

**Nurse Rocks Mooloolaba:
New aggregation of critically
endangered Grey Nurse
Sharks (*Carcharias taurus*)**

SUMMARY

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**Marine
Education**

Summary

- Growing number of Grey Nurse Sharks (*Carcharias taurus*) congregating on a reef named *Nurse Rocks* (also named *Wobby Rock* or *The Tunnels*).
- Up to 20 male sharks and 2-3 females recorded at the site in winter 2021.
- 2-3 male sharks and 5-10 females, including heavily pregnant females and females with mating scars at the site in early spring 2021.
- Male Grey Nurse Sharks arrive at Wolf Rock (Rainbow Beach Qld) to mate in late spring. Pregnant females leave Wolf Rock in winter before mating begins.
- No-one knows where they go to give birth. Could it be Nurse Rocks?
- Grey Nurse Shark listed as *Critically Endangered* under EPBC Act 1999.
- *Grey Nurse Shark Recovery Plan (2014)* states to find and protect new key aggregation sites. The Plan is due for review. Many objectives not actioned.
- Nurse Rocks meets the criteria as a *key aggregation site* (>5 sharks at any one time) but is *not* listed in the plan (discovered *after* the plan was made).
- Nurse Rocks also supports other endangered species such as a resident Loggerhead Turtle, Hawksbill turtle and ornate ghost pipefish.
- Nurse Rocks is not protected nor managed.
- Threats include anchor damage, fishing, discarded or foul hooked fishing tackle, and harassment from unregulated tourism.
- Several sharks had fishing line trailing from their mouths (hooks swallowed).
- Nurse Rocks, being outside the 3 nm State Limit, lies in Commonwealth waters.
- The protection of species in Commonwealth waters falls under the EPBC Act (1999) in which the east coast population is listed as 'critically endangered'.
- The last site that was declared a protected zone for GNS was back in 2007. It was one of two in Commonwealth waters.
- Minister has the power to protect the site now under the precautionary principle, as it qualifies as a critical habitat site.



Figure 1: Heavily pregnant female 14/07/2021
(photo: Karen Anderson)

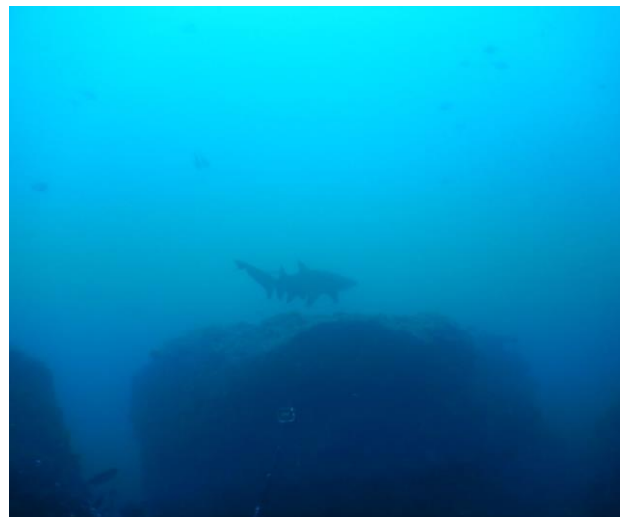


Figure 2: Juvenile (tbc) 28/10/2018
(photo: Karen Anderson)



Figure 3: Shark with dart tag 29/08/2018
(photo: Karen Anderson)



Figure 3: Shark with dart tag 29/08/2018
(photo: Karen Anderson)



Figure 4: Predominantly male sharks 25/07/2020 (photo: Karen Anderson)

