 145.697 | F | 262 | FALSE | TRUE  | FALSE | 453  | 132.42  | Juvenile |
| 31/10/2018 | -28.868 | 153.599 | F | 270 | TRUE  | FALSE | FALSE | 114  | 26.45   | Juvenile |
| 12/08/2015 | -16.353 | 145.697 | F | 280 | TRUE  | TRUE  | FALSE | 158  | 72.24   | Juvenile |
| 04/02/2019 | -28.841 | 153.616 | F | 280 | TRUE  | FALSE | FALSE | 174  | 604.10  | Juvenile |
| 12/06/2019 | -20.259 | 148.941 | F | 285 | TRUE  | TRUE  | FALSE | 278  | 263.43  | Juvenile |
| 01/01/2019 | -28.892 | 153.584 | F | 287 | TRUE  | FALSE | FALSE | 140  | 877.56  | Juvenile |
| 25/03/2011 | -26.444 | 153.121 | F | 290 | FALSE | TRUE  | FALSE | 155  | 402.38  | Juvenile |
| 08/12/2006 | -11.583 | 144.033 | F | 295 | FALSE | TRUE  | FALSE | 63   | 169.34  | Juvenile |
| 16/12/2007 | -11.588 | 144.031 | F | 296 | FALSE | TRUE  | TRUE  | 232  | 88.76   | Juvenile |
| 13/12/2007 | -11.588 | 144.031 | F | 300 | FALSE | TRUE  | TRUE  | 21   | 451.27  | Juvenile |
| 18/02/2015 | -16.353 | 145.697 | F | 300 | TRUE  | TRUE  | FALSE | 1300 | 2031.83 | Juvenile |
| 12/09/2019 | -20.259 | 148.941 | F | 300 | TRUE  | TRUE  | FALSE | 186  | 338.60  | Juvenile |
| 04/02/2015 | -24.890 | 153.159 | F | 301 | TRUE  | TRUE  | FALSE | 388  | 167.89  | Juvenile |
| 01/12/2013 | -11.588 | 144.031 | F | 308 | FALSE | TRUE  | FALSE | 16   | 149.38  | Juvenile |
| 26/09/2019 | -28.884 | 153.585 | F | 308 | TRUE  | FALSE | FALSE | 41   | 597.21  | Juvenile |
| 25/09/2010 | -26.408 | 153.116 | F | 310 | FALSE | TRUE  | TRUE  | 10   | 194.44  | Juvenile |
| 25/03/2013 | -11.588 | 144.031 | F | 311 | FALSE | TRUE  | FALSE | 383  | 210.84  | Juvenile |
| 18/02/2015 | -16.353 | 145.697 | F | 317 | TRUE  | TRUE  | FALSE | 385  | 2137.84 | Juvenile |
| 21/02/2002 | -11.600 | 144.057 | F | 320 | FALSE | TRUE  | TRUE  | 90   | 473.82  | Juvenile |
| 05/05/2007 | -34.290 | 151.637 | F | 320 | FALSE | TRUE  | TRUE  | 48   | 1838.04 | Juvenile |
| 27/03/2019 | -36.871 | 149.950 | F | 320 | TRUE  | FALSE | FALSE | 64   | 666.38  | Juvenile |
| 13/12/2019 | -20.259 | 148.941 | F | 321 | TRUE  | TRUE  | FALSE | 70   | 1491.15 | Juvenile |
| 18/12/2002 | -11.583 | 144.050 | F | 327 | FALSE | TRUE  | TRUE  | 79   | 106.80  | Adult    |
| 03/12/2006 | -11.583 | 144.033 | F | 330 | FALSE | TRUE  | FALSE | 44   | 435.61  | Adult    |
| 18/02/2015 | -16.353 | 145.697 | F | 330 | TRUE  | TRUE  | FALSE | 472  | 650.00  | Adult    |
| 23/07/2019 | -28.873 | 153.605 | F | 330 | TRUE  | TRUE  | TRUE  | 246  | 1350.26 | Adult    |
| 13/09/2019 | -20.259 | 148.941 | F | 330 | TRUE  | TRUE  | FALSE | 183  | 379.79  | Adult    |
| 26/02/2020 | -28.868 | 153.599 | F | 330 | TRUE  | FALSE | FALSE | 786  | 600.33  | Adult    |
| 25/03/2013 | -11.588 | 144.031 | F | 331 | FALSE | TRUE  | FALSE | 110  | 212.63  | Adult    |
| 05/04/2008 | -32.783 | 152.412 | F | 335 | FALSE | TRUE  | TRUE  | 1480 | 998.43  | Adult    |
| 16/12/2018 | -20.259 | 148.941 | F | 340 | TRUE  | TRUE  | FALSE | 425  | 550.92  | Adult    |
| 23/11/2004 | -11.583 | 144.033 | F | 350 | FALSE | TRUE  | FALSE | 17   | 276.00  | Adult    |
| 26/11/2006 | -11.500 | 144.200 | F | 350 | FALSE | TRUE  | TRUE  | 43   | 67.33   | Adult    |
| 09/05/2019 | -33.671 | 151.331 | F | 350 | TRUE  | FALSE | FALSE | 240  | 285.80  | Adult    |
| 11/06/2019 | -28.883 | 153.595 | F | 354 | TRUE  | FALSE | TRUE  | 199  | 747.44  | Adult    |
| 02/02/2015 | -24.890 | 153.159 | F | 355 | TRUE  | TRUE  | FALSE | 1580 | 1019.47 | Adult    |
| 14/02/2015 | -16.186 | 145.889 | F | 360 | TRUE  | TRUE  | FALSE | 203  | 64.80   | Adult    |

