**Delineating spatial use combined with threat assessment to aid critical recovery of northeast Australia’s endangered hawksbill turtle, one of western Pacific last strongholds**

**Christine A. Madden Hof 1/2/\*, Caitlin Smith1/2, Simon Miller3, Kita Ashman2, Kathy A. Townsend1 , Justin Meager 4**

1 University of the Sunshine Coast, School of Science, Technology and Engineering, Sippy Downs, Australia

2 WWF-Australia, Healthy Land and Seascapes, Brisbane, Australia

3 Australian Marine Conservation Society, West End, Australia

4 GHD, Natural Resources, Maroochydore, Australia

**\* Correspondence:** Corresponding Author: chof@wwf.org.au

**Supplementary Data**

**Table SM1:** Tracked-turtle summary[CCL, curved carapace length; P, primary; ISR, interseason recapture]

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Turtle track ID** | **Max CCL (cm)** | **Year tracked** | **Primary flipper tag number** | **Tag status & first time tagged date (if known)** | **Destination direction (east or west Queensland, Torres Strait)** | **Final location (name; GPS, decimal degrees)** | **Tracker duration (days)** |
| 133403 | 80.9 | 2016 | QA47369 | ISR (1994) | East | Cooktown coast (145.25, -14.9033) | 155 |
| 133404 | 82 | 2016 | T75028 | ISR | West | Aurukun coast (141.612, -13.1181) | 83 |
| 133761 | 81.4 | 2016 | QA49257 | P (2017) | West | Mission River coast (141.606, -12.5132) | 79 |
| 166706 | 75.1 | 2017 | K81554 | ISR (2008) | East | Milman Island (143.103, -12.296) | 401 |
| 166707 | 80 | 2017 | K16172 | ISR (2001) | East | North pint patch (143.333, -12.296) | 425 |
| 166708 | 80.8 | 2017 | QA58727 | ISR (1995) | East | Cockburn reef (143.307, -11.799) | 366 |
| 166709 | 80.4 | 2017 | QA49441 | P (2017) | Torres Strait (east) | Tudu Islands (142.986, -9.7686) | 260 |
| 166710 | 76 | 2017 | QA49444 | P (2017) | Torres Strait (west) | Canoe Island (142.107, -10.3427) | 295 |
| 166711 | 80.4 | 2017 | K99857 | ISR (1997) | West | Kowanyama coast (~50km) (140.361, -15.2921) | 58 |
| 166732 | 75.3 | 2017 | QA49442 | P (2017) | West | Doughboy river (~10km NW) (142.03, -11.393) | 265 |
| 166733 | 84.4 | 2017 | K33408 | ISR (2001) | West | Aurukun coast (~30km north) (141.572, -13.0339) | 345 |
| 166734 | 79 | 2017 | T72537 | ISR (2004) | West | Pennefather river (141.706, -12.2377) | 116 |
| 166735 | 74.2 | 2017 | T58785 | ISR (1995) | Torres Strait (west) | Bamaga (north of) (142.265, -10.7861) | 301 |

**Table SM2:** Threat exposure assessment and spatial datasets. Identified hawksbill turtle threat categories in northeast Australia are: (1) fisheries by-catch and net entanglement (2) exotic and native egg predation, (3) unsustainable take, (4) habitat loss and degradation, (5) marine pollution (6) climate change (projected long-term beach erosion; skewed sand temperature sex determination of hatchling).