Timeline of Events

Science highlighted in Yellow

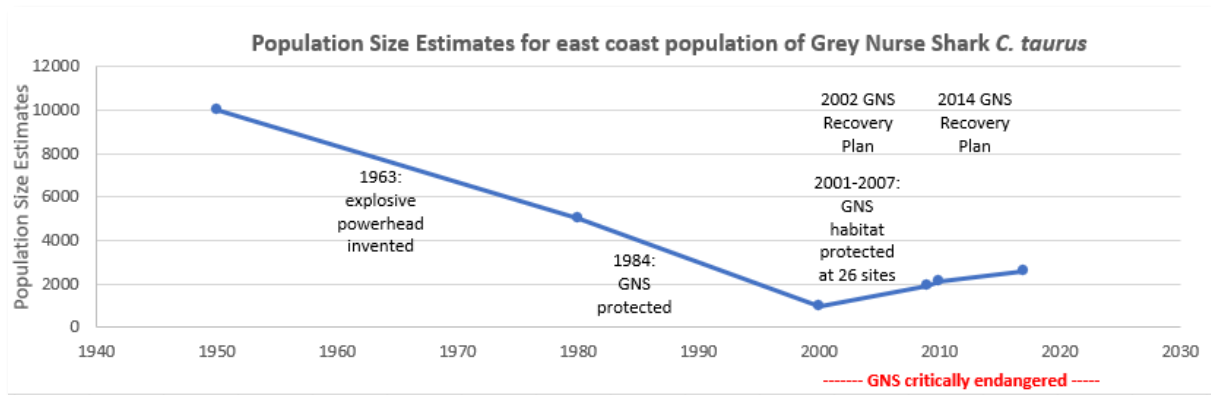


Figure 5: Timeline of key events for the Grey Nurse Shark (GNS) *Carcharias taurus* from 1950 to 2022. Dots represent scientific publication dates estimating population size.

1950s: GNS east coast population estimated to be 90% larger than today

During the early 1950s (in NSW) and 1960s (in Qld), an average of 36 GNS (grey nurse shark) would be recovered from shark nets every year (Reid & Krogh, 1992; Environment Australia, 2002). In comparison, there was an average of 18 GNS recovered from shark nets every year in the 1980s, and an even lower average of 2 sharks recovered from shark nets every year between 1993-2004 (Australian Government, 2022a).

Early 1960s: explosive shotgun powerheads invented and killed many sharks

Ben Cropp helped design the explosive powerhead in 1963 that made it very easy to kill the GNS using a speargun. Justified by the common misconception that GNS were dangerous, the shotgun powerhead was “the catalyst that virtually sent the GNS into extinction” (Cropp, 2016). By the time Cropp realized the GNS were not dangerous and swapped his speargun for a camera in 1964, the damage was already done (Cropp, 2016). The species continued to be actively persecuted and killed off New South Wales by spear fishers in the 60s and 70s (Reid and Krogh, 1992 cited in Rigby *et al.*, 2021).

1960-1979: Game-fishing clubs catch 405 GNS

Although organized game-fishing began off eastern Australia in 1936, the majority of catches were made after 1960. NSW Game-fishing clubs recorded catching a total of 405 GNS between 1960 and 1979 but GNS were not the primary target species (Pepperrall, 1992). After noticing a decline in numbers, the game-fishers voluntarily banned Grey Nurse Shark captures in 1979 (Australian Government, 2022b).

Nov 1984: NSW lists GNS as *vulnerable* in Fisheries & Oyster Farms Act 1935

The Grey Nurse Shark was afforded protected status in New South Wales waters in 1984.

Four main reasons why requests were made to NSW Fisheries to protect the species include (1) reduced numbers observed by recreational scuba divers (2) declining catches by spear fishers (3) reduced catches in beach meshing programs, and (4) the realisation that the shark was not a “man-eater” (Otway *et al.*, 2003). It is classed as ‘vulnerable’ and becomes the world’s first protected shark.

1991 and 1995: Preliminary studies at Seal Rocks by the Ecology Lab

At that time, the (then) NSW Department of Fisheries commissioned The Ecology Lab (now Cardno Ecology Lab) to do a preliminary study conducting underwater visual counts of grey nurse sharks (and wobbegong sharks) at four sites in the Seal Rocks area: Big Seal, Little Seal, Edith Breaker and Skeleton Rocks (The Ecology Lab 1991; Otway *et al.*, 2003).

