# Cook Islands Turtles: Endangered Species Risk Assessment

## Summary Terms of Reference for this work:

Output 1 (this document):

A desktop study risk assessment that identifies key areas that may impact sea turtle populations that occur in the Cook Islands. A draft risk assessment should be shared with key stakeholders to ground truth initial risk ratings, before finalisation

It should be noted that an Ecosystem Based Approach to Fisheries Management (EAFM) assessment[1] has been undertaken for the Cook Islands tuna fishery which includes an assessment for turtles. This may be used to inform the method and approach used for determining risk ratings.

Output 2:

Management measures should be proposed to respond to risk areas that are identified as having a significant impact on sea turtles.

The expected outcome of this work is a set of policy recommendations to manage key risk areas that impact the populations of sea turtles that occur in the Cook Islands. This would form the basis for a formal set of guidelines, backed by regulation for issues where full compliance is considered necessary.



[1] https://www.mmr.gov.ck/content/CI-EAFM-comm-pelagic-fishery-FINAL-24-March-2020.pdf

# EXECUTIVE SUMMARY

- The main two turtles found in the Cook Islands—*Chelonia mydas* (Green) and *Eretmochelys imbricata* (Hawksbill)—are both highly migratory but not in quite the same way as tuna. Tuna range over broad areas of ocean both for reproducing and feeding while turtles are more like migratory shorebirds which move long distances between feeding and nesting areas, but whose coastal foraging areas and beach nesting areas are limited in size (with nesting beaches being much more limited than foraging areas). Nesting beaches are the point of greatest long-term risk for the whole population. Turtle biology tries to compensate for this by the production of large numbers of eggs by (formerly) numerous individuals in the same area at the same time.
- Industrial tuna fishery (particularly longline) bycatch of turtles is an obvious hazard, but is spread over a wide area of ocean, and turtle bycatch can be dramatically reduced with determination, monitoring and deterrence, as has been demonstrated in the Hawaii longline fishery. Tuna fishery bycatch would become the main threat to turtles if fishing effort was increasing and mitigation measures were not enforceable, but with the increasing effectiveness of actions by national fisheries administrations and through WCPFC, these risks are being mitigated across the range of these turtles. Industrial fishing forms a greater proportion of the total risk to adult turtles which are not confined to inshore feeding areas, or which are only found at sea in Cook Islands waters, such as the leatherback (*Dermochelys coriacea*).
- Inshore artisanal fishing specifically for turtles, and bycatch in gillnets set for other purposes, are often the main fishery-related hazards to Green and Hawksbill turtles because these turtles when feeding are concentrated into smaller coastal areas, and because they are actively hunted in many coastal locations across their Pacific range, although taking turtles is banned in many.
- In the 1970s it seemed logical that concentrating effort on the most vulnerable stages of the lifecycle—nesting and hatching—would be the most effective way of conserving turtle populations. Headstarting programmes—relocating eggs to protected areas and raising juveniles until they seemed old enough to fend for themselves—took off across the Pacific, and there was a major pioneering effort in the Cook Islands.
    - Unfortunately, it later emerged through tag analysis that headstarted turtles did not breed as successfully as naturally hatched turtles. Their geographical imprinting—their ability to return to the beach where they were hatched 20 or more years ago in order to lay their own eggs—was apparently impaired[2]. Also, life history-explicit population assessments have made it clear that the survival of turtle populations is more sensitive to the survival of adults than survivorship of the youngest life stages. Turtle populations can persist for many years with little recruitment but are quickly extirpated if adult survivorship is also low.
    - But later research has pointed out that conservation choices are complicated by social issues. Eggs are relatively inexpensive to protect and hatchlings to raise, and a small

[2] Burke, R L (2015) Head-starting Turtles: Learning from Experience. Herpetological Conservation and Biology 10(Symposium):299-308 *(based on a 2010 presentation)*

investment in headstarting could have a large positive impact[3] if done in such a way that juveniles can imprint on their nesting beaches (keeping hatcheries adjacent). And they can be a great focus for public education.

- Thus, turtles are at risk across their entire lives, but from different hazards at different points in the life cycle, and with a different risk profile for different species:
    - at nesting, hatching and breeding time they are very vulnerable to predation and disturbance, mitigated by large numbers of eggs. In places where nesting beaches still exist and are not heavily compromised, it may make more sense to concentrate conservation action on adults;
    - as adults they are much less vulnerable to predation, but adults are much fewer in number. In places where catching adult turtles is already rigorously controlled, or successfully avoided, it may make sense to concentrate further on protecting nesting beaches, or even headstarting;
- Because turtles are migratory, and because their primary foraging areas and nesting areas may be in different countries, there are also risks to Cook Islands nesting or foraging turtles that are outside the direct control of the Cook Islands.
- However, given the fact that (by)catching turtles is controlled in Cook Islands waters, with longliners required to use dip nets, de-hookers or line-cutters and release turtles alive wherever possible, with one of the highest rates of longline observer coverage in the Pacific Islands, the main risk to the regional turtle population when those turtles are in the Cook Islands is probably during the breeding season. Nesting beach management is possibly the most important thing that the Cook Islands can contribute as part of the regional effort to avoid extinction of Green and Hawskbill turtles. But even in this, the Cook Islands does not host a great number of turtle nests compared to some areas further west, particularly Melanesia, Australia and Indonesia.
- The other important action that could be taken by the Cook Islands would be to use its influence in regional management and conservation bodies (SPREP, WCPFC, SPC) to push for more effective collaborative action. Each country that is a host to individuals from these regional turtle populations – whether they are nesting, feeding or migrating through that country – needs to shoulder a share of the conservation burden. No country can do it alone, and no developing country should have to bear a disproportionate share of this regional burden (unless it caused a disproportionate share of the regional problem in the first place).
- Finally, it is worth noting that turtle conservation efforts worldwide appear to be having definite effect. Due to a combination of nesting beach protections and fisheries bycatch mitigation or restrictions on target fishing, most populations are showing signs of recovery according to one recent study[4]. Pacific leatherback turtles are one exception, based on the declining number of nests at major nesting sites. But this is something outside the direct influence of the Cook Islands, since leatherbacks do not nest here and are rarely killed at sea here.

[3] Alho, C.J.R. 1985. Conservation and management strategies for commonly exploited Amazonian turtles. *Biological Conservation* 32:291–298; and Allen, C.H. 1990. Give "headstarting" a chance. *Marine Turtle Newsletter* 51:12–16.

[4] Mazaris, Antonios D.; Schofield, Gail; Gkazinou, Chrysoula; Almpanidou, Vasiliki; Hays, Graeme C. (2017) Global sea turtle conservation successes. Science Advances Vol 3, Issue 9. DOI: 10.1126/sciadv.1600

# General Introduction

This is an endangered species risk assessment, not just an assessment of the risk to turtles from commercial fisheries, but an assessment which considers the relative risk of mortality across the entire range of hazards facing the turtles that travel through, reside, forage or breed in Cook Islands waters.

Caveat: although a lot of work has been done on turtles in the past two decades, there is still not enough information to make a *quantitative* assessment of the relative importance of all the hazards that face turtles throughout their lives. Most of this risk assessment will necessarily be qualitative or based on a balance of opinion.