|            |         |         |   |     |       |       |       |     |         |          |
|------------|---------|---------|---|-----|-------|-------|-------|-----|---------|----------|
| 06/01/2020 | -20.263 | 148.942 | F | 360 | FALSE | TRUE  | FALSE | 65  | 115.41  | Adult    |
| 13/07/2019 | -29.107 | 153.452 | F | 364 | TRUE  | FALSE | FALSE | 15  | 260.03  | Adult    |
| 26/11/2007 | -11.588 | 144.031 | F | 368 | FALSE | TRUE  | TRUE  | 121 | 301.42  | Adult    |
| 18/12/2018 | -20.259 | 148.941 | F | 370 | TRUE  | TRUE  | FALSE | 453 | 1164.02 | Adult    |
| 10/06/2019 | -20.259 | 148.941 | F | 386 | TRUE  | TRUE  | FALSE | 276 | 230.30  | Adult    |
| 08/05/2019 | -30.322 | 153.180 | M | 157 | TRUE  | TRUE  | TRUE  | 46  | 1418.17 | Juvenile |
| 25/05/2019 | -29.091 | 153.445 | M | 167 | TRUE  | FALSE | FALSE | 30  | 15.50   | Juvenile |
| 09/05/2019 | -30.237 | 153.187 | M | 176 | TRUE  | FALSE | FALSE | 192 | 9.93    | Juvenile |
| 12/01/2018 | -30.386 | 153.105 | M | 182 | TRUE  | FALSE | FALSE | 651 | 287.53  | Juvenile |
| 07/02/2018 | -34.697 | 150.871 | M | 186 | TRUE  | FALSE | FALSE | 20  | 150.58  | Juvenile |
| 06/01/2018 | -28.816 | 153.616 | M | 212 | TRUE  | FALSE | FALSE | 296 | 335.87  | Juvenile |
| 15/02/2018 | -28.871 | 153.607 | M | 215 | TRUE  | FALSE | FALSE | 284 | 154.40  | Juvenile |
| 18/02/2015 | -16.353 | 145.697 | M | 230 | TRUE  | TRUE  | FALSE | 159 | 762.61  | Juvenile |
| 16/12/2018 | -20.259 | 148.941 | M | 230 | TRUE  | TRUE  | FALSE | 228 | 79.45   | Juvenile |
| 23/01/2019 | -29.105 | 153.446 | M | 234 | TRUE  | FALSE | TRUE  | 2   | 126.98  | Juvenile |
| 20/03/2019 | -28.778 | 153.606 | M | 239 | TRUE  | FALSE | FALSE | 217 | 36.45   | Juvenile |
| 11/04/2019 | -33.742 | 151.335 | M | 240 | TRUE  | FALSE | FALSE | 78  | 607.25  | Juvenile |
| 15/04/2018 | -34.657 | 150.876 | M | 242 | TRUE  | FALSE | FALSE | 426 | 186.73  | Juvenile |
| 11/12/2019 | -20.259 | 148.941 | M | 245 | TRUE  | TRUE  | FALSE | 94  | 274.32  | Juvenile |
| 13/12/2019 | -28.848 | 153.611 | M | 245 | TRUE  | FALSE | FALSE | 2   | 2.59    | Juvenile |
| 25/01/2019 | -30.323 | 153.179 | M | 248 | TRUE  | FALSE | TRUE  | 31  | 140.94  | Juvenile |
| 16/03/2019 | -28.822 | 153.617 | M | 254 | TRUE  | FALSE | FALSE | 28  | 31.53   | Juvenile |
| 15/03/2019 | -29.088 | 153.446 | M | 263 | TRUE  | FALSE | FALSE | 113 | 124.99  | Juvenile |
| 10/06/2019 | -20.259 | 148.941 | M | 264 | TRUE  | TRUE  | FALSE | 205 | 163.82  | Juvenile |
| 20/02/2019 | -28.839 | 153.617 | M | 266 | TRUE  | FALSE | FALSE | 27  | 617.74  | Juvenile |
| 22/12/2018 | -28.843 | 153.617 | M | 282 | TRUE  | FALSE | FALSE | 39  | 760.16  | Juvenile |
| 09/05/2019 | -30.328 | 153.152 | M | 284 | TRUE  | TRUE  | TRUE  | 139 | 1196.19 | Juvenile |
| 18/12/2005 | -11.589 | 144.031 | M | 288 | FALSE | TRUE  | FALSE | 356 | 927.99  | Juvenile |
| 10/12/2007 | -11.588 | 144.031 | M | 292 | FALSE | TRUE  | TRUE  | 409 | 241.69  | Juvenile |
| 06/11/2019 | -33.780 | 151.301 | M | 300 | TRUE  | FALSE | FALSE | 35  | 15.95   | Adult*   |
| 17/04/2007 | -33.569 | 151.370 | M | 310 | FALSE | TRUE  | TRUE  | 15  | 699.12  | Adult*   |
| 10/06/2019 | -20.259 | 148.941 | M | 316 | TRUE  | TRUE  | FALSE | 242 | 1021.49 | Adult*   |
| 07/01/2020 | -20.263 | 148.942 | M | 330 | FALSE | TRUE  | FALSE | 69  | 701.15  | Adult*   |
| 11/06/2019 | -20.259 | 148.941 | M | 335 | TRUE  | TRUE  | FALSE | 221 | 360.31  | Adult*   |

