Supplementary Material

**Supplementary Table 1.** Previous studies using maximum likelihood methods on whale sharks.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Location** | **No. individuals** | ***N (a1)*** | **Residency in (a2)** | **Residency out (a3)** | **mortality (a4)** | **% male** | **Reference** |
| Al Lith, Saudi Arabia | 136 | 21.30 | 11.70 | 37.60 | 0.3000 | 47.00 | Cochran et al. 2016 |
| Gulf of Mexico | 1361 | 57.40 | 0.80 | 6.90 | *na* | 61.50 | McKinney et al. 2017 |
| Qatar (Arabian Gulf) | 422 | 123.70 | 28.80 | 62.70 | *na* | 69.00 | Robinson et al. 2016 |
| Oslob (Non-provisioned) | 104 | 5.60 | 22.40 | 94.70 | 0.0030 | 85.00 | Araujo et al. 2014 |
| Maldives (no scars) | 170 | 9.01 | 69.91 | 18.12 | 0.0014 | 90.00 | Harvey-Carroll et al. 2021 |
| Maldives (scarred) | 97 | 13.67 | 46.54 | 28.51 | 0.0004 | 90.00 | Harvey-Carroll et al. 2021 |
| Oslob (Provisioned) | 54 | 13.30 | 44.90 | 22.60 | 0.0003 | 91.00 | Araujo et al. 2014 |
| Qatar (Al Shaheen) | 437 | 115.90 | 17.50 | 37.50 | 0.0004 | 69.00 | Prebble et al. 2018 |
| Southern Leyte | 93 | 15.60 | 27.00 | 42.00 | 0.0007 | 81.00 | Araujo et al. 2017 |
| Honda Bay | 183 | 41.10 | 6.40 | 58.20 | 0.0010 | 96.50 | Araujo et al. 2019 |
| Donsol | 482 | 52.50 | 49.80 | 56.40 | 0.0006 | 88.00 | McCoy et al. 2018 |
| Honduras | 95 | 4.63 | 11.76 | 86.00 | 0.0008 | 65.00 | Fox et al. 2013 |
| St Helena | 273 | 102.15 | 18.90 | 32.82 | 0.0006 | 52.00 | Perry et al. 2020 |
| Bahía de La Paz | 125 | *na* | *na* | *na* | *na* | 75.00 | Ramírez-Macías et al. 2012a |
| Bahía de Los Ángeles | 129 | *na* | *na* | *na* | *na* | 76.00 | Ramírez-Macías et al. 2012b |
| Mozambique | 664 | 50.60 | 9.00 | 29.90 | 0.0006 | 72.00 | Prebble et al. 2018 |
| Tanzania | 139 | 34.78 | 30.63 | 23.90 | 0.0003 | 87.00 | Prebble et al. 2018 |

**Supplementary Table 2**. Results for modified maximum likelihood methods for 25 global whale shark sites as described in Table 2, run on program SOCPROG 2.9 (Whitehead, 2009). QAIC: quasi-Akaike Information Criterion, AIC: Akaike Information Criterion. \*indicates model selection based on AIC, otherwise we followed the QAIC (Whitehead, 2007). Highlighted in **bold** are models with a ΔAIC or ΔQAIC ≤ 2 (Burnham & Anderson, 2002).