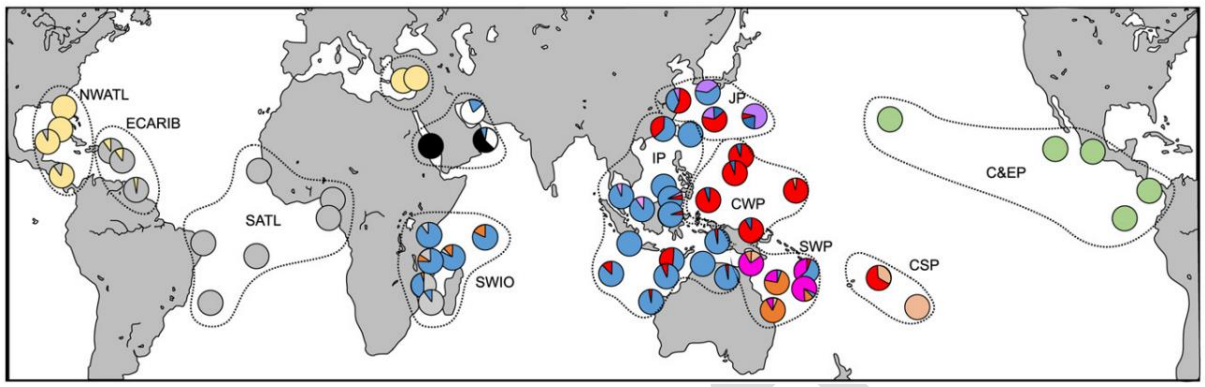
Key references summarising this more recent knowledge are:

- SPREP's 2021 Review of the Status of Sea Turtles in the Pacific Ocean (Pilcher, 2021)
- The 2020 and 2021 Annual Reports of the IUCN-SSC Marine Turtle Specialist Group, edited by Work, Parker and Balazs: "Sea Turtles in Oceania", including a comprehensive chapter on the Cook Islands by Michael White.
- Michael White's 2016 report, "Honu. Tongareva Henua. Sea Turtles in the Cook Islands: Volume Two (2013-2015)" https://www.honucookislands.com/downloads.php
- Although not "recent", NOAA's Recovery Plans for Hawksbill turtle and Green turtle (1996) contain comprehensive listings of hazards facing these turtles.

## Species of turtles found in the Cook Islands

- **Green turtle** (*Chelonia mydas*) appears to be the most commonly-seen turtle in the Cook Islands, especially in the northern islands and Palmerston.
    - Many of the green turtles that nest in the Cook Islands appear to migrate to feeding grounds around other Pacific Islands, and return every 2-5 years to mate and lay eggs. And according to turtle tourism operators, some may also be resident in the Cooks for several years, or possibly even spend their entire lives here. A comprehensive factsheet on the green turtle has been prepared by the USA National Oceanic and Atmospheric Administration (NOAA) and the general information is relevant to the Cook Islands, although the Hawaiian and south-eastern Polynesian green turtle populations may not interact much. The green turtle is IUCN red-listed as "endangered", following a global assessment in 2004.
    - There are two major green turtle populations in the world according to mitochondrial DNA analysis—the Atlantic and Indo-Pacific. Green turtles prefer warmer waters, and the Cape of Good Hope between the Atlantic and Indian Oceans and Cape Horn between the Pacific and Atlantic Oceans are too far south to allow easy migration, although there is some recent DNA analysis that suggests there may be a warm-water corridor allowing some mixing between Atlantic and Indian Ocean populations. The USA also recognises 8 "distinct population segments" (DPSs) in the Indo-Pacific population, and 3 DPSs in the Atlantic (including one in the Mediterranean). This is supported by genetic work published in 2019[5] proposing 11 genetically distinct "Management Units" (see map below), based on sampling of nesting turtles. Note that one of these (CSP) covers sites in American Samoa and French Polynesia and thus probably also includes the Cook Islands.

[5] Jensen MP, FitzSimmons NN, Bourjea J, Hamabata T, Reece J, Dutton PH (2019) The evolutionary history and global phylogeography of the green turtle (Chelonia mydas). J Biogeogr. 00:1–11. https://doi.org/10.1111/jbi.13483




Note that these were samples from rookeries (nesting areas), and this compartmentalisation does not preclude the possibility that the turtles that nest in these geographical regions might forage more widely in other areas, and mingle with turtles from other management units without interbreeding (in green turtles, mating seems to occur only close to nesting beaches) and, more importantly for any risk assessment, become exposed to the additional possibility of being fished or predated upon in these broader areas.

- At least one study complains about the lack of availability of genetic samples from most Pacific Islands, including the Cook Islands[6]. Tagging studies involving Cook Islands nesting or foraging turtles are also scarce. There are however examples of turtles tagged at Scilly Atoll in French Polynesia being recorded in Tonga, New Caledonia, Vanuatu, the Cook Islands, and Fiji (Balazs et al. 1995[7]). Some samples for genetic analyses have now been submitted from the Cook Islands (White, 2020).
- Green turtles apparently move between the same nesting and feeding areas for most of their lives. Adults (turtles older than about 30 years) and subadults (turtles 5-30 years old) are almost entirely herbivorous and tend to stay close to shore. Juveniles (<5yr) remain in the open ocean around convergence zones, are omnivorous and often swim deep[8]. The shift to coastal herbivory around 5 years of age turns the body fat green, hence the name.

- Hawskbill turtle *(Eretmochelys imbricata)* is red-listed as "critically endangered" by IUCN, following a global assessment in 2008. A comprehensive factsheet on the hawksbill turtle has been prepared by NOAA and is a very useful general reference.
  - Hawksbills mature slightly earlier (20-35 years) than Green turtles (25-35), and do not grow quite as large. Their lifespan is unknown, but 50-60 years has been quoted, whereas green turtles can live for 70 years or more.
  - While adult green turtles appear to be mainly herbivorous by preference and are usually found around seagrass beds in Melanesia[9], hawksbills eat a variety of foods including algae, corals, small fish, jellyfish, molluscs, crustaceans and sea-urchins but prefer sponges. Their preferred feeding grounds are coral reefs. The Cook Islands do not ever appear to have had seagrass beds and green turtles presumably subsist here on a similar diet to Hawksbills.

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[6] Peter H. Dutton, Michael P. Jensen, Karen Frutchey, Amy Frey, Erin LaCasella, George H. Balazs, Jennifer Cruce, Alden Tagarino, Richard Farman, and Miri Tatarata (2014) Genetic Stock Structure of Green Turtle (Chelonia mydas) Nesting Populations Across the Pacific Islands. Pacific Science, 68(4):451-464. DOI:10.2984/68.4.1

[7] Balazs, G. H., P. Siu, and J. P. Landret. 1995. Ecological aspects of green turtles nesting at Scilly Atoll in French Polynesia. Pages 7 – 10 in J. I. Richardson and T. H. Richardson, eds. Proceedings of the 12th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361.

[8] "Green Turtle, *Chelonia mydas*" Fisheries: Office of Protected Resources. U. S. National Oceanographic Atmospheric Administration. 2007. Retrieved September 2, 2007

[9] Although true seagrasses do not appear to exist in the Cook Islands, and a dietary analysis of the green turtles that are apparently resident in Rarotonga for years could be interesting.