| **Proposed threat exposure categories (& description of threat)** | **As a proxy for** | **Threat components** | **Data Points** | **Data description and assessment** | **Data period** | **Report, source or spatial layer** | **Sourced (y/n)** | **Analysed (y/n)** | **Risk (Low, Moderate, High, Very High)** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Lack of marine protection | adequate protection | GBR Coast (DES and GBRMPA) and C'wealth Marine Park | Protected areas in Australia | Marine and indigenous protected areas allow for a variety of extractive resources. Marine reserves ("no-take" marine national parks equivalent to IUCN category I and II), and Indigenous Protected Areas (IPA) were only included in this assessment. IPA were combined with a C’wealth dedicated IPA spatial layer to ensure full coverage. Total home range equated to = 4,712km2Indigenous Protected Areas = 0.07km2 Great Barrier Reef Marine Parks = 1251.8km2 DAWE = 140.2km2 Refer Manuscript. | to 2020 | CAPAD 2020, <https://www.environment.gov.au/fed/catalog/main/home.page>IPA, <https://www.environment.gov.au/fed/catalog/search/resource/details.page?uuid=%7BC64658F0-95AD-4209-8D1E-F94BD0A4E827%7D> | y | y | Very High |
| Torres Strait Treaty Boundary | Boundary | Bounds of the Torres Strait. See descriptions provided: https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/torres-strait; https://www.pzja.gov.au/resources/maps; https://www.afma.gov.au/sustainability-environment/fishing-closures/closure-direction-maps. Refer Manuscript. | n/a | [Alcock, M., Taffs, N.J. 2014. Treaties - Australian Maritime Boundaries 2020 (AMB2020) - Geodatabase. Geoscience Australia, Canberra. http://pid.geoscience.gov.au/dataset/ga/140090; https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/83161](https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/83161) | y | y | n/a |
| Fishery by-catch and net entanglement (in ghost nets, fishing gear (line, net and pot) and boat collision) | bycatch/entanglement & effort/interactions  | QLD Fisheries SOCI reports | Note raw data only | Queensland fishers are required to report interactions with Species of Conservation Interest. This database maintains these reports and presents data for each year at a species level and the fishing gear interacted. This data was tabulated as spatial data is not provided. Refer SM3. | 2006-2019 | <https://www.data.qld.gov.au/dataset/total-number-of-species-of-conservation-interest-interactions-with-released-conditions/resource/4ad21384-35fe-4ee5-8013-0099d4aa9e65?truncate=30&inner_span=True> | y | y | State level: Very High |
| QLD East Coast Inshore Fin Fish Fishery Observer data | Note raw data only | Fisheries QLD ran an observer program in the net component of the ECIFFF from 2006 to 2012. Interactions are reported at a species level for each year and include the number of observer days. This data was tabulated as spatial data is not provided. Refer SM3. | 2006-2012 | Upon request was provided. SOCI data reported from 2005 was included. | y | Y |
| QLD fishing operators/Activities catch and effort data for all fisheries  | Raw data in report form (as spatial data cannot be exported). However, for gillnet and ringnet and trawl exported datasets, were created into heat maps | QFISH is a database maintained by Fisheries Qld as it manages multiple fisheries such as the Commercial Line, Net and Trawl in addition to the Queensland Shark Control Program. The commercial fishing catch and effort data is collected through commercial fishery logbooks. Information from 1990 onwards is presented in QFish, including species catch and fishing effort for various Qld fisheries, which can be refined for a specified time period, fishing method and/or region (but protected as commercial in confidence if a query results in data from less than five commercial fishers). Days fished for gill net and trawl fisheries was extracted from QFISH and created as a spatial layer, number of days fished. Refer manuscript. In comparison to other fisheries, trawl effort was considered low risk, but calculated to have 1387 km2 of post nesting homerange within trawl fished areas, with a total sum of 39439 days fished/year.  | 1990-2019 | [http://qfish.fisheries.qld.gov.au](http://qfish.fisheries.qld.gov.au/) Accessed 12/04/2021 | y | Y |
| C’wealth commercial fishing catch and effort data | Raw data in report form only | Catch and effort data by species, year and fishery as reported in fisher logbooks. This data was tabulated as spatial data is not provided. | 2002-2018 | <https://data.gov.au/dataset/ds-dga-b36304ae-4e15-4d5c-abe2-097a57a05b25/details> | y | y | Commonwealth: High |
| C’wealth Fisheries threatened species interactions | Raw data in report form only | AFMA reports threatened species interactions quarterly. Data is available by a species and fishery level. This data was tabulated as spatial data is not provided.  | 2012-2019  | <https://www.afma.gov.au/sustainability-environment/protected-species-management/protected-species-interaction-reports> | y | Y |
| potential effort/interaction, and take/trade | Torres Strait Turtle Fishery | Boundary | See descriptions provided: <https://www.agriculture.gov.au/abares/research-topics/fisheries/fishery-status/torres-strait>;<https://www.pzja.gov.au/resources/maps> Refer Manuscript. | n/a | <https://www.afma.gov.au/sustainability-environment/fishing-closures/closure-direction-maps> | y | n | Very High (refer also Harvest) |
| entanglement  | Ghost nets | particle modelling, net collection / interaction (not where lost) | Ghost net / turtle risk interaction recreated from Wilcox et al., 2013. Refer Manuscript. | to 2013 | Wilcox et al., 2013; verbal discussions regarding representativeness of data with Riki Gunn (ex-GhostNets Australia) and Western Cape Threat Abatement Alliance | y | y | Very High |