\* Adult male sharks excluded from the analysis due to low sample size.

**Table S2.** Details of the response and explanatory variables used in the tiger shark modelling approach. The coast centroid has been delimited at latitude 24.5°S, as it corresponds to the current boundary between the northern Great Barrier Reef Marine Park and the Coral Sea marine regions, and the southern Temperate East marine region (please see Figure 1 for further details). All explanatory variables were modelled as candidate effects interacting with the three significant biological classes (1 = juvenile females; 2 = juvenile males; 3 = adult females).

| Variable type | Variable name                                                   | Acronym   | Details                                                                                                                                                                                                                       |
|---------------|-----------------------------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Response      | Location latitude                                               |           | The observed track latitude including both acoustic and satellite positions of the tiger sharks monitored.                                                                                                                    |
|               | Shark movement patterns in the North Region (latitude >24.5°S)  |           | Daily binomial values including 0 for the simulated track locations and 1 for the locations from the observed shark satellite tracks.                                                                                         |
|               | Shark movement patterns in the South Region (latitude ≤ 24.5°S) |           | Daily binomial values including 0 for the simulated track locations and 1 for the locations from the observed shark satellite tracks.                                                                                         |
|               | Maximum dive depth                                              |           | Shark daily maximum dive depths (in metres) recorded by Pop-up Satellite Archival Tags (PSAT).                                                                                                                                |
| Explanatory   | Month                                                           | Month     | Calendar month ranging from January (1) to December (12).                                                                                                                                                                     |
|               | Oceanic Niño Index                                              | ONI       | Monthly values corresponding to 3-month temperature differences calculated for the Niño 3.4 region (from 5°N, 120°W to 5°S 170°W) and is represented by a negative (cooling = La Niña) to positive (warming = El Niño) scale. |
|               | Derivative Sea Surface Temperature                              | derSST    | Difference between present and past 6-day average local SST (°C), with 0.5° latitude x 0.5° longitude resolution.                                                                                                             |
|               | Sea Surface Temperature difference from the 22°C isotherm       | SST.22    | Difference between present and past 6-day average local SST (°C) subtracted from the 22°C isotherm, with 0.5° latitude x 0.5° longitude resolution.                                                                           |
|               | Derivative chlorophyll-a                                        | derChloro | Difference between present and past 6-day average local surface concentration of chlorophyll-a (mg/m <sup>3</sup> ), with 0.5° latitude x 0.5° longitude resolution.                                                          |
|               | Region                                                          |           | Categorical variable representing the Marine Region (i.e. North or South Region) where a tiger shark track was located, based on the respective location latitude in relation to the 24°S latitude centroid.                  |