Green turtles may be driven to range widely beyond preferred feeding areas in order to find, or return to, undisturbed nearshore areas and beaches for breeding and nesting.
    - Much less is known about the genetic structure of hawksbill turtle stocks or "management units" than about green turtle. As a species, the hawksbill "is critically endangered globally but is among the least studied marine turtles".[10] However, like the green turtle, two major populations or subspecies are recognised – *E. imbricata imbricata* in the Atlantic and *E. imbricata bissa* in the Indo-Pacific. The Indo-Pacific subspecies is itself divided into two groups – one which is confined to the eastern Pacific and does not appear to interact with the main population found from the east coast of Africa to Hawaii and French Polynesia. This eastern Pacific population does not forage primarily on coral reefs like the Indo-western-central-Pacific hawksbill but prefers mangroves and estuaries[11].
    - An extensive series of towed-diver surveys across all the American Pacific Islands over 13 years covered 7,300km and saw 3,400 turtles and found, amongst other things, that green turtles were observed 11 times more often than hawksbills[12] thus appearing to justify the more extreme conservation status of the hawksbill.
    - The Cook Islands Turtle Project survey of Aitutaki in 2012-2013 sighted 105 turtles over 14 weeks, with the green turtles being in "much higher abundance" than hawksbills. It was also thought that turtles were probably more abundant then than fifteen years previously, and that they have faced fewer threats in more recent years.
- Loggerhead turtles (*Caretta caretta*) have apparently been recorded from the Cook Islands (Palmerston). But they have never been seen nesting, and they are easily confused by humans with the green turtle (although loggerheads appear to be more confused with the hawksbill turtle by hawksbill turtles themselves, since these two species have been known to interbreed and produce viable offspring[13]).
- Leatherback turtles (*Dermochelys coriacea*) are said to be occasionally present in Cook Islands waters. It is not clear if this is known from occasional interactions with tuna fishing vessels, or from satellite tracking of migrating tagged leatherbacks.

This risk assessment will concentrate on Green and Hawksbill turtles.

## Nesting and foraging sites in the Cook Islands

From (White, 2021)

- Tongareva (Penrhyn) is "is by far the most important sea turtle nesting site nationally ... Chelonia mydas nest year-round on Mangarongaro (an uninhabited motu) … nests have been laid in every month since August 2014". Between 550 and 1767 nests per year have been laid in the last decade.
    - "Tongareva lagoon is the most important developmental habitat for C. mydas and frequent sightings are made year-round. Green turtle mating is commonly observed at Omoka Wharf and in Taruia Passage, making this atoll a critical habitat."
- Rakahanga "has 4 suitable nesting beaches but *C.mydas* does not nest here annually"
    - "Rakahanga Atoll's outer reef has large green turtles, especially females, foraging year-round. As little nesting occurs on Rakahanga, Manihiki, Nassau or Pukapuka it seems likely

[10] Bell, I., & Jensen, M. P. (2018). Multinational Genetic Connectivity Identified in Western Pacific Hawksbill Turtles, Eretmochelys imbricata. Wildlife Research, 45(4), 307-315 https://doi.org/10.1071/wr17089

[11] Richardson, Matthew (2023) *Threatened and Recently Extinct Vertebrates of the World: A Biogeographic Approach*. Cambridge University Press. 729pp. DOI.org/10.1017/9781108863308

[12] Becker, S. L., Brainard, R. E., & Van Houtan, K. S. (2019). Densities and Drivers of Sea Turtle Populations across Pacific Coral Reef Ecosystems. *PLoS One*, 14(4) https://doi.org/10.1371/journal.pone.0214972

[13] Oceanic Society (2022) The State of the World's Sea Turtles 17. Seaturtlestatus.org

that these adults may also use Tongareva for egg-laying (distance is 350 km between Rakahanga and Tongareva).

- Manihiki "is largely unsuitable for nesting, although egg laying does occasionally occur along the northwestern shore". "The most suitable beach (west side near original boat wharf) is sand mined for building materials."
    - "It is unclear if Manihiki still has C. mydas in the lagoon: this appears to be degraded due to artisanal black-pearl farming that supplies Rarotonga's tourist trade"
- Nassau: "Nesting occurs occasionally around the island. The crawl over the reef-top can be long (300+ metres) especially at low water; eggs are often laid in coral rubble"
- Pukapuka: "Green turtles nest occasionally"
- Suwarrow: "Green and hawksbill turtles are present in the lagoon but there is little dry land. One motu is called Turtle Island". White noted a few nests.
    - "Suwarrow lagoon is still in good condition: green adults and juveniles were observed"
- Palmerston was assumed to be the most important nesting ground in the Cook Islands until recently, based on one report. However it is still the most important turtle rookery in the southern group of Cook Islands, and the second largest after Tongareva. Possibly 100 nests are laid per year on average.
    - "Greens and juvenile hawksbills were observed in the lagoon and on the outer reef. Loggerheads have been reported from the lagoon, but no evidence of them nesting (Bill Marsters pers. com. 2009)"
- Manuae (near Aituataki, uninhabited) apparently minor nesting on both motu
    - Manuae has green turtles in the lagoon and on the outer reef. The status of hawksbills is unclear as they used to be present but may now have gone (Clive Baxter pers. com)
- Aitutaki – CITP surveys 2012-13. Occasional nesting on Maina and Onefoot. "Unusually, tiny pockets of sand along the rocky eastern margin of the runway have had nests. A large accreting sandbank 'Honeymoon Isle' in the lagoon may become available for nesting in decades to come."
    - Aitutaki has *C. mydas* in the lagoon and large turtles are known to rest in shallow areas (2 m depth) along the southernmost sector
- Takutea (near Atiu, uninhabited bird sanctuary). "An unbroken reef fringes the cay, which does have suitable turtle egg-laying sites. Present nesting status is unknown."
- Rarotonga "has been lost as a nesting habitat, assuming that nesting did occur historically, because the entire coastal zone has been destroyed for tourism development". "The northern and eastern coastlines are rocky with the fringing reef abutting the land; the western and southern lagoonal shores are sandy with hotels, resorts, restaurants and various watersports. Light pollution is ubiquitous along with people, cars and motorbikes meaning there are few quiet places anywhere along the shore. Some potentially suitable sandy areas are submerged at high water"
    - "*C. mydas* and *E. imbricata* are on the outer reef and in the southern lagoon"
- The other southern islands are generally unsuitable for nesting but might occasionally have a nest. Several *C. mydas* nests were reported from small coves on Mauke; these sites are dynamic, sometimes gaining sand but being unavailable in other years. Mauke – CITP survey 2012
    - The other southern islands have greens and occasionally hawksbills in their coastal waters, but there are no data. Woodrom Rudrud (2010) noted sea turtles present everywhere apart from Mitiaro.

# Sources of risk to sea turtles that nest in, forage in, or migrate through the Cook Islands

The NOAA's Recovery Plans for Hawksbill turtle and Green turtle list 26 different threats to these species in the USA. They note that a quantitative assessment of the relative importance of these risks to different species in different places is not feasible, given the current state of data availability, but they attempt to rank these risks in a qualitative fashion in order to prioritise different potential recovery activities. This assessment has used a similar classification but with fewer subdivisions.