| bycatch and entanglement & effort/interactions | stranding data for bycatch, entanglement, and ingestion | 322 out of 7300 data points (0.44%; all species) combined for tangled, tangled in crab pot, ghost fishing - tangled in discarded or lost net, drowned in gill net, drowned in net, tangled in fishing, line, tangled in float line, presumed anthropogenic sources of mortality or impact - tangled.  | StrandNet is a database maintained by DES, of marine wildlife strandings and deaths. The primary focus of this database is to record information on where sick, injured, dying and dead marine animals have been found in Queensland and assess causes of injury and death, if possible. StrandNet indicates when marine animal deaths occur directly as a result of human causes, which can be used for changes to policy and management. We combined the 5 year dataset and extracted all strandings per species that related to the threat. A table was developed based on the threat, per latitude and plotted for Queensland. The greatest threat interaction for hawksbill turtles was fishing gear. Refer manuscript. Boat strike accounted for 15% of all hawksbill threats (primarily in higher latitudes). | 2009-2014 | StrandNet, Department of Environment and Science, Queensland Government | y | y | n/a |
| Exotic and native predation (including eggs, hatchlings, or adult females by native (e.g. goanna or crocodile) or exotic (e.g. pig) species) | Predation | Known predation | Presence vs absence | The Atlas of Living Australia (ALA) is a collaborative, digital, open infrastructure that pulls together Australian biodiversity data from multiple sources, making it accessible and reusable to the public. We constructed a dataset from Atlas of Living Animals using Explore Your Area function | Accessed 3 March 2021 | <https://biocache.ala.org.au/explore/your-area> | y | y | Moderate |
| Predation | stranding data for crocodile, dog or dingo, shark attack, predation or severe bits or death caused by another animal | 14 out of 7300 data points (0.002%; all species) | StrandNet (see description above). For hawksbills alone, predation accounted for 2% of all threats. | 2009-2014 | StrandNet, Department of Environment and Science, Queensland Government | y | y | n/a |
| Unsustainable take [or harvest] (direct (targeted) take of adults, sub-adults and juvenile turtles as whole, or in part for shell, meat, eggs, oil, fat or bones) | unsustainable take areas and/or adequate protection | Harvest | Boundary | An ILUA (Indigenous Land Use Agreement) is a voluntary agreement between a native title group and others about the use of land and waters under the Native Title Act 1993 (Cwlth). A TUMRA (Traditional Use of Marine Resources Agreement) is formal (non-binding) to manage Great Barrier Reef traditional use /take of sea country activities in partnership with the Australian and Queensland governments. No registered or notified ILUA or TUMRA agreements with C’wealth Government or Queensland Government (GBRMPA) NEQld stock boundary. No further assessments made. | Current | ILUA and TUMRA agreements (shapefile) |  y | n  | Very High |
| Harvest | Boundary | Indigenous Protected Areas – refer adequate protection above. |  |  |  |  |
| Harvest | Particle distribution point data *(\*note, cumulative exposure was used to depict post-hatchling life history phase)* | The final positions (lat/long) data was extracted from the Connie 3.0 ocean current modelling text files, for all available years 1993-2007. These were then collated for each particle (post hatchling “lost years”) across years. Spatial data was then imported into GIS to examine the distribution of data points across Exclusive Economic Zones (EEZ). Number of points and proportions of data points within each EEZ was then calculated by intersecting both layers.Total points equated to 112,419,192, with Australia = 70,516,358; Indonesia = 2,198,683; New Caledonia = 386,106; Papua New Guinea = 35,084,374; Solomon Islands = 3,682,993; Vanuatu: 550,678. Refer Manuscript. | 1993-2007 | Connie 3.0 CSIRO Connectivity Interface, <https://connie.csiro.au/>; Run 15/3/21)Exclusive Economic Zones Boundaries (EEZ)Australian Ocean Data NetworkCSIRO, sourced under CC license Coastal Waters (State/Territory Powers) Act 1980 - Australian Maritime Boundaries 2014a – Geodatabasehttps://data.gov.au/data/dataset/coastal-waters-state-territory-powers-act-1980-australian-maritime-boundaries-2014a-geodatabase | Y | Y |
| Habitat use and degradation (both human induced and natural including changes to beach habitat, access barriers, light pollution, vehicle strike, human disturbance, entrapment/stranding hazards) | habitat use / urban activity | Coastal and urban development (Regional planning urban footprint) | Boundary | No further assessments made given important hawksbill nesting beaches are primarily on uninhabited (non-developed) land. | n/a | n/a | n | n | Low |
| sky glow | stranding data by street lights, or disoriented by altered light horizons | 2 out of 7300 data points (0.003%; all species) | StrandNet. No light pollution threat was identified for hawksbill turtles. | 2009-2014 | StrandNet, Department of Environment and Science, Queensland Government |  y | y  | Low |
| sky glow | Light glow or pollution | Mulittemporal satellite night-light data combined with linear mixed model analysis | Broadscale artificial light exposure using DMSP-OLS data (and risk assessment) at turtle nests between 1993-2010, inferred low light pollution for NEQld stock distribution (refer Kamrowski et al., 2012; 2014). Supported by assessments made in this study using www.lightpollutionmap.info that displays VIIRS/DMSP/World Atlas overlays/IAU observatories and the user measurements overlay over Microsoft Bing base layers (road and hybrid Bing maps), VIIRS data revealed minimal light pollution. No further assessments were made.  | 2012-2020 | Kamrowski et al., (2014); <https://www.lightpollutionmap.info/#zoom=4&lat=-3014851&lon=16524461&layers=B0FFFFFTFFFFFFFF> | y | y |