|  |  |
| --- | --- |
|  | **ΔAIC/QAIC**  |
| **Site** | Model A | Model B | Model C | Model D | Model E (Emigration + re-immigration) | Model F | Model G | **Model H** |
| (Closed) | (Closed) | (Emigration and mortality) | (Emigration and mortality) | (Emigration + re-immigration) | (Emigration + re-immigration + mortality) | **(Emigration + re-immigration + mortality)** |
| GAL | 570.6 | 81.3 | 37.9 | 9.2 | 37.9 | 188.7 | 4.1 | **0.0** |
| KOH | 109.2 | 109.2 | 34.2 | 48.5 | 34.2 | **0.9** | **0.0** | **0.9** |
| HOB | 6683.4 | 261.3 | 122.1 | 24.7 | 122.1 | 46.2 | 24.7 | **0.0** |
| HON | 183.8 | 183.8 | 60.0 | 60.0 | 42.9 | **0.0** | 42.9 | **0.0** |
| NIN | 326563.3 | 1621.3 | 500.9 | 192.5 | 500.9 | 163.5 | 192.5 | **0.0** |
| EAS | 74.6 | 74.6 | 6.1 | 55.3 | 6.1 | **0.0** | 6.2 | **0.0** |
| MOZ | 77250.8 | 1055.3 | 152.1 | 150.3 | 152.1 | **0.0** | 150.3 | **0.0** |
| SEY | 91.0 | 91.0 | 22.9 | 70.0 | 22.9 | 26.0 | 6.8 | **0.0** |
| QAT | 16749.3 | 105.4 | 44.3 | 71.5 | 44.3 | 22.4 | 17.7 | **0.0** |
| YUC | 380962.3 | 858.1 | 133.9 | 710.5 | 133.9 | 59.1 | 377.1 | **0.0** |
| SAU | 207.3 | 207.3 | 25.7 | 25.7 | 40.4 | 12.6 | 40.4 | **0.0** |
| THA | 70.6 | 70.6 | 35.1 | 50.5 | 35.1 | 27.4 | **0.5** | **0.0** |
| MAD | 1195.9 | 1195.9 | 224.1 | 419.9 | 224.1 | 81.5 | 419.9 | **0.0** |
| STH | 1901.5 | 23.8 | **1.8** | 2.1 | **1.8** | 5.8 | 2.1 | **0.0** |
| BLP | 833.0 | 833.0 | 151.8 | 81.1 | 151.8 | 129.6 | 81.1 | **0.0** |
| PER\* | 52.3 | 52.3 | **0.0** | **1.9** | **0.0** | 2.9 | **2.0** | 2.9 |
| DON | 18867.1 | 18867.1 | 598.6 | 600.5 | 598.6 | 479.4 | 600.5 | **0.0** |
| PIN | 4701.8 | 4701.8 | 115.0 | 108.4 | 115.0 | **0.0** | 117.0 | **0.0** |
| DJI | 1850.8 | 1850.8 | 205.5 | 4.9 | 205.5 | 98.4 | 202.3 | **0.0** |
| MAF | 2390.0 | 2390.0 | 93.8 | 53.7 | 93.8 | 27.2 | 53.7 | **0.0** |
| SOU\* | 11040.5 | 11040.5 | 269.1 | 269.1 | 267.5 | 207.2 | 271.1 | **0.0** |
| OSL | 129425.4 | 129425.4 | 2641.9 | 2584.2 | 2641.9 | 1660.5 | 2584.2 | **0.0** |
| HAW\* | 1447.6 | 218.0 | 145.2 | 145.2 | 48.3 | 149.2 | 6.7 | **0.0** |
| BLA | 4803.6 | 4803.6 | 607.4 | 607.4 | 593.0 | **0.0** | 2191.5 | **0.0** |
| BEL | 143.3 | 143.3 | 5.7 | 5.7 | 39.9 | 9.7 | **0.0** | 3.6 |

**Supplementary Table 3.** Example of studies reportingindividual whale shark movements between different sites using photographic identification (photo-ID).

|  |  |
| --- | --- |
| **Reference** | **Highlighted photo-ID movements** |
| Andrzejaczek et al. 2016 | Mozambique and Seychelles |
| Araujo et al. 2014 | Within the Philippines, multiple sites |
| Araujo et al. 2017 | Within the Philippines, multiple sites, and Taiwan |
| Araujo et al. 2019 | Within the Philippines, multiple sites, and Indonesia |
| Araujo et al. 2020 | Malaysia and Philippines |
| McKinney et al. 2017 | Gulf of Mexico & the Meso-American Barrier Reef |
| Norman et al. 2017 | Within the Gulf of Mexico and the Meso-American Barrier Reef; Within the Arabian Gulf; Within the Red Sea & Gulf of Aden; Within the eastern coast of Africa; Malaysia & Thailand; Indonesia and Australia; Saudi Arabia and Djibouti |
| Prebble et al. 2018 | Tanzania and Mozambique |
| Ramírez-Macías et al. 2012a | Within the Gulf of California, multiple sites |
| Robinson et al. 2016 | Within the Arabian Sea |

**Supplementary Table 4.** Changes in Lagged Identification Rates (LIR) from 1 day to ~1 year for all sites.

|  |  |  |  |
| --- | --- | --- | --- |
| **Location** | **LIR 1 day** | **LIR ~1 year** | **LIR decline proportion** |
| YUC | 0.0048 | 0.002 | 0.5833 |
| QAT | 0.0086 | 0.0022 | 0.7442 |
| STH | 0.0115 | 0.0027 | 0.7652 |
| SEY | 0.0125 | 0.0033 | 0.736 |
| NIN | 0.0131 | 0.0026 | 0.8015 |
| PER | 0.0137 | 0.0059 | 0.5693 |
| DJI | 0.0142 | 0.005 | 0.6479 |
| BLA | 0.0235 | 0.0052 | 0.7787 |
| MOZ | 0.0241 | 0.0035 | 0.8548 |
| HOB | 0.0257 | 0.0018 | 0.93 |
| DON | 0.0262 | 0.0098 | 0.626 |
| MAF | 0.0263 | 0.0135 | 0.4867 |
| GAL | 0.0303 | 0.0005 | 0.9835 |
| MAD | 0.0354 | 0.0093 | 0.7373 |
| OSL | 0.048 | 0.0263 | 0.4521 |
| BLP | 0.0501 | 0.0159 | 0.6826 |
| EAS | 0.0569 | 0.0122 | 0.7856 |
| PIN | 0.0599 | 0.0163 | 0.7279 |
| SOU | 0.0661 | 0.0302 | 0.5431 |
| SAU | 0.0693 | 0.013 | 0.8124 |
| HAW | 0.1417 | 0.0011 | 0.9922 |
| BEL | 0.1475 | 0.0688 | 0.5336 |
| KOH | 0.1684 | 0.0008 | 0.9952 |
| HON | 0.2289 | 0.0236 | 0.8969 |
| THA | 0.274 | 0.0526 | 0.808 |

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