1995: Drop line fisheries closure declared at South West Rocks

Scuba divers at Fish Rock located at South West Rocks NSW noticed continued declines in the abundance of GNS in the area and voiced their concern at a public meeting. In July 1995, NSW Fisheries declared a drop line fisheries closure over an area covering a 500-metre radius around Fish Rock. After the closure, instead of the GNS arriving in May and leaving in November, they were arriving in May and staying until February. The closure was later extended to July 2003 (Otway and Parker, 2000).

1996: IUCN lists GNS as *vulnerable* in IUCN Red List of Threatened Animals

At the international level, the International Union for Conservation of Nature (IUCN) compiles the Red List, a comprehensive guide to the global conservation status of both animal and plant species. The Red List is used as a foundation for developing policy and legislation to protect species at risk. Species can be listed as: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient and not evaluated. In 1996, GNS were listed as vulnerable in the Red List.

1997: Qld protects GNS under Fisheries Act, 1994 (Fisheries Regulation, 1995)

1997: Qld upgrades GNS to *endangered* in Qld Nature Conservation Act 1992

Under Part 5, Division 2 of the Act, a regulation may prescribe native wildlife as *endangered* wildlife if: (a) there have not been thorough searches conducted for the wildlife and the wildlife has not been seen in the wild over a period that is appropriate for the life cycle or form of the wildlife; or (b) the habitat or distribution of the wildlife has been reduced to an extent that the wildlife may be in danger of extinction; or (c) the population size of the wildlife has declined, or is likely to decline, to an extent that the wildlife may be in danger of

extinction; or (d) the survival of the wildlife in the wild is unlikely if a threatening process continues (State of Queensland, 2018; pg89).

1998: More preliminary studies at Seal Rocks & SW Rocks by Ecology Lab

The Ecology Lab surveys in 1991 were repeated and extended to include South West Rocks in 1998. The four sites at Seal Rocks were the same: Big Seal, Little Seal, Edith Breaker and Skeleton Rocks. The four sites at South West Rocks were: Fish Rock Cave, Fish Rocks Aquarium, Black Rock and Green Island. These were surveyed over consecutive days from 30 November to 4 December, 1998 to ensure similar timing with previous 1991 and 1995 surveys (Otway and Parker, 2000).

1999: NSW lists GNS as *vulnerable* in (new) Fisheries Management Act 1994

1998: NSW protects 3 GNS sites using precautionary principle

The precautionary principle was applied in 1998 to protect three historically known GNS sites in popular Jervis Bay: The Docks, Boat Harbour and Weedy Valley. They were abandoned Grey Nurse Shark aggregation sites, not included as critical habitat in NSW fisheries legislation. During planning for the Jervis Bay Marine Park, the rationale for protecting these sites was application of the precautionary principle for biodiversity conservation, which the NSW MPA was obliged to consider (Lynch *et al.*, 2004). The park was established in 1998 and its zones and management rules commenced in October 2002 (DPI, 2022).

1998-2001: Surveys reveal only 300-3000 sharks left in east coast population

Dr Nick Otway of NSW Fisheries leads a team of researchers and engages a large percentage of the dive community to conduct 10 surveys between 1998 and 2001 recording all GNS from Flat Rock in southern Queensland to Eden near the NSW/Victoria border. Dr Nick Otway estimates the population size to be 300 (worst), 1000 (likely) and 3000 (best). The highest number of individuals observed during a single survey of 62 reefs in winter 2000 is 292. The sharks are counted in month-long surveys (i.e. 1 survey is 1 month) using underwater visual counts over a 15 minute period. At each site, divers record the number, sex and size of any Grey Nurse sharks present. They also record the presence of hooks, mating scars, etc. (Otway *et al.*, 2003). The surveys are funded by the National Heritage Trust.