| boat strike | stranding data for boat strike, propeller cuts, fractures and lacerations | 313 out of 7300 data points (0.04%; all species) | StrandNet. For hawksbills alone, boat strike accounted for 15% of all threats, but primarily at latitudes south of Townsville (outside of NEQld stock distribution). | 2009-2014 | StrandNet, Department of Environment and Science, Queensland Government | y | Y | Moderate |
| potential boat strike/noise/loss of habitat | shipping channels | Line data | In contrast to fishery bycatch interactions, there is little data to support a negative hawksbill interaction with shipping activity. Whilst incidental turtle mortality is less comprehensively recorded across northern Australia (Limpus, 2009), boat strike StrandNet data suggests a low impact. Very few studies on the impact of noise/sound on turtles and their subsequent behavioural response has been conducted, as such no shipping assessment was made. | 2015+ | <https://www.operations.amsa.gov.au/Spatial/DataServices/DigitalData> | y | n |
| Marine pollution (including interaction and ingestion of litter, oil spills, nutrients, sediments and pesticides causing toxicity or health issues) | Food availability / chemical contamination | Exposure to pollutants (indicative of nitrogen and TSS input)Flood plume maps (indicative of freshwater input) |   | Overall, pollutants (sediment, nutrients, pesticides) in eastern Cape York catchments currently present a relatively low risk to adjacent coastal and marine ecosystems, with coral, seagrass and other ecosystems with the Cape York GBR reef are typically in good condition (Waterhouse et al., 2017). The greatest influence from degraded water quality is around Princess Charlotte Bay in the wet season, so with limited runoff pollution within NEQld stock distribution, no further assessments were made. | 2017 | Scientific Consensus Statement2017, State of Queensland | n | n | Moderate |
|   | Stranding data for ingested material of anthropogenic origin, synthetic material | 42 out of 7300 data points (0.006%; all species) | Cape York is exposed to the highest risk of emerging contaminants, marine plastic pollution (Kroon et al., 2015). In the absence of any other data, using stranding data for hawksbills alone, this equated to 0%. This was corroborated by a recent study (Duncan et al., 2021) that found no incidents plastic (> 1mm) ingestion in hawksbill turtles from Queensland (or Western Australia). No further assessment was made. | 2009-2014 | StrandNet, Department of Environment and Science, Queensland Government |  y | y  | Moderate |
| Disease and ill health | DiseaseGut parasitesEncephalopathyPneumoniaSepticemiaBlood fluke (spirochid) infectionAnaemiaLiver malfunction, including hepatitsis and necrosis | 99 out of 7300 data points (0.01%) | There has been limited study of disease in wild hawksbill turtles (Limpus, 2008). Using StrandNet, for hawksbill turtles, (unconfirmed) disease and ill health accounted for 20% of all threats.  | 2009 - 2014 | StrandNet, Department of Environment and Science, Queensland Government |  y | y  | Low |
| Climate change (including sand erosion, elevated temperatures, sea level rise, nest inundation or collapse, loss of food source, entrapment/stranding hazards | sea level rise and loss of nesting beaches | Short term storm impactsLong term trends of sediment loss and channel migration | Erosion prone Areas (refer DES, Queensland Government for definition). | Erosion Prone Area overlaid with important nesting beaches resulted in complete coverage for all islands, noting, some data is high quality from high resolution DEM and Lidar, other not (especially if not an inhabited island, may have whole island as EPA). Thwart with resolution limitations for key nesting beaches, no further assessments made, referenced in manuscript. | Current - 2100 | Department of Environment and Science Qspatial footprint map. Data downloaded 02/03/2021. The component sea level rise layer only exists for inhabited islands in the Torres Strait. http://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={52B4C820-488C-4B91-B31D-E1CBA02076F1} Use all components version. | y | y | Very High |
| feminisation | Sand nest temperature | Monthly values of minimum temperature, maximum temperature, averaged over 20 year periods (2021-2040, 2041-2060, 2061-2080), at spatial resolution of 10 minutes (expressed as minutes of a degree of longitude and latitude). | The data used are CMIP6 downscaled future climate projections. The downscaling and calibration (bias correction) was completed using WorldClim v2.1 as a baseline climate.For CMIP6 data, monthly values of minimum temperature and maximum temperature were processed for nine global climate models (GCMs): BCC-CSM2-MR, CNRM-CM6-1, CNRM-ESM2-1, CanESM5, GFDL-ESM4, IPSL-CM6A-LR, MIROC-ES2L, MIROC6, MRI-ESM2-0, and for four Shared Socio-economic Pathways (SSPs): 126, 245, 370 and 585. This produced gridded weather and climate data for historical (near current) and future conditions which enabled the investigation of projected climate changes in minimum and maximum temperatures at nesting beaches. Refer manuscript. | Current - 2080 | [Data made available from the World Climate Research Programme, which, through its Working Group on Coupled Modelling, coordinated and promoted CMIP6. Spatial layers can be accessed via: https://www.worldclim.org/data/cmip6/cmip6climate.html](https://www.worldclim.org/data/cmip6/cmip6climate.html) | y(CMIP6 model data licensed under a Creative Commons Attribution-ShareAlike 4.0 International License) | y | High |