Ideally, we would be able to identify the contribution of each human-related risk factor to a mortality estimate for each major stage in the life history of each sea turtle population. However, we're only just beginning to be able to do that for comparatively data-rich marine species like tuna, and most of that data comes from commercial fisheries. Given the lack of commercial fisheries targeting turtles in the Cook Islands, and elsewhere in the Pacific, the main sources of new data for these species are:

(a) commercial fisheries targeting other species for which turtles are accidentally caught. This can only produce a limited range of data, mainly relevant to assessing the impact of that fishery on turtles, or monitoring relative abundance through bycatch rate trends (of limited statistical value when turtle encounters are relatively rare events)
(b) governmental surveys of foraging areas, monitoring of nesting beaches, and community questionnaire surveys – can be long-term if required by regulation of the necessity for reporting, and funded in Ministry budgets, but often suffer from low prioritisation
(c) volunteer and NGO monitoring of foraging areas, monitoring of nesting beaches, and community questionnaire surveys – usually highly focussed and effective but may be subject to short-term projectisation and long-term funding difficulties, or dependent on the enthusiasm and leadership of one individual.
(d) commercial turtle tour operators, if they organise exercises for tourists to carry out standardised observations and regularly report to a central database. Non-extractive users, unlike fisheries, and strong motivation to restore or maintain turtle numbers at levels that allow a reliable frequency of sightings[14].

## Direct hazards - at sea

**1. Ingestion/entanglement**

- From: Wilcox, C., Puckridge, M., Schuyler, Q.A. et al. A quantitative analysis linking sea turtle mortality and plastic debris ingestion. Nature Scientific Reports volume 8, Article number: 12536 (2018). https://doi.org/10.1038/s41598-018-30038-z
    - "recent analyses suggest that plastic physically resembling turtles' natural food is ingested at a higher rate than other types"
    - "Globally, it is estimated that approximately 52% of all sea turtles have ingested plastic debris; however, this varies considerably between regions"
    - "We found a 50% probability of mortality once an animal had 14 pieces of plastic in its gut"
    - "This increases to a probability of 1.0 (i.e. certain death) at 226 items"
    - "Our analysis suggests that at this lower end, there is a 22% chance of dying due to ingesting a single debris item"

[14] According to White (2021) "A new organization 'Te Ara o te Onu' is just being Incorporated in Rarotonga by Ariki Holidays with an aim of coordinating all sightings from turtle-related tourism (Scuba, snorkeling, glass-bottom boats etc). They are co-operating with a Ridge-to-Reef project (R2R) at the National Environment Service and note presence, size classes, photo-recognition, behaviour, interaction with tourists. They plan to write an ethical guide to turtle watching for local businesses."

- For turtles that eat jellyfish, such as leatherbacks, juvenile greens (oceanic) and hawksbills (nearshore), plastic bags and balloons released into the oceanic environment appear to be a major hazard.
- Longline fisheries used to (and some possibly still do) discard large quantities of the plastic wrapping used to isolate each piece of bait in the package.

**2. Artisanal fisheries**

Turtles are traditionally an iconic species in most Pacific Island societies, including the Cook Islands. In most Pacific Island societies, particularly Polynesia and Fiji, the consumption of turtles was traditionally restricted to Chiefs, or to Priests, or to significant ceremonies or in emergencies following natural disasters. Increasing egalitarianism in society and commodification of food sources has eroded these values to a great extent. The fact that any member of society could now partake of these reserved foods led a great increase in exploitation of turtles and giant clams across many of the Pacific Islands in the decades after the Second World War, until the conservation need became apparent and largely accepted, shortly before the start of the new millennium.

For the Cook Islands specifically, Regina Woodrom Rudrud in her 2010 paper about Traditional Laws Pertaining to Sea Turtle Consumption in Polynesia said:

> *"Reports of traditional regulation of sea turtle consumption in the region vary. Early reports discuss purely chiefly consumption throughout the county (Gill 1885 cited in Crocombe 1961; Williamson 1933). Additional sources writing about Aitutaki, Rakahanga, and Tongareva Atolls as well as the island of Rarotonga support those reports with priests additionally able to eat turtle on Tongareva and Rarotonga (Williams 1837; Gill 1885; Pakoti 1895; Ariki-tara-are 1919; Smith 1899; Smith 1903; Large 1903; Hiroa 1932). At Pukapuka Atoll, however, reports indicate consumption by all people but only through special ceremony (Beaglehole & Beaglehole 1938; Parsons 1962)."*

It is very difficult to find any publicly available statistics about current turtle fishing or consumption in the Cook Islands, only anecdotal reports that turtles are occasionally taken artisanally. The SPREP Regional Marine Species Action Plan Review 2021 for example says, according to NES, that "Some islands keep records of turtle harvest, in particular the island of Penrhyn where they encourage no harvesting of females." White (2021) says "Traditional hunting happens occasionally, mostly random encounters. There is a noticeable generational shift as younger people prefer western food instead of an entirely island food diet".

Apart from any directed artisanal take of turtles, either on the nesting beach or by chasing them down in the water, turtles may also become bycatch in artisanal coastal gillnets set for other purposes. Worldwide, gillnets, whether anchored or drifting, appear to have been possibly the main cause of global adult turtle mortality over the last century. For example, in Trinidad in 2000, over 3,000 adult turtles were estimated to have been caught in the gillnet fishery, although around 70% of them were reckoned to have been released alive.

**3. Longline fisheries**

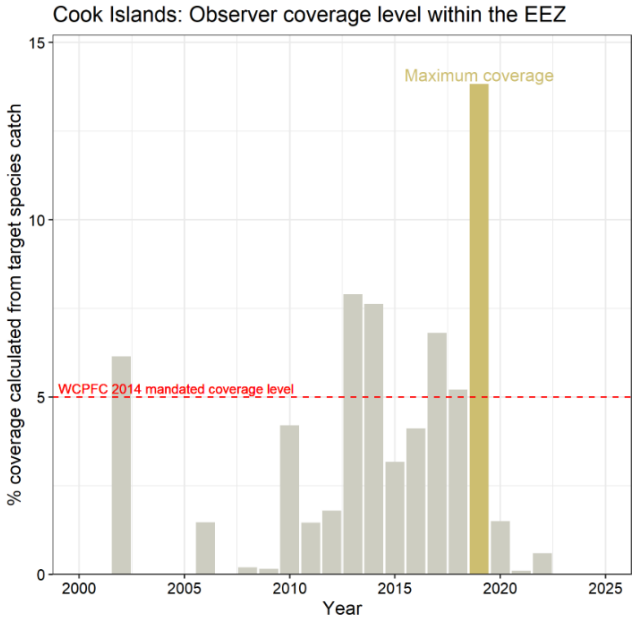
Turtles can take baited longline hooks, especially on shallower-set longlines for swordfish, or any hooks directly attached to longline floats in all longline fisheries. It is difficult to assess the scale of turtle interactions in longline fisheries because there is a relatively low level of independent observer coverage in the region as a whole (<5%) and longline vessels often do not always voluntarily report such interactions if there is no observer aboard. This lack of bycatch reporting was much commoner in the past, making any analysis of historical longline logsheets for turtle bycatch almost useless, in most countries.

The Cook Islands nowadays however has better longline observer coverage – up to 14% – than most other SPC members (apart from the USA (Hawaii) longline fishery, Australia and New Zealand), and recent estimates of turtle bycatch in Cook Islands waters should be relatively reliable.

As already mentioned, longliners that target swordfish tend to have higher interaction rates with turtles because they set hooks closer to the surface, and because their bait tends to be more attractive to turtles. The Cook Islands has had local longliners that target swordfish, but it is notable that the actual catch of swordfish in Cook Islands waters has only been 0.25% of the total regional catch of swordfish over the period 1990-2021 which suggests that the potential impact on turtle populations from Cook Islands fisheries was also low, compared to the catch in Australia, Hawaii, Kiribati or New Zealand for example. Additionally, the catch of swordfish on the southern WCPO high seas is as large as these EEZs combined, and additionally to that, the swordfish fishery on the northern high seas is far larger than the catch from these southern high seas and EEZs combined (however any turtles that are caught on the northern high seas are probably not turtles that nest or feed in the Cook Islands).