March 2000: IUCN upgrades GNS listing to *endangered* in Red List

April 2000: NSW upgrades GNS to *endangered* in Fisheries Mgmt. Act 1994

Species listed in Appendix I and II of CITES are translated into Australian legislation by the Commonwealth Government through the EPBC Act 1999. Under the EPBC Act, species that are listed as threatened are divided into the following categories: extinct, extinct in the wild, critically endangered, endangered, vulnerable and conservation dependent. CITES is an intergovernmental agreement designed to ensure trade of wildlife does not threaten species survival (Fisheries Qld, 2011). GNS was listed as vulnerable in August 2000.

The GNS is listed as two separate populations (west and east coast populations). The threatened Species Scientific Committee (TSSC) recommended that the list referred to in section 178 of the Environment Protection and Biodiversity Conservation Act 1999 be amended by transferring the east coast population from the vulnerable category to the critically endangered category. The TSSC judged the East Coast population to be eligible for listing as critically endangered under the EPBC Act, due to the small population size and decline in numbers and distribution (e.g. no longer found at Brush Island and Jervis Bay where aggregations of 40 plus were observed in the 1950s and 1960s). Robert Hill was the Minister for the Environment and Heritage at the time.

The area around Pimpernel Rock (a 500 m radius from the rock or 78.54Ha) is declared a sanctuary zone by the Commonwealth government and all forms of fishing (i.e. spearfishing, recreational, charterboat and commercial fishing) are banned. It is the first area designated ‘critical habitat’ for the GNS (Lynch *et al.*, 2013). It is also the first GNS aggregation site in *Commonwealth waters* that is protected. Pimpernel Rock is located near Brooms Head NSW.



2001: Voluntary Code of Conduct for scuba diving with GNS is developed

A total of 181 surveys were mailed out to the diving community (Table 1) with 86 returned complete. Respondents were given the opportunity to provide additional comments, summarized in Table 2, and were able to see all statewide responses before the “voluntary code of conduct for scuba diving with Grey Nurse Sharks” was developed (Table 3) using an 80% level of acceptance (Otway *et al.*, 2003).

Table 1: The statewide responses by the scuba diving community

Question	Agree		Disagree		No comment	
	No.	%	No.	%	No.	%
1. Each location to have at least one Grey Nurse Shark sanctuary area	71	83	12	14	3	3
2. Observe shark from tops of ridges	47	55	36	42	3	3
3. Keep out of gutters	39	45	43	50	4	5
4. Do not block entrances to cave or gutter	84	98	2	2	0	0
5. Do not interrupt the swimming pattern of the sharks	85	99	1	1	0	0
6. Do not feed or touch sharks	79	92	6	7	1	1
7. Do not chase or harass sharks - no mechanical apparatus i.e. scooters, horns	85	99	1	1	0	0
8. Divers must stay together as a group	58	67	25	29	3	4
9. Group must be no more than ten divers	72	84	10	12	4	4
10. Recognised Grey Nurse Shark dives must be led by a qualified dive guide	57	66	28	33	1	1
11. All dive guides to attend a workshop on Grey Nurse Sharks	56	65	25	29	5	6
12. All dive guides to have logged at least 20 dives with Grey Nurse Sharks	47	55	33	38	6	7
13. A dive brief to be given by the dive leader before each dive	81	94	3	4	2	2
14. All commercial operators to be signatories to the Code of Conduct	82	95	1	1	3	4
15. Code of Conduct to be displayed in the boat or shop	78	91	4	5	4	4
16. All divers to comply with the Code of Conduct (clubs, private dive groups)	84	98	1	1	1	1
17. Dive operators to participate in scientific research	77	90	8	9	1	1

Table 2: Suggestions for the voluntary code of conduct provided by the Scuba Divers Association of NSW