**Legend:**

Risk assessment matrix framework, following Commonwealth of Australia, 2017

|  |  |
| --- | --- |
| **Likelihood of occurrence (relevant to NEQld stock)** | **Consequences** |
| **No long-term effect** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
| **Almost certain** | Low | Moderate | Very high | Very high | Very high |
| **Likely** | Low | Moderate | High | Very high | Very high |
| **Possible** | Low | Moderate | High | Very high | Very high |
| **Unlikely** | Low | Low | Moderate | High | Very high |
| **Unknown** | Low | Low | Moderate | High | Very high |

Levels of risk and the associated priority for action are defined as follows:

* Very High – immediate additional mitigation action required.
* High – additional mitigation action and an adaptive management plan required, the precautionary principle should be applied.
* Moderate – obtain additional information and, where multiple threats receive a moderate rating, develop additional mitigation action if required.
* Low – monitor the threat occurrence and reassess threat level if likelihood or consequences change.

**Table SM3:** Hawksbill (HB), unspecified (Un-s) and all turtle species (All turtle) bycatch in Queensland and Commonwealth (C’wealth) fisheries, a) absolute and average over all available years, NA = no data reported or available, b) HB, Un-S and adjusted hawksbill interactions per fishery, c) absolute and average HB and adjusted hawksbill interactions over common reporting period (2012-2019) with HB-prop usprange provided in shaded box, percentage in red text, d) turtle interaction rates from the QLD Fishery Observer Program in the ECIF (2006-2012) and potential hawksbill interactions, e) BPUE in the ETBF pre and post introduction of electronic monitoring, and f) Extrapolated BPUE, hawksbill turtle and adjusted hawksbill interactions based upon increase in BPUE observed in the ETBF fishery once independent monitoring was introduced.

**SM3a:**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Queensland Fisheries** |  | **Commonwealth Fisheries** |  |
|  | **Gillnet & ringnet fisheries (of ECIF & GoCIF)**  | **East Coast Otter Trawl Fishery** | **East Coast and GoC Crab Fishery** | **Torres Strait Prawn Fishery** | **Eastern Tuna and Billfish Fishery** | **Northern Prawn fishery** |
| **Year** | **HB** | **Un-s** | **All turtle** | **HB** | **Un-s** | **All turtle** | **HB** | **Un-s** | **All turtle** | **HB** | **Un-s** | **All turtle** | **HB** | **Un-s** | **All turtle** | **HB** | **Un-s** | **All turtle** |
| **2005** | 5 | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2006** | 2 | 31 | 223 | 0 | 5 | 14 | 0 | 2 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2007** | 2 | 48 | 191 | 0 | 0 | 7 | 0 | 0 | 0 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2008** | 1 | 3 | 303 | 0 | 0 | 2 | 0 | 0 | 0 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2009** | 0 | 0 | 134 | 0 | 0 | 3 | 0 | 0 | 2 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2010** | 5 | 1 | 106 | 0 | 0 | 3 | 0 | 0 | 1 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2011** | 1 | 3 | 44 | 0 | 0 | 3 | 0 | 0 | 0 | NA | NA | NA | NA | NA | NA | NA | NA | NA |
| **2012** | 0 | 2 | 55 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 5 | 0 | 1 | 10 | 2 | 14 | 66 |
| **2013** | 3 | 0 | 18 | 0 | 0 | 4 | 0 | 0 | 1 | 0 | 1 | 4 | 0 | 0 | 15 | 2 | 20 | 72 |
| **2014** | 0 | 0 | 34 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 4 | 5 | 0 | 1 | 11 | 1 | 36 | 60 |
| **2015** | 0 | 1 | 54 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 6 | 7 | 2 | 6 | 30 | 1 | 46 | 62 |
| **2016** | 4 | 2 | 144 | 0 | 0 | 8 | 0 | 0 | 0 | 1 | 2 | 4 | 1 | 17 | 100 | 0 | 43 | 55 |
| **2017** | 1 | 0 | 156 | 0 | 0 | 12 | 0 | 0 | 1 | 0 | 1 | 1 | 2 | 18 | 198 | 1 | 40 | 63 |
| **2018** | 1 | 0 | 82 | 0 | 0 | 5 | 0 | 0 | 1 | 0 | 1 | 2 | 5 | 22 | 156 | 0 | 51 | 78 |
| **2019** | 0 | 0 | 47 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 8 | 18 | 151 | 1 | 46 | 73 |
| **2020** | NA | NA | NA | NA | NA | NA | NA | NA | NA | 0 | 0 | 0 | 3 | 20 | 94 | 0 | 76 | 107 |
| **Absolute** | 25 | 91 | 1,591 | 0 | 5 | 69 | 1 | 2 | 9 | 2 | 16 | 30 | 21 | 103 | 765 | 8 | 372 | 636 |
| **Average** | 1.7 | 6.5 | 113.6 | 0.0 | 0.4 | 4.9 | 0.1 | 0.1 | 0.6 | 0.2 | 1.8 | 3.3 | 2.3 | 11.4 | 85.0 | 0.9 | 41.3 | 70.7 |
| **Proportion HB**  | 1.7% |  |  | 0% |  |  | 14.3% |  |  | 14.3% |  |  | 3.2% |  |  | 3% |  |  |

**SM3b:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | HB | Un-s | HB + adjusted hawksbill interactions | All turtle | HB Proportion | HB + adjusted hawksbill interactions |
| ECIF & GoCIF | 25 | 91 | 27 | 1591 | 1.6% | 1.7% |
| ECOTF | 0 | 5 | 0 | 69 | 0.0% | 0% |
| EC & GoC Crab | 1 | 2 | 1 | 9 | 11.1% | 11.1% |
| TSPF | 2 | 16 | 4 | 30 | 6.7% | 13.3% |
| ETBF | 21 | 103 | 24 | 765 | 2.7% | 3.1% |
| NPF | 8 | 372 | 19 | 636 | 1.3% | 3% |