### Modelling tiger shark dispersal

**Table S3.** Stepwise variable selection procedure for the Generalized Additive Mixed Model of tiger shark latitude along the east coast of Australia. Included are the corresponding model Akaike Information Criterion (AIC),  $\Delta$ AIC (model AIC - lowest AIC), and calculated AIC weights ( $w_{AIC}$ ). The final selected model is highlighted in bold.

| Variable                                                                 | AIC             | $\Delta$ AIC | $w_{AIC}$     |
|--------------------------------------------------------------------------|-----------------|--------------|---------------|
| Null                                                                     | 45952.28        | 7846.62      | <0.0001       |
| Class x Month                                                            | 45191.67        | 7086.01      | <0.0001       |
| Class x ONI                                                              | 44681.10        | 6575.44      | <0.0001       |
| Class x derSST                                                           | 44430.00        | 6324.34      | <0.0001       |
| Class x SST.22                                                           | 43483.45        | 5377.79      | <0.0001       |
| Class x SST.22 + Class x Month                                           | 39851.60        | 1745.94      | <0.0001       |
| Class x SST.22 + Class x ONI                                             | 41943.46        | 3837.80      | <0.0001       |
| Class x SST.22 + Class x derSST                                          | 42944.24        | 4838.58      | <0.0001       |
| Class x SST.22 + Class x Month + Class x ONI                             | 39058.03        | 952.37       | <0.0001       |
| Class x SST.22 + Class x Month + Class x derSST                          | 38880.02        | 774.36       | <0.0001       |
| <b>Class x SST.22 + Class x Month + Class x derSST +<br/>Class x ONI</b> | <b>38105.66</b> | <b>0.00</b>  | <b>0.9999</b> |

### Modelling tiger shark movement patterns

**Table S4.** Stepwise variable selection procedure for the Generalized Additive Mixed Model of tiger shark habitat preference in the North Region. Included are the corresponding model Akaike Information Criterion (AIC),  $\Delta$ AIC (model AIC - lower AIC), and calculated AIC weights ( $w$ AIC). The final selected model is highlighted in bold.

| Variable                            | AIC             | $\Delta$ AIC | $w$ AIC       |
|-------------------------------------|-----------------|--------------|---------------|
| Null                                | 79910.24        | 5182.47      | <0.0001       |
| Class x Month                       | 79859.83        | 5132.06      | <0.0001       |
| Class x SST.22                      | 77818.23        | 3090.46      | <0.0001       |
| <b>Class x derChloro</b>            | <b>74727.77</b> | <b>0.00</b>  | <b>0.9999</b> |
| Class x ONI                         | 78976.56        | 4248.79      | <0.0001       |
| Class x derChloro + Class x Month*  |                 |              |               |
| Class x derChloro + Class x SST.22* |                 |              |               |
| Class x derChloro + Class x ONI*    |                 |              |               |

\* Model discarded due to lack of statistical significance

**Table S5.** Stepwise variable selection procedure for the Generalized Additive Mixed Model of tiger shark habitat preference in the South Region. Included are the corresponding model Akaike Information Criterion (AIC),  $\Delta$ AIC (model AIC - lowest AIC), and calculated AIC weights ( $w$ AIC). The final selected model is highlighted in bold.