Additional Comments

- the possibility of limiting some diving & boating activities at Grey Nurse Shark sites,
- the development of an education program,
- the promotion of passive observations,
- an “exclusion” zone at some sites,
- limit or ban flash photography and bright lights,
- limit anchoring,
- banning extractive activities,
- diver experience,
- limit approach to sharks according to a distance in meters,
- guided shark dives,
- promotion of the Code of Conduct,
- public moorings to be provided on shark sites,
- a “Shark Tax” for commercial divers towards management,
- access be limited to charter boats in areas where it is felt more control is required,
- all shark dives to be conducted by registered (permitted) operators or clubs,

Table 3: Code of Conduct

Code of conduct

1. Do not block entrances to caves or gutters
2. Do not interrupt the swimming pattern of the sharks
3. Do not feed or touch the sharks
4. Do not chase or harass the sharks (i.e. no mechanical apparatus such as scooters, horns and anti-shark devices are to be used)
5. Dive groups must not have more than 10 divers
6. A dive brief is to be given by the dive leader before each dive
7. All commercial operators are to be signatories to the Code of Conduct
8. Code of Conduct is to be displayed in the shop and on the dive boat
9. Dive operators are to participate in scientific research

2001: Numerous sites mapped and key habitat preferences of GNS identified

Numerous sites in the Tweed-Morton Shelf, Manning Shelf and Hawkesbury Shelf bioregions were mapped. In doing so, it became apparent that caves, sandy-bottomed and boulder-filled gutters and large overhangs were crucial habitats utilised by Grey Nurse Sharks (Otway *et al.*, 2004).

2002: First Recovery Plan for the Grey Nurse Shark in Australia

The overall recovery plan objective was to increase Grey Nurse Shark numbers in Australian waters to a level that will see the species is removed from the schedules of the EPBC Act (EA, 2002).

December 2002: NSW declares 10 aggregation sites as Critical Habitat

Critical habitat is defined within both Australian state and federal Threatened Species Conservation Acts as areas that are crucial to the survival of particular threatened species, populations, and/or ecological communities (Lynch *et al.*, 2013). Critical habitat for GNS was hence considered to be known aggregation sites. In December 2002, under Section 220Q of the Fisheries Management Act 1994 (and Amendments) NSW Fisheries declared 10 Critical Habitats at: Julian Rocks (Byron Bay), Fish Rock and Green Island (South West Rocks), The Pinnacle (Forster), Big and Little Seal Rocks (Seal Rocks), Little Broughton Island (Port Stephens), Magic Point (Sydney), Bass Point (Shellharbour), the Tollgate Islands (Batemans Bay), and Montague Island (Narooma) (Lynch *et al.*, 2013). The critical habitat size in NSW is a core 200-m area (no fishing with bait and/or wire trace line, no night diving) surrounded by a 800-1000m buffer zone (no commercial drop, drift and set line fishing) (NSW Fisheries, 2003). Fines vary from \$500 for less serious breaches to \$11000 for breaking fishing and diving rules in critical habitat sites. If a grey nurse shark is harmed, fines of up to \$220,000 apply (NSW Fisheries, 2003).

2003: Habitat Maps created for all known GNS aggregation sites in Qld.

In 2002 members of UniDive applied successfully for World Wide Fund for Nature, Threatened Species Network funds to map the critical Grey Nurse Shark Habitats in south east Queensland. UniDive members used the funding to survey key aggregation sites, from the boats of local dive operators at Wolf Rock at Double Island Point, Gotham, Cherub's Cave, Henderson's Rock and China Wall at North Moreton and Flat Rock at Point Look Out during 2002 and 2003. UniDive members were trained in mapping and survey techniques by experts from the University of Queensland including Chris Roelfsema (Centre of Marine Studies, Biophysical Remote Sensing) and the Queensland Parks and Wildlife Service who are also UniDive members. Habitats were mapped using a combination of towed GPS photo transects, aerial photography, bathymetry surveys and expert knowledge (Roelfsema *et al.*, 2016).

October 2003: Tagging processes reviewed and recommendations made

The Department of the Environment and Heritage and other stakeholders expressed concern about the unexpected impacts that fin tags seem to be having on the welfare of the tagged individuals, resulting in the commissioning of an independent review.