**SM3c:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Queensland Fisheries** | **C’wealth Fisheries** |  |  |  |  |
|  | **Gillnet & ringnet fisheries (ECIF & GoCIF)**  | **East Coast Otter Trawl Fishery** | **East Coast and GoC Crab Fishery** | **Torres Strait Prawn Fishery** | **Eastern Tuna and Billfish Fishery** | **Northern Prawn fishery** | **Total HB only** | **Total (HB+ adjusted HB interactions)** | **Total all turtles** | **Extrap HB for ECIF, GOCIF & Crab & other fisheries** | **Extrap HB+adjusted HB interactions for ECIF, GOCIF & Crab & other fisheries** |
| **Year** | **HB** | **Adjusted HB interactions** | **HB** | **Adjusted HB interactions** | **HB** | **Adjusted HB interactions** | **HB** | **Adjusted HB interactions** | **HB** | **Adjusted HB interactions** | **HB** | **Adjusted HB interactions** |  |  |
| **2012** | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 0.0 | 3.0 | 3.0 | 138.0 | 8 | 8 |
| **2013** | 3.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 1.0 | 5.0 | 6.0 | 114.0 | 20 | 21 |
| **2014** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 0.0 | 1.0 | 1.0 | 1.0 | 3.0 | 114.0 | 1 | 3 |
| **2015** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 2.0 | 0.0 | 1.0 | 1.0 | 3.0 | 5.0 | 156.0 | 3 | 5 |
| **2016** | 4.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 1.0 | 1.0 | 0.0 | 1.0 | 6.0 | 8.0 | 311.0 | 26 | 28 |
| **2017** | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.0 | 1.0 | 1.0 | 1.0 | 4.0 | 6.0 | 431.0 | 9 | 11 |
| **2018** | 1.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 5.0 | 1.0 | 0.0 | 2.0 | 6.0 | 9.0 | 324.0 | 11 | 14 |
| **2019** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 8.0 | 1.0 | 1.0 | 1.0 | 10.0 | 12.0 | 273.0 | 10 | 12 |
| **Absolute** | 9.0 | 0.0 | 0.0 | 0.0 | 1.0 | 0.0 | 2.0 | 2.0 | 18.0 | 4.0 | 8.0 | 8.0 | **38.0** | **52.0** | **1,861.0** | 87 | 101 |
| **Average** | 1.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.3 | 0.3 | 2.3 | 0.5 | 1.0 | 1.0 | **4.8** | **6.5** | **232.6** | **10.9** | **12.6** |
| **Absolute HB/adjusted hawksbill interaction** | 9 |  | 0.0 |  | 1.0 |  | 4 |  | 22.0 |  | 16.0 |  | **HB caught/all fisheries/all years** | **38/1861 = 2%** |  |  |
| **Average HB/adjusted hawksbill interaction** | 0.6 |  | 0.0 |  | 0.1 |  | 0.3 |  | 1.4 |  | 1.0 |  | **HB+HB prop unsp caught/all fisheries/all years** | **52/1861 = 2.8%** |  |  |

**SM3d:**

|  |  |  |  |
| --- | --- | --- | --- |
| **QLD FOP days observed** | **Observed turtle interactions** | **Interaction rate (turtles/day)** | **Reported Hawksbill proportion 2005-2019** |
| 426 | 35 | 0.082 | 1.67% |
|  |  |  |  |
|  |  |  |  |
| **Year** | **Fishing effort (days)** | **Potential turtle interactions (interaction rate x effort)** | **Potential HB interactions (Reported HB prop x potential turtle interactions)** |
| 2005 | 39581 | 3252 | 54 |
| 2006 | 39253 | 3225 | 54 |
| 2007 | 38341 | 3150 | 53 |
| 2008 | 38917 | 3197 | 53 |
| 2009 | 35242 | 2895 | 48 |
| 2010 | 33671 | 2766 | 46 |
| 2011 | 32768 | 2692 | 45 |
| 2012 | 32633 | 2681 | 45 |
| 2013 | 29868 | 2454 | 41 |
| 2014 | 27622 | 2269 | 38 |
| 2015 | 27739 | 2279 | 38 |
| 2016 | 27684 | 2275 | 38 |
| 2017 | 26594 | 2185 | 36 |
| 2018 | 25492 | 2094 | 35 |
| 2019 | 19915 | 1636 | 27 |
|  |  | **Total potential HB interactions** | **651** |

**SM3e:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | **Hawksbills** | **Unspecified turtles** | **Adjusted HB interactions** | **All Turtles** | **Dead turtles** | **Effort (hooks)** |
| **2012** | 0 | 1 | 0 | 10 | 1 | 6792185 |
| **2013** | 0 | 0 | 0 | 15 | 3 | 6777421 |
| **2014** | 0 | 1 | 0 | 11 | 0 | 6955085 |
| **2015** | 2 | 6 | 0 | 30 | 4 | 8219473 |
| **2016** | 1 | 17 | 1 | 100 | 15 | 7823984 |
| **2017** | 2 | 18 | 1 | 198 | 29 | 8746936 |
| **2018** | 5 | 22 | 1 | 156 | 23 | 7899398 |
|  |  |  |  |  |  |  |
| **BPUE HB+adjusted HB interactions (2012-2015)** | **0.00007** |  |  |  |  |  |
| **BPUE HB+adjusted HB interactions (2016-2018)** | **0.00041** |  |  |  |  |  |