| Variable                        | AIC             | $\Delta$ AIC | $w$ AIC       |
|---------------------------------|-----------------|--------------|---------------|
| Null                            | 16574.76        | 583.18       | <0.0001       |
| Class x Month                   | 16497.55        | 505.97       | <0.0001       |
| <b>Class x SST.22</b>           | <b>16107.63</b> | <b>0.00</b>  | <b>0.9999</b> |
| Class x ONI                     | 16516.79        | 525.21       | <0.0001       |
| Class x SST.22 + Class x Month* |                 |              |               |
| Class x SST.22 + Class x ONI*   |                 |              |               |

\* Model discarded due to lack of statistical significance

### Modelling tiger shark dive depth

**Table S6.** Stepwise variable selection procedure for the Generalized Additive Mixed Model of tiger shark maximum dive depth. Included are the corresponding model Akaike Information Criterion (AIC),  $\Delta$ AIC (model AIC - lowest AIC), and calculated AIC weights ( $w$ AIC). The final selected model is highlighted in bold.

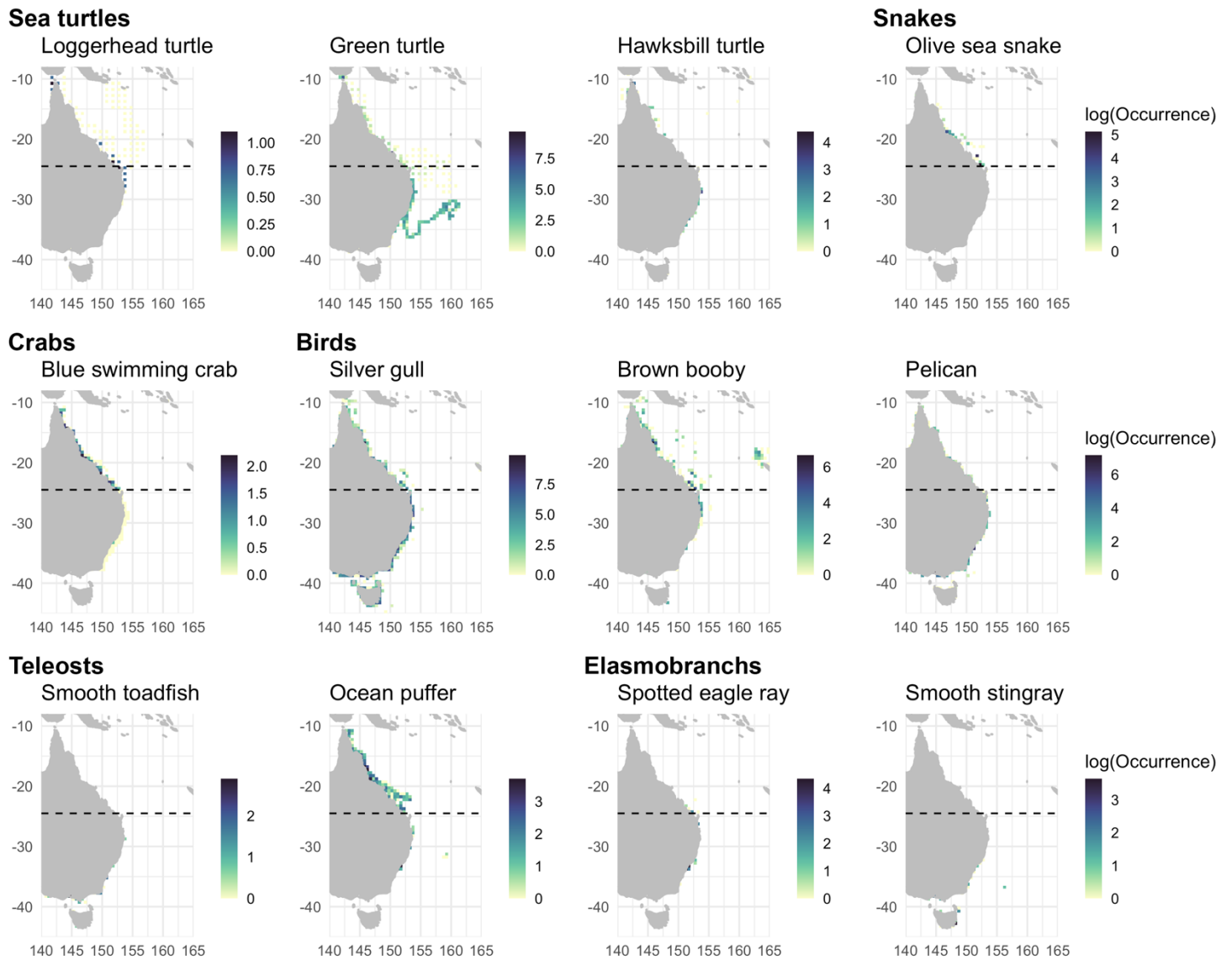
| Variable                             | AIC            | $\Delta$ AIC | $w$ AIC       |
|--------------------------------------|----------------|--------------|---------------|
| Null                                 | 10380.45       | 1028.16      | <0.0001       |
| Region x Month                       | 10333.22       | 980.93       | <0.0001       |
| Region x ONI                         | 9406.27        | 53.98        | <0.0001       |
| <b>Region x ONI + Region x Month</b> | <b>9352.29</b> | <b>0.00</b>  | <b>0.9999</b> |