Recommendations from that review include: stop using cattle-ear rototags for tagging GNS; avoid the capture, restraint and removal of GNS to the surface for tagging; utilise non-capture and/or restraint; underwater pole-tagging or similar tag application techniques; tags must be designed to minimise biofouling, and abrasive contact with the skin, and should ideally have a planned limited life; avoid double tagging where possible; and tag a minimum scientifically feasible number of animals (DEH, 2003).

2003: <50 GNS in 6-8 years (worst) 45-54 years (likely) or 173-200 years (best)

Otway *et al.*, (2004) models the time to quasi-extinction (years elapsed for the population to consist of <50 females) for the east coast GNS population. Otway *et al.*, (2004) states, '*if under-reporting of dead sharks is occurring, time to quasi-extinction for worst-, likely and best-case scenarios ranges from 6 to 8 years, 45–53 years and 173–200 years, respectively*'. The life history (long-lived to 25+ years), late maturation (6–8 years), low fecundity (2 live young biennially), specific habitat requirements, limited inshore distribution, and small population size render them particularly vulnerable to extinction (Otway *et al.*, 2004).

December 2003: QLD declares 4 aggregation sites as Critical Habitat

In December 2003, the Queensland government (EPA) declared Critical Habitats at Wolf Rock (Rainbow Beach), Cherubs Cave (Moreton Island), Henderson Rock (Moreton Island) and Flat Rock (Stradbroke Island). Subsequently Department of Primary Industry (DPI) - Fisheries closed the sites to all extractive activities that include line fishing, crabbing, blue water hunting and marine aquarium collecting. Queensland sites offer protection within a 1.2km radius of the sharks aggregation point. One mooring was installed at Wolf Rock and four moorings were installed at Flat Rock. No moorings were installed at Cherubs Cave or Henderson Rock. All four sites relatively difficult to access due to location.

June 2006: DNA tests confirm East and West GNS populations are separate

Analyses of 235 AFLP loci and 700 DNA base pairs provide the first account of genetic variation and geographical partitioning (east and west coasts of Australia, South Africa) in GNS (Stow *et al.*, 2006).

May 2007: Australia lists Cod Grounds as a Commonwealth Marine Reserve

The Cod Grounds is a renowned Grey Nurse Shark site located approximately four nautical miles off the coast in Commonwealth waters near Laurieton on the NSW mid north coast. During a NSW Fisheries GNS survey, a minimum of 74 Grey Nurse Sharks were found at the site in September 2000 (Otway and Parker, 2000). Grey Nurse Sharks at the site were under

pressure from both commercial and recreational fishers. There were reports in May 2001 by recreational scuba divers of recreational fishers catching and taking Grey Nurse Sharks from this site (Otway and Parker, 2000). The Commonwealth site became protected in May 2007. Both Commonwealth protected GNS sites now offer a 0.5–1.0-km radius of protection from the shark's aggregation point (Lynch *et al.*, 2013). There have been no other sites in State or Commonwealth waters protected since that time.

January 2008: Qld upgrades GNS listing to *critically* endangered

January 2009: Review of the 2002 Grey Nurse Shark Recovery Plan

This review found that progress had been made on most of the 40 actions listed in the recovery plan. Of the 40 actions, 12 had been completed, 25 had been partially completed and were considered to be ongoing, and three had little or no action recorded against them (DEWHA, 2009; cited in Australian Government, 2014a). Since 2002, all but one of the 19 key aggregation sites listed as 'habitat critical to the survival of the species' in the recovery plan had been given some level of protection. The review found it was not possible to determine if the east coast population had shown any sign of recovery since the implementation of the plan and identified an ongoing need to maintain a recovery plan for the species. The review also found no reason to alter the status of the east coast population from critically endangered, or the west coast population from vulnerable, under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) (Australian Government, 2014a).