**Longline: annual observation coverage**

Annual longline observation coverage rate for the fleets operating in the EEZ. Data may be incomplete for the most recent years. The year with the highest observer coverage is highlighted in the yellow colour. Sources: observer data and best annual catch estimates. Note that the "WCPFC 2014 mandated coverage rate" applies at the flag-vessel level and is shown here merly for illustrative purposes.



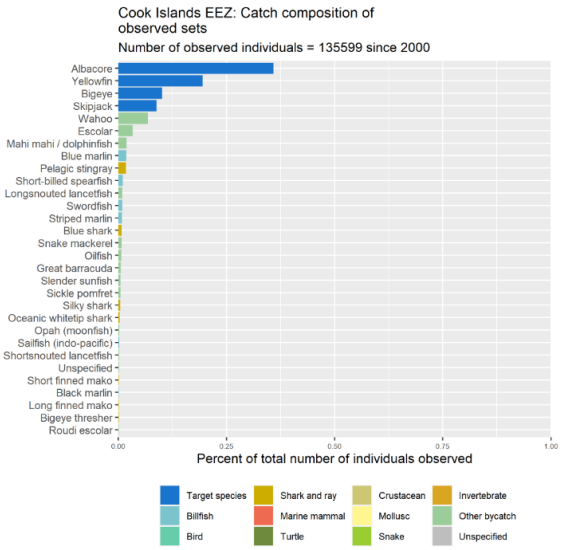

Data source: SPC-OFP Cook Islands Country Pages (https://ofpmembercountries.spc.int/index.php?option=com_content&view=article&id=6&Itemid=4567)

Note that recent coverage has been impacted by COVID, which also resulted in a reduction of the total observer cadre, and the need to recruit and train more.

Most of the observer coverage in the Cook Islands has been in the northern half of the EEZ, on vessels that normally land their catch in Pago Pago and whose landings thus can't be inspected in Cook Islands ports like the locally-based boats.

**Longline: observed overall catch composition**

Overall composition (in number of individuals) by species of observed catch recorded by observers for longliners operating in the EEZ for the indicated years. Data are presented for the 30 most frequent species. Source: observer.




As a result of this observer coverage, we know that turtles are not among the top 30 species caught on longline hooks in the Cook Islands EEZ since 2000.

However, Cook Islands-associated turtles roam outside the EEZ, as far afield as Fiji, Kiribati and eastern French Polynesia, and are subject to some risk of capture by longliners throughout this area. The sub-regional level of risk is important.

Electronic Monitoring using video cameras aboard longliners should enable much more accurate estimates of turtle bycatch and interactions.

The latest WCPFC observer data[15] suggests that most turtles that are caught by longliners die before they can be released, and most of those die before they can even be brought aboard. Looking at green and hawksbill turtles only, those caught in 2022 by longliners across the WCPFC region apparently had 100% mortality although leatherbacks and loggerheads had very high survival rates. Interestingly, the mortality rate of green and hawksbill turtles appears to have increased since 2019. 2019 was the last year before COVID and thus the last year with normal observer deployment. In 2019 the mortality of green and hawksbill turtles caught by longliners across the WCPFC as a whole was 40-50%, according to observers.

The main species of turtle caught by longliners across the WCPFC region – according to observers – is the Olive Ridley (*Lepidochelys olivacea*). This is not a Cook Islands species but is found further west and is apparently the most globally abundant sea turtle.

Overall, in 2022 across the WCPFC region, 0.74% of observed longline fishing days included a turtle encounter (mainly Olive Ridleys) and 60% of these turtles died. In 2019, 1.13% of observed longline fishing days included a turtle encounter and 20% of these turtles died. According to WCPFC there were major differences in the areas where observers were deployed in 2019 and 2022, due to COVID which probably accounts for the different mortality rates (due to a different level of diligence in dehooking etc by operators).

Although these figures are extremely variable, they do provide an indication of the scale of turtle interactions with tuna longline fisheries.

**4. Purse-seine fisheries**

Turtles can be trapped inside purse-seine nets and landed on the boat along with the catch. Observer reports suggest that almost all turtles encountered by purse-seiners are released alive. In 2022, 0.12% of observed purse-seine fishing days included a turtle encounter (mainly Olive Ridleys) and 0% of these turtles died. In 2019, 0.19% of observed purse-seine fishing days included a turtle encounter and 2% of these turtles died.

Comparing purse-seine to longline turtle interactions, WCPFC longliners are about six times more likely to catch a turtle than purse-seiners, per fishing day. And longliners are likely to kill at least 10 times more of the turtles that they catch than purse-seiners.

The differential mortality is due to the fact that turtles are air-breathers and can be trapped below the surface on longline hooks for many hours before the line is hauled, whereas the purse-seining operation is quicker and provides opportunities to surface for air.

**5. Vessel strikes**

All marine creatures that need to breathe air – dolphins, whales, turtles, dugong etc – are vulnerable to being struck by boats, especially in coastal waters. This is less of a risk for the turtle species like leatherbacks that spend most of their time in the open ocean, and more of a risk for coastally-foraging species like green and hawksbill. Temporally, the risk is greatest during the breeding season and spatially, in boat passages.

The US National Oceanic and Atmospheric Administration (NOAA) webpage about vessel strikes estimates that "hundreds" of turtles are struck by vessels in the USA every year, and many of these are killed without being observed. Vessel-strike injuries are seen on 20-30% of turtles that are found stranded or beached. The USA has a coastal stranding network where people can report such events, or they can be reported on an app (for Apple devices only).

[15] WCPFC (2023) Annual Report on the Regional Observer Programme. IP12 at the 20th WCPFC Annual Session, Rarotonga, December 2023

There is apparently no information available on the frequency of boat strikes on turtles in the Cook Islands, nor on beaching of injured turtles, although there are occasional items in the news (eg Washed up turtle released after a week in rehab - Cook Islands News).

## 6. Fisheries outside Cook Islands waters

Most sea turtles are highly migratory and the turtles that forage, nest or pass through Cook Islands waters are also exposed to risks outside the Cook Islands. And these threats may be much greater than the threats within the Cook Islands, simply because the turtles that are seen occasionally in the Cook Islands may actually spend most of their time foraging or nesting in other countries. Consider for example estimates of the total numbers of green turtles nesting in each Pacific country relative to the Cook Islands. Data are very variable and often unreliable, but the best available compilation seems to be in SPREP's 2021 review of the Status of Sea Turtles in the Pacific Ocean (Pilcher, 2021). Note that these are estimates of the average number of green turtles that *nest* each year in each country. The number present or foraging in that country may be many times larger, but it is the *relative* numbers between countries that are interesting. The following table is compiled from the data in that publication