\* Model discarded due to lack of statistical significance

### Class-specific distribution models

**Table S7.** List of potential prey occurrence data downloaded from the Ocean Biodiversity Information System (OBIS) for the period between January 2002 and December 2020.

| Potential prey group | Common name              | Scientific name                        | Number of records | Latitude range (min   max) |
|----------------------|--------------------------|----------------------------------------|-------------------|----------------------------|
| Sea turtles          | Loggerhead turtle        | <i>Caretta caretta</i>                 | 130               | -41.23   -9.50             |
|                      | Green turtle             | <i>Chelonia mydas</i>                  | 21,570            | -38.78   -9.40             |
|                      | Hawksbill turtle         | <i>Eretmochelys imbricata</i>          | 246               | -42.02   -8.10             |
|                      | Leatherback turtle       | <i>Dermochelys coriacea</i>            | 132               | -41.50   -8.50             |
|                      | Olive Ridley turtle      | <i>Lepidochelys olivacea</i>           | 346               | -40.81   -10.44            |
| Crabs                | Blue swimming crab       | <i>Portunus pelagicus</i>              | 267               | -37.75   -9.82             |
|                      | Three-spot swimming crab | <i>Portunus sanguinolentus</i>         | 147               | -34.25   -12.03            |
|                      | Mud crab                 | <i>Scylla serrata</i>                  | 421               | -37.75   -21.74            |
| Dugongs              | Dugong                   | <i>Dugong dugon</i>                    | 5,241             | -36.89   -9.18             |
| Sea snakes           | Olive sea snake          | <i>Aipysurus laevis</i>                | 363               | -25.26   -12.96            |
| Birds                | Silver gull              | <i>Chroicocephalus novaehollandiae</i> | 164,678           | -44.54   -9.24             |
|                      | Brown booby              | <i>Sula leucogaster</i>                | 2,407             | -43.14   -9.29             |
|                      | Australian pelican       | <i>Pelecanus conspicillatus</i>        | 6,505             | -42.96   -10.79            |
| Teleosts             | Smooth toadfish          | <i>Tetractenos glaber</i>              | 114               | -43.30   -28.54            |
|                      | Ocean puffer             | <i>Lagocephalus lagocephalus</i>       | 607               | -33.84   -10.61            |
|                      | Dusky flathead           | <i>Platycephalus fuscus</i>            | 13,944            | -38.25   -27.03            |
| Elasmobranchs        | Spotted eagle ray        | <i>Aetobatus ocellatus</i>             | 154               | -22.74   -9.51             |
|                      | Eastern shovelnose ray   | <i>Aptychotrema rostrata</i>           | 192               | -36.22   -22.03            |
|                      | Smooth stingray          | <i>Bathytoshia brevicaudata</i>        | 104               | -43.30   -32.20            |



**Figure S4.** Species-specific occurrences between January 2002 and December 2020, downloaded from the Ocean Biodiversity Information System for tiger shark potential prey species (sea turtles, snakes, crabs, birds, teleosts and elasmobranchs) found to be positively correlated with tiger shark presence (Table S8).