**SM3f:**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Year** | **HB** | **Adjusted HB interactions** | **Fishing Effort (days)** | **BPUE HB** | **BPUE HB Extrap** | **BPUE HB + adjusted HB interactions** | **BPUE HB +adjusted HB interactions Extrap** | **HB at extrap BPUE** | **HB +adjusted HB interactions at extrap BPUE** |
| **2005** | 5 | 0 | 39581 | 0.000126 | 0.000745 | 0.000126 | 0.000745 | 30 | 30 |
| **2006** | 2 | 1 | 39253 | 0.000051 | 0.000301 | 0.000076 | 0.000451 | 12 | 18 |
| **2007** | 2 | 1 | 38341 | 0.000052 | 0.000308 | 0.000078 | 0.000462 | 12 | 18 |
| **2008** | 1 | 0 | 38917 | 0.000026 | 0.000152 | 0.000026 | 0.000152 | 6 | 6 |
| **2009** | 0 | 0 | 35242 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0 | 0 |
| **2010** | 5 | 0 | 33671 | 0.000148 | 0.000876 | 0.000148 | 0.000876 | 30 | 30 |
| **2011** | 1 | 0 | 32768 | 0.000031 | 0.000180 | 0.000031 | 0.000180 | 6 | 6 |
| **2012** | 0 | 0 | 32633 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0 | 0 |
| **2013** | 3 | 0 | 29868 | 0.000100 | 0.000593 | 0.000100 | 0.000593 | 18 | 18 |
| **2014** | 0 | 0 | 27622 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0 | 0 |
| **2015** | 0 | 0 | 27739 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0 | 0 |
| **2016** | 4 | 0 | 27684 | 0.000144 | 0.000852 | 0.000144 | 0.000852 | 24 | 24 |
| **2017** | 1 | 0 | 26594 | 0.000038 | 0.000222 | 0.000038 | 0.000222 | 6 | 6 |
| **2018** | 1 | 0 | 25492 | 0.000039 | 0.000231 | 0.000039 | 0.000231 | 6 | 6 |
| **2019** | 0 | 0 | 19915 | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0 | 0 |
|  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  | **Total** | 150 | 162 |

**Table SM4:** Quantified presence (+) versus absent (x) predation by F/D = fox/dingo; P = pig; G/M = goanna/monitor; Cr = crocodile; C = cat; SF = scrub fowl; H = human (traditional harvest)and non-peak clutch loss to predation by P, G, SF and H extrapolated to 14, 30 and 60 survey days at neQld stock key nesting sites.

|  |  |  |
| --- | --- | --- |
| **Key nesting sites** | **Presence/absence predator data** | **Non-peak clutch loss to predation** **(P, G, SF, H)** |
| **# predator species present** | **F/D** | **P** | **G/M** | **Cr** | **C** | **SF** | **H** | **Percentage % (# predated/total recorded nests)** | **Over 14 days** | **Over 30 days** | **Over 60 days** |
| **Albany** | **3** | + | + | + | X | X | X | X |  |  |  |  |
| Aukane (Au Kein) | 2 | X | X | X | X | + | X | + | 2.1 (2/96) | 5 | 10 | 20 |
| Aureed | 2 | X | X | X | X  | + | X | + | 2.1 (2/95) | 5 | 10 | 20 |
| **Bet Islet (Bara)** | **3** | X | X | + | X | + | X | + | 15.5 (18/116) | 36 | 77 | 154 |
| Bourke (Bak) | 2 | X | X | X | X | + | X  | + |  |  |  |  |
| Boydong Island | 1 | X | X | X | + | X | X | X |  |  |  |  |
| **Cap Islet (Mukar)** | **3** | X | X | + | X | + | X | + | 34.2 (13/38) | 46 | 98 | 195 |
| Dadali Islet (Canoe) | 2 | X | X | + | X | X | X | X |  |  |  |  |
| Dayman | 0 | X | X | X | X | X | X | X |  |  |  |  |
| Dugong Islet (Atub) | 1 | X | X | X | X | X | X | + |  |  |  |  |
| Garboi (Arden) | 1 | X | X | X | X | + | X | X |  |  |  |  |
| Hawkesbury (Warral) | 2 | X | X | + | X | X | X | + |  |  |  |  |
| Igab (Marsden) | 2 | X | X | X | X | + | X | + |  |  |  |  |
| Kabbikane (Kebi Kein) | 1 | X | X | X | X | + | X | X  |  |  |  |  |
| Lacey | 2 | X | X | + | X | X | X | + |  |  |  |  |
| **Laoyak (Yauk)** | **3** | X | X | + | X | + | X | + |  |  |  |  |
| Little Adolphis (Smol Muri) | 2 | X | X | + | X | X | X | + |  |  |  |  |
| Maitak (Wilson) | 0 | X | X | X | X | X | X | X |  |  |  |  |
| Milman Island | 2 | X | X | X | + | X | X | + |  |  |  |  |
| Mimi | 1 | X | X | X | X | + | X | X |  |  |  |  |
| Mt Adolphus (Muri) | 2 | X | X | + | X | X | X | + |  |  |  |  |
| **Poll Islet (Guiya)** | **3** | X | X | + | X | + | X | + | 20.7 (6/29) | 28 | 60 | 120 |
| Saddle (Ullu) | 3 | X | X | + | X | + | X | + | 10 (1/10) | 7 | 15 | 30 |
| Sassie (Long) | 2 | X | X | + | X | X | X | + | 3 (4/133) | 6 | 13 | 27 |
| **Saunders (Wuthathi)** | **3** | X | X | X | + | X | + | + |  |  |  |  |
| Sauraz (Suarji) | 1 | X | X | + | X | X | X | X |  |  |  |  |
| Gebar (Two Brothers) | 2 | X | + | + | X | X | X | X | 100 (49/49) | 49 | 105 | 210 |
| Uluf | 1 | X | X | + | X | X | X | X |  |  |  |  |
| Ului (West) | 1 | X | X | + | X | X | X | X |  |  |  |  |
| Woody Wallace | 1 | X | X | X | X | X | X | + |  |  |  |  |
| Yarpar (Roberts) | 1 | X | X | X | X | + | X | X |  |  |  |  |
| Zuizin (Halfway) | 1 | X | X | X | X | X | X | + |  |  |  |  |
|  | **Total clutch loss** | **16.9 (95/566)** | **181** | **388** | **776** |