| Place | Green turtles nesting annually* | Green turtles present or foraging, if estimated | Regional Management Unit (RMU) |
|---|---|---|---|
| Hawaii (NWHI) | 450 | 3,800 | North Central Pacific |
| Palmyra | 0 – possibly some in past | | |
| Johnson | - | | |
| American Samoa (Rose Atoll) | "several dozen" | | South Central Pacific RMU |
| Cook Islands | <50 | | |
| Fiji | 50-75 | 4,000-6,000 | |
| French Polynesia | <200 | | |
| Kiribati – Gilberts | 10-50 | | |
| Kiribati – Phoenix | 100-300 | | |
| Kiribati – Line | ? | | |
| Nauru | 0 – possibly in past | | |
| Niue | 0 | | |
| Pitcairn-Henderson | 10 | | |
| Samoa | 0 | | |
| Tokelau | 120 | | |
| Tonga | 10-20 | | |
| Tuvalu – Funafuti | <10 | | |
| Tuvalu – other islands | Apparently | | |
| Wallis & Futuna | Not known | | |
| CNMI | 10 | | Central West Pacific RMU |
| Guam | 1-4 | | |
| FSM | 500-1000 | | |
| Japan Pacific Islands | 500 | | |
| PNG | Lots | | |
| Philippines turtle sanctuary – Sulu Sea | 3,000-4,000 | | |
| RMI – inhabited isles | ? | | |
| RMI – Bikar Atoll | 100-500 | | |
| Palau – Hatohobei & Sonsorol | 100-150 | | |
| Palau elsewhere | 1-10 | | |
| Australia | 16,000-40,000 | | South West Pacific RMU |
| New Caledonia | 1,000-2,500 | | |
| Solomon Islands | 300 | | |
| Vanuatu | At least 100-300 | | |

*note that this is an esti
the number of *individua
*green turtles* nesting an
an estimate of the *numb
nests*. Each turtle may n
times in one season.

Although the amount if interaction between the turtles in these different regional management units is not known very precisely, the turtles that feed or nest in the Cook Islands, or are found in Cook Islands waters, may also be travelling to, feeding, or breeding in several other Pacific Island countries as well (American Samoa, Fiji, French Polynesia, Kiribati, Nauru, Niue, Pitcairn, Samoa, Tokelau, Tonga, Tuvalu, Wallis & Futuna are probably all in the same regional management unit). What happens in these other countries may affect the number of turtles to be seen, or which breed, in the Cook Islands.

And it is assumed that these Green Turtle "regional management units" do not interact very much. If that is the case, then any decline in the South Central Pacific RMU is not going to be made up by migration from the far more populous South West Pacific RMU. The South Central Pacific RMU countries need to work together to maintain their shared turtle population.

Note that the "regional management unit" concept (Wallace et al 2010) is one way of looking at intra-regional connectivity between turtles, and at the identification of management units that can be managed more or less independently of each other (whereby excess mortality in one management unit will not affect the status of other management units). Another is the Nesting Aggregation concept, whereby populations of interacting turtles are identified according to nesting data. Dethmers et al. (2006) identify 24 nesting aggregations in Oceania based on proximity (<500 km apart) and some genetic data (although not many locations have been sampled yet). White (2006) suggests that the following Nesting Aggregations are of direct relevance to Green turtles in the Cook Islands (Hawksbills are not known to nest in the Cooks):

i) Western Polynesia: Pukapuka is included with Samoa and American Samoa
ii) Northern Cook Islands: Manihiki, Nassau, Rakahanga, Suwarrow and Tongareva
iii) Southern Cook Islands: Aitutaki, Atiu, Mangaia, Manuae, Mauke, Mitiaro, Palmerston, Rarotonga and Takutea.

It might be useful to reconcile these various metapopulation ideas with additional tagging and genetic sampling, to identify what is the most effective minimum scale at which different islands would need to collaborate in order to most effectively conserve the turtles that make use of their waters. However, given that threats extend across the entire migratory range of any individual turtle, the main extent of Cook Islands collaboration would probably need to be at least with all countries that shared an individual turtle tag or identification record with the Cook Islands (i.e. a sighting of Turtle X was recorded in both Country Y and the Cook Islands). Primary scientific analysis is beyond the scope of this report, but the SPREP TREDS[16] database and the SWOT[17] project appear to have aggregated much of the available data tagging and genetic data regarding individual turtles.

Milani Chaloupka's 2003 work[18] for GBRMPA expanded the groundwork for this kind of turtle population modelling, and a 2010 doctoral thesis[19] applied genetic and modelling methodologies for establishing the connectivity between nesting and foraging habitats, noting that understanding the population dynamics in both breeding and foraging habitats is a vital part of assessing the long-term viability of highly migratory species, and that monitoring of populations at foraging grounds may help detect early signs of population trends that would otherwise take decades to be observed at the nesting beach.

[16] Turtle Research and Monitoring Database System (TREDS) https://www.sprep.org/thetreds
[17] The State of the World's Sea Turtles (SWOT) https://www.seaturtlestatus.org/ and https://www.seaturtlestatus.org/online-map-data
[18] Chaloupka, M (2003) Phase 2: Development of a population model for the Southern Great Barrier Reef green turtle stock. Great Barrier Reef Marine Park Research Publication No.81.
[19] Jensen, M P (2010) Assessing the composition of green turtle (Chelonia Mydas) foraging grounds in Australasia using mixed stock analyses. Doctoral thesis, University of Canberra https://doi.org/10.26191/3fvq-2v21

## Direct hazards - on land

### 7. Egg harvesting

"Sea turtle egg-take has practically disappeared in the Cook Islands: 40 years ago, most nests would have been harvested" (White, 2021)

### 8. Turtle taking during nesting

Has been known to occur in the Cook Islands (eg Cook Islands Turtle Project: Mauke Report 2012), but is apparently not significant nowadays.

## Indirect hazards resulting from human activities

### 9. Climate change

- Nest temperature determines the sex of turtle hatchlings, with more females resulting from warmer temperatures. Turtles may be able to change the depth at which they bury their eggs to try and achieve the optimum incubation temperature. However, this may not be very effective—at some locations recently on the Great Barrier Reef up to 99% of the hatchlings from some turtle nests were female. But an overabundance of females compare to males is not necessarily a bad population survival strategy, in a species where there is no parental investment in the rearing of the young.
- Hawksbill turtles tend to excavate their nests higher up the beach than Green turtles, and thus may be less vulnerable to any sea-level rise, or beach erosion, but only Greens are known to nest in the Cook Islands.
- It has been suggested that progressive acidification of the ocean may possibly interfere with the senses involved in navigation and return to nesting beaches or foraging areas, but there is no strong evidence to judge the plausibility of this.
- "Past climatic fluctuations greatly affected the distribution of genetic diversity in the highly migratory green turtle. Our data suggest that past climatic events influenced local populations in different ways and the species appears to have survived the last glaciations in multiple glacial refugia."[5]
- The SPREP 2021 Review of the of the "Regional Marine Species Action Plans" reports correspondence from the Cook Islands which says that the *"biggest problem* (facing nesting turtles in the Cooks, presumably) *is climate change killing trees behind nesting beaches meaning they get full sun all day. Over 6000 trees have been planted since 2018 (on Tongareva) to create shadow and localised cooling (GEF award 2018)."*