**Table S8.** Generalized Linear Models of tiger shark occurrence as a function of potential prey abundance, including the significant positively correlated species for each shark biological class. Included are the coefficient estimates (Est), standard errors (SE), z-value (z) and p-values (p) of each model variable.

| Biological class | Potential prey group | Common name       | Est  | SE   | z     | p      |
|------------------|----------------------|-------------------|------|------|-------|--------|
| Juvenile Females | Sea turtles          | Loggerhead        | 0.58 | 0.10 | 5.59  | <0.001 |
|                  |                      | Green             | 0.29 | 0.01 | 23.25 | <0.001 |
|                  | Snakes               | Olive sea snake   | 0.18 | 0.04 | 4.07  | <0.001 |
|                  | Crabs                | Blue swimming     | 0.23 | 0.04 | 5.55  | <0.001 |
|                  | Birds                | Gull              | 0.36 | 0.01 | 48.06 | <0.001 |
|                  |                      | Booby             | 0.08 | 0.01 | 5.81  | <0.001 |
|                  |                      | Pelican           | 0.06 | 0.01 | 4.52  | <0.001 |
|                  | Teleosts             | Toadfish          | 0.17 | 0.04 | 4.11  | <0.001 |
|                  |                      | Puffer            | 0.63 | 0.02 | 25.81 | <0.001 |
|                  | Elasmobranchs        | Smooth stingray   | 0.21 | 0.09 | 2.28  | 0.022  |
| Juvenile Males   | Sea turtles          | Green             | 0.47 | 0.02 | 21.25 | <0.001 |
|                  | Birds                | Gull              | 0.19 | 0.02 | 10.89 | <0.001 |
|                  | Teleosts             | Puffer            | 1.39 | 0.04 | 33.91 | <0.001 |
|                  | Elasmobranchs        | Spotted eagle ray | 0.64 | 0.16 | 4.08  | <0.001 |
| Adult Females    | Sea turtles          | Loggerhead        | 1.28 | 0.10 | 12.49 | <0.001 |
|                  |                      | Green             | 0.24 | 0.02 | 13.44 | <0.001 |
|                  |                      | Hawksbill         | 0.26 | 0.06 | 4.16  | <0.001 |
|                  | Snakes               | Olive sea snake   | 0.14 | 0.04 | 3.36  | <0.001 |
|                  | Birds                | Gull              | 0.27 | 0.01 | 23.04 | <0.001 |
|                  |                      | Pelican           | 0.32 | 0.02 | 17.23 | <0.001 |
|                  | Teleosts             | Puffer            | 0.95 | 0.03 | 29.38 | <0.001 |

**Table S9.** Generalized Additive Models of thermal influence upon the species-specific occurrences of tiger shark potential prey. Included are the effective degrees of freedom (edf), reference degrees of freedom (Ref.df), F-value (F) and p-value (p), from the respective modelled effects of sea surface temperature for each species.

| Potential prey group | Common name        | edf  | Ref.df | F     | p      |
|----------------------|--------------------|------|--------|-------|--------|
| Sea turtles          | Loggerhead         | 3.60 | 3.91   | 5.27  | <0.001 |
|                      | Green              | 3.46 | 3.84   | 20.86 | <0.001 |
|                      | Hawksbill*         | 1.87 | 2.30   | 1.20  | 0.386  |
| Snakes               | Olive sea snake*   | 3.23 | 3.68   | 2.08  | 0.051  |
| Crabs                | Blue swimming      | 2.37 | 2.87   | 8.32  | <0.001 |
| Birds                | Gull               | 2.77 | 3.29   | 4.80  | 0.001  |
|                      | Booby              | 3.27 | 3.71   | 5.79  | <0.001 |
|                      | Pelican            | 1.00 | 1.00   | 12.55 | <0.001 |
| Teleosts             | Toadfish           | 2.74 | 3.25   | 11.95 | <0.001 |
|                      | Puffer             | 3.68 | 3.94   | 10.76 | <0.001 |
| Elasmobranchs        | Smooth stingray    | 3.11 | 3.59   | 3.69  | 0.022  |
|                      | Spotted eagle ray* | 1.00 | 1.00   | 1.12  | 0.291  |

\* Non-significant species removed from the analysis.