**Table SM5:** neQld stock harvest history review

|  |  |
| --- | --- |
| **Timeline** | **Harvest history review** |
| 18th century-1930s | At least 86,020lb or over 38 ton of tortoiseshell was exported from north Queensland at the time of commercial tortoiseshell trade. Applying a conversion factor of 2lb of tortoiseshell per large turtle (Limpus & Miller, 2008), approximately 43,010 adult-sized hawksbill turtles were taken from the northern GBR and Torres Strait. Other publications suggest this is equivalent to an annual harvest in excess of 1000 hawksbill turtles (Limpus & Miller, 2008; Limpus, 2009). |
| 1932-1968 | Whilst seasonal closures to harvesting green turtles and their eggs south of 17°S in Queensland was ordered (with restricted and eased amendments) under the *Fisheries Act* in 1932, 1950 and 1958, no protection was provided to hawksbill turtles. The tortoiseshell industry effectively ceased during the 1940s and became illegal with the protection of hawksbill turtles in Queensland in 1968 (Limpus, 2009). |
| 1970-1994 | Unpermitted take remained illegal in Queensland until the *Native Title Act 1994* (section 211) came into effect, allowing Aboriginal and Torres Strait Islander (ATSI) people with legitimate Native Title rights to hunt hawksbills in Australia for traditional (personal, domestic, communal, non-commercial) purposes within their traditional country. ATSI’s hunted hawksbills for centuries for tortoiseshell, meat and eggs (Limpus, 2009); today take is generally managed through customary law. However, changes in technology and the disruption of Indigenous culture are a growing challenge to the intensity of take (MACC Taskforce, 2005). |
| 1992-2013 | Harvest rates today remain relatively unquantified. A survey sampling 1,147 Indigenous persons in northern Queensland during 2000-2001 estimated a (species unspecified) annual marine turtle take of 3,851 and egg take of 3,976 (Commonwealth of Australia, 2003). Within confined sample survey studies, an estimated annual take of 50 hawksbills per year in 1992 (Harris, 1992a, b) and 75 in 2013 (Humber et al., 2014) would suggest an annual Indigenous take of 50-100 hawksbills (Limpus, 2009). |
| 2015+ | Today, the hawksbill turtle is not traditionally harvested by ATSI’s within the Torres Strait (TSRA, 2015), however, there is a noted preference for hawksbills eggs (Department of Environment and Science, 2018), and outside of the limited TSRA (2017) study, an unquantified number of hawksbill eggs are collected from rookeries throughout Cape York Queensland and the Torres Strait. Whilst unknown, the level of hawksbill take (for food and tortoiseshell) in PNG is likely to be substantially high (Kinch & Burgess, 2009) as it also remains an unprotected species, and is likely to be having negative consequences for the NEQld stock, noting compliance intervention into turtle and egg poaching by PNG nationals in the Torres Strait (in contravention to the provisions of the Torres Strait-PNG Treaty), also remain unresolved (The Cairns Post, 2017). As there is evidence of illegal international trade of tortoiseshell and/or whole hawksbill turtles out of the Arafura Sea – Coral Sea Region (Department of Environment and Science, 2018), inadequate monitoring and enforcement of endangered species trade regulation by CITES signatory States (including Australia, PNG and Indonesia (as reports of NEQld stock being found here; Barr et al., 2021) requires attention – particularly implementing Turtle Decisions 18.210 to 18.217.  |

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