### 10. Nesting beach and nearshore feeding grounds disturbance

- Coastal construction, particularly for beach-adjacent tourism developments, especially if these beaches are known nesting beaches. The criteria used by the Cook Islands Turtle Project in 2010-2012 to classify beaches around several islands into three types according to their suitability or known history as nesting beaches could be useful as an environmental impact criterion for turtles in any new shoreside development – if this is not done already. Apart from physical alterations – reclamation, seawalls etc. one of the main risk factors for turtle mortality under this heading is light. Hatchling turtles need to find their way to the sea as quickly as possible. They often hatch at night, and tend to orient themselves away from darker areas (which usually denotes the landward side of the beach) and towards lighter areas (which are usually on the ocean side).
- Tourism – swimming with turtles – is becoming increasingly popular in several Pacific Island countries. Observing turtle nest hatching may possibly interfere with the ability of turtle hatchlings to find their

way to the sea if not properly supervised, but it may even help increase survival. Swimming with turtles while they are foraging on the reef or in seagrass beds may not be a major problem, but if turtles are being fed by tourists then there could be unintended consequences. Research in Barbados[20] found that Green turtles that were fed as part of a "swimming with turtles" tour operation became up to three times heavier than turtles without access to supplementary feed. This could have health consequences (especially if they are being given junk food that is nothing like their natural diet), and it could also lead to a higher incidence of boat strikes as the turtles congregated in feeding areas. On the other hand, turtle tourism operators have a healthy motivation for conserving turtles since more turtles mean more reliable sightings, and tourists themselves can increase their engagement with the marine environment by taking part in surveys of turtle sightings, identification etc. It is also possible that well-fed turtles will have less need to gulp down any plastic bags, condoms, balloons or other bits of debris that they find.

### 11. Other Pollution

The high level of risk to turtles that plastic bags and other food-resembling garbage entering the marine environment poses has already been included under "ingestion" above. Other sources of pollution include pesticides and fertilisers in terrestrial runoff and are particularly significant for species that feed in coastal waters. It is possible that fertiliser runoff, as used to occur at Aitutaki when bananas were a major commercial crop, leading to algal overgrowth in the main boat passage, could even provide more food for green turtles, provided these algae were not toxic species. However, pesticides would definitely be deleterious to survival, and have been suggested to possibly be a cause of the fibropapillomas that afflicted many Hawaiian turtles in decades past.

## Hazards not attributable to humans

### 12. Disease

- From Wikipedia https://en.wikipedia.org/wiki/Turtle_fibropapillomatosis

*"Turtle fibropapillomatosis (FP) is a disease that affects sea turtles. It is characterized by benign but ultimately debilitating epithelial tumors on the surface of biological tissues. FP exists all over the world, but it is most prominent in warmer climates, affecting up to 50–70% of some populations. The causative agent of the disease is believed to be Chelonid alphaherpesvirus (ChHV-5), a species of virus in the genus Scutavirus, subfamily Alphaherpesvirinae, family Herpesviridae, and order Herpesvirales. Turtle leeches are suspected mechanical vectors, transmitting the disease to other individuals. The disease is thought to have a multifactorial cause, including a tumor-promoting phase that is possibly caused by biotoxins or contaminants."*

- Antoine M. Dujon, Gail Schofield, Roberto M. Venegas, Frédéric Thomas, and Beata Ujvari (2021) Sea Turtles in the Cancer Risk Landscape: A Global Meta-Analysis of Fibropapillomatosis Prevalence and Associated Risk Factors. Pathogens. 10(10): 1295. doi: 10.3390/pathogens10101295

*"Several cancer risk factors (exposure to ultraviolet-B, pollution, toxins and pathogens) have been identified for wildlife, to form a "cancer risk landscape." However, information remains limited on how the spatiotemporal variability of these factors impacts the prevalence of cancer in wildlife. Here, we evaluated the cancer risk landscape at 49 foraging sites of the globally distributed green turtle (Chelonia mydas), a species affected by fibropapillomatosis, by integrating data from a global meta-analysis of 31 publications (1994–2019). Evaluated risk factors included ultraviolet light exposure, eutrophication, toxic phytoplanktonic blooms, sea surface temperature, and the presence of mechanical vectors (parasites and symbiotic species). Prevalence was highest in areas where nutrient concentrations facilitated the emergence of toxic phytoplankton blooms. In contrast, ultraviolet light exposure and the presence of parasitic and/or symbiotic species did not appear to impact disease prevalence. Our*

[20] Should Tourists Swim with Endangered Sea Turtles? - Scientific American Blog Network (2016)

*results indicate that, to counter outbreaks of fibropapillomatosis, management actions that reduce eutrophication in foraging areas should be implemented."*

- Van Houtan KS, Smith CM, Dailer ML, Kawachi M. (2014) Eutrophication and the dietary promotion of sea turtle tumors. PeerJ 2:e602 http://dx.doi.org/10.7717/peerj.602

*"tumors—their greatest known source of mortality"*

- McGowin, A.E.; Truong, T.M.; Corbett, A.M.; Clark, Dave (2011). "Genetic barcoding of marine leeches (Ozobranchus spp.) from Florida sea turtles and their divergence in host specificity". Molecular Ecology Resources. 11 (2): 271–278. doi:10.1111/j.1755-0998.2010.02946.x. PMID 21429133. S2CID 34067696.

*"Fibropapilloma is caused by a herpesvirus that is transmitted by leeches such as Ozobranchus branchiatus, a species of leech which feeds almost entirely on green sea turtles"*

13. **Predation at sea** – often at breeding/nesting sites – tiger sharks are often implicated, but oceanic whitetip sharks (not to be confused with reef whitetip sharks) are known to occasionally take turtles. Humans are the only other predator of adult turtles.

14. **Beach predation** on hatchlings, eggs, or nesting females by birds, ghost crabs, rats, (in Fiji) mongoose, cats, dogs etc. This is a very significant source of hatchling mortality, and one where human intervention can have beneficial effects. Turtle hatching events can be a major tourist attraction in places where nesting is common and predictable, but need to be managed carefully to avoid disturbance – especially by light.

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# Hazard checklist for turtles in the Cook Islands

This follows much the same format used by the 2020 MMR report on application of the Ecosystem Approach to the Management of the Cook Islands Large Pelagic Fishery. However, this is an endangered species risk assessment. It is not just an assessment of the risk to turtles from commercial fisheries, but an assessment which considers the relative risk of mortality across the entire range of hazards facing the turtles that travel through, reside, forage or breed in Cook Islands waters. Whereas the Ecosystem Approach to fisheries management looks at the impact of one hazard (a fishery) on the entire ecosystem, this Endangered Species risk assessment looks at the impact on one species of the entire range of (significant or known) hazards in its environment.

There are many ways of classifying relative risks in the absence of comprehensive data. In line with the recent we will use one which is based on "Likelihood" and "Consequence". Likelihood is the chance that a management objective will not be met. Consequence is the seriousness of associated impact if it occurs.

1. Risk context – defines the broader parameters of the assessment including the risk that is to be analysed (i.e. the management objective trying to be achieved or undesirable event trying to be avoided), the spatial extent of the analysis, the conservation and management regime and any timeframes.

2. Risk identification – identifies the sources of risk that have the potential to contribute to the occurrence of an undesirable outcome for the management unit (population in a particular area, species or species group) being assessed.

3. Risk characterisation – provides an estimate (low, medium, high) of the likelihood that one or more of the identified sources of risk will result in an undesirable event occurring. For risk assessment in a data-poor situation, this stage focuses on the key hazards and the risk that they pose to each of the management units.

Risks are assessed at three levels of **likelihood** – likely, possible, or unlikely. The definitions used in the risk assessments are as follows:

| Likelihood | Descriptor |
|---|---|
| Likely (3) | It is expected to occur (Probability of 40 - 100% if quantitative |
| Possible (2) | Evidence to suggest this is possible and will occur occasionally (Probability of 10 - 39%) |
| Unlikely (1) | Uncommon here, or has been known to occur elsewhere (Probability of 1 -10%) |

The **consequence** levels for the assessment units are as follows:

| Consequence | Local Impact (country level) |
|---|---|
| Minor (1) | Possibly detectable, but no real impact on the status of the assessment unit in the Cook Islands |
| Moderate (2) | Some reduction of abundance in Cooks |
| Major (3) | Major reduction of abundance in Cooks, with significant effects on any environmental, economic or societal value associated with the assessment unit |
| Extreme (4) | Effective extinction of assessment unit within Cook Islands |

For each issue, the likelihood and consequences of objectives not being met are presented in a matrix, as follows:

| | Consequence to turtle population of hazard occurring | | | |
|---|---|---|---|---|
| **Likelihood of hazard occurring** | Minor **1** | Moderate **2** | Major **3** | Extreme **4** |
| Unlikely (1) | 1 | 2 | 3 | 4 |
| Possible (2) | 2 | 4 | 6 | 8 |
| Likely (3) | 3 | 6 | 9 | 12 |

Based on the weightings from the risk assessment, each issue is assigned a Risk Category, as follows:

| | |
|---|---|
| Low Risk | not considered further |
| Medium Risk | management responses considered, with an emphasis on monitoring |
| High Risk | appropriate management responses identified. |

**Risk categorisation for each hazard identified**

| Hazard | Objective | Conse-quence | Likel-ihood | Risk score | Reasons |
|---|---|---|---|---|---|
| **Direct Hazards – at sea** | | | | | |
| 1. Ingestion/ entanglement | To greatly reduce plastics and ALDFG[21] entering the sea from fishing vessels (WCPFC CMM 2017-04) and from land (NES). | 3 | 3 | 9 | Turtles may mistake plastic bags for jellyfish and may ingest pieces of plastic. Even one ingestion carries a 20% risk of mortality. Entanglement in ALD line or net carries high risk of drowning. |
| 2. Artisanal fisheries | To minimise any artisanal take to sustainable levels | 2 | 2 | 4 | Without community or government control, artisanal fisheries have potential to exert high levels of fishing mortality on adult turtles, and the Cook Islands turtle population is not large compared to the regional average. |
| 3. Tuna Longline fisheries | To achieve full compliance with MMR & WCPFC measures for avoiding bycatch and maximising live release. | 3 | 3 | 9 | Without effective avoidance measures, pelagic longliners, especially shallow-set LL, exert relatively high fishing mortality on turtles in the open ocean, and most captured turtles die |
| 4. Tuna purse-seine fisheries | To achieve full compliance with WCPFC measures for avoiding bycatch and maximising live release. | 1 | 2 | 2 | Purse-seiners do capture turtles, but at a 6th of the number, per fishing day (WCPFC), of longliners, and almost all are released alive. There are fewer purse-seiners than longliners operating in the Cook Islands. |
| 5. Vessel strike | To minimise boat strikes through best practice guidelines for tourism operators and artisanal fishers, and monitoring. | 2 | 2 | 4 | Mainly a problem in nearshore areas, particularly passages and specific feeding areas and the more populated islands. Probably not many strikes in Cooks, but can be fatal to turtles. |
| 6. Fisheries outside Cook Islands waters | Cook Islands leadership or full participation in regional initiatives to | 3 | 3 | 9 | Most turtles seen in the Cook Islands are part of subregional populations, and are probably subject to higher mortality |

[21] ALDFG = Abandoned, Lost or Discarded Fishing Gear

| Hazard | Objective | Conse-quence | Likel-ihood | Risk score | Reasons |
|---|---|---|---|---|---|
| | minimise turtle mortality, legally binding and nonbinding | | | | when they feed or nest in certain range States. The risk of potential non-Cook Islands impacts is significant |
| **Direct Hazards – on land** | | | | | |
| 7. Egg harvesting | Eliminate of human harvesting of turtle eggs | 2 | 1 | 2 | Apparently now rare, but taking of large numbers of eggs could have major consequences for population survival |
| 8. Turtle taking during nesting | Elimination of human harvesting of turtles during nesting | 4 | 1 | 4 | Apparently now rare, but nesting is the most vulnerable activity for female turtles, and adult females have far greater significance for population survival than any other population members. |
| **Indirect Hazards – resulting from human activities** | | | | | |
| 9. Climate change | Mitigation of effects of climate change on turtles, particularly at nesting stage, inc. management of rookeries | 3 | 3 | 9 | Expected effects of climate change most likely to affect nesting stage – sea level rise, increased storms, warming. Adaptation to changes may occur, as has happened in the past. Turtles are migratory. But natural climate refugia more likely to be available outside Cook Islands than in. |
| 10. Nesting beach[22] and nearshore feeding grounds disturbance | (a) Zoning any new shore-side construction to avoid important turtle nesting beaches.<br>(b) guidelines for tourism operators on avoiding deleterious impact on turtle feeding and nesting spaces, and for organising "informal science" observations<br>(c) Public education on minimising boat speed in passages etc | 2 | 2 | 4 | Non-fatal nesting beach and feeding ground disturbance can have major long-term impacts on turtles. Sometimes these impacts may take 30 years to become evident when adult turtles finally return to the beach they were imprinted on when they hatched. "Turtle watching" tourism is likely to become disturbing if there are too many operators trying to get their clients as close as possible, but can also contribute positively to public education and scientific observations. Operators have a vested interest in turtle conservation. |
| 11. Other pollution | Eutrophication and pesticide runoff into lagoons and nearshore reefs is avoided as far as possible. | 2 | 2 | 4 | The Cook Islands has some shallow and enclosed lagoons which may concentrate any runoff – such as from the fertiliser from the banana plantations at Aitutaki in decades past. Green turtles feed on seagrass in other countries further west but the results of eutrophication are complex – it may fertilise seagrass or it may encourage plankton growth that blocks seagrass photosynthesis |
| **Hazards not attributable to humans** | | | | | |
| 12. Disease | Monitor, and try to avoid conditions that may encourage disease – possibly reductions in water quality | 2 | 1 | 3 | Green turtles are subject to tumorous growths (fibropapillomas) caused by a herpes-like virus probably transmitted by turtle leeches. Not necessarily fatal, but debilitating. Research suggests that this may be more prevalent in waters that have become eutrophic[23]. There do not appear to have been any reports from the Cook Islands yet. |

[22] The direct take of eggs and nesting turtles is covered elsewhere under Hazards 7 and 8

[23] "eutrophic" essentially means "overfertilised"

| Hazard | Objective | Conse-quence | Likel-ihood | Risk score | Reasons |
|---|---|---|---|---|---|
| 13. Predation at sea | Not applicable – not readily controlled by any human authority | 1 | 2 | 2 | Adult turtles at sea have very few predators apart from sharks – particularly tiger sharks. |
| 14. Predation on nesting beaches | Reduce beach predation threats through public education and properly-managed tourist "turtle hatching watching" | 1 | 3 | 3 | Hatchlings have a lot of potential predators, many of which are controllable by humans |

# Part 2 (will be)

# Policy Framework for the management of key risk areas that impact the populations of sea turtles that occur in the Cook Islands.

Will be completed after discussion in Cooks and comments on the risk assessment.