2009: A total of 26 sites offer protection for GNS along east Australian coast

An additional 7 sites not mentioned in the GNS Recovery Plan were also protected between 2001 and 2009. Making a total of 26 sites (NSW=16; Qld=8; Commonwealth=2) spread across 6 Marine Protected Areas (MPAs) along the east Australian seaboard, at least in part, to manage human interactions with a GNS. The 6 MPAs are: (1) marine reserves managed by the Commonwealth (2) critical habitat and (3) aquatic reserves managed by the NSW DPI, (4) critical habitat managed by Qld Fisheries, (5) marine parks managed by the NSW Marine Parks Authority (NSW MPA) and (6) marine parks managed by the Qld Department of Environment and Resource Management (DERM). Five sites remain open to some form of fishing. While all 16 critical habitat sites were established primarily for GNS conservation, other sites and overlaying zones were often created for additional reasons such as biodiversity conservation (Lynch *et al.*, 2013).

January 2009: GNS at Wolf Rock SEQld: mating, pregnancies and resting years

Bansemer and Bennet (2009) collected data from Wolf Rock SEQld over 5 years from December 2002 to January 2008 using photo-identification or PID (n=181 sharks; 162 female), underwater surveys (n=525), *active* acoustic tracking (n=2 tagged sharks

transmitting data to boat that followed them for 7 and 17 hrs respectively) and *passive* acoustic tracking (n=4 tagged sharks transmitting to 4 deployed receivers collecting data for 8-15days). Wolf Rock Dive Centre conducted 17 out of 32 PIDs and 488 out of 525 underwater surveys (measuring abundance, gender, mating scars and pregnancy). Every year between 2002 and 2008 the number of grey nurse sharks at Wolf Rock increased overall (site protected in December 2003). Interestingly, females were present all year round, but numbers dropped by almost half before the males (and more females) arrived to mate in Spring. Fresh mating scars were observed from October to December, healing within 2-3 months. All the males had left by January. Most of the females stayed with more arriving over summer. Not all sharks with mating scars became pregnant and not all visibly pregnant females had mating scars. **All pregnant females had left Wolf Rock by October, presumably headed south to give birth.** The location of pupping sites for the east coast population were (and still are) unknown or unpublished. The presumption that GNS head south to give birth by Bansemer and Bennet (2009) was based on three key observations. Firstly, the idea that pregnant females undergo a southerly migration to give birth stems from a pregnant shark in Africa that swam 1897km from her northern gestation area to her southern pupping site, and a second swam 383km (Dicken et al., 2006a; cited in Bansemer and Bennet, 2009). Secondly, pregnant sharks initially at Wolf Rock were identified, still visibly pregnant, at sites south of Wolf Rock in July, believed to be en-route to pupping grounds (author's unpubl. data). Lastly, the closest site to Wolf Rock with young of the year (YOY) or juvenile sharks was about 500 km south of Wolf Rock (authors' unpubl. data)". After giving birth, post-partum females were not immediately returning to Wolf Rock. Bansemer and Bennet (2009) thought they might be having a 'resting year' in cooler waters, based on unpublished data of females that were not pregnant and without mating scars, but previously identified as pregnant at Wolf Rock, at (undisclosed) locations south of Wolf Rock.

August 2009: Migratory patterns of GNS confirmed in tagging studies

Between October 2003 and July 2008, 15 sharks (7 mature males, 1 immature male, 1 mature female and 6 immature females) were tagged with pop-up archival satellite transmitters. 14 sharks were tagged at Fish Rock off South West Rocks in NSW and 1 shark was tagged at Julian Rocks off Byron Bay. Listening stations that had been deployed at regular intervals between Eden and Tweed Heads identified each shark by its tag when it passed by. The tag automatically released from the shark and surfaced 38 to 180 days later (although 2 did fail to release). Sharks that were tagged in summer were recorded migrating south (except for the 1 tagged immature male that stayed at Flat Rock). Sharks that were tagged in winter were recorded migrating north. One mature male tagged in May made it all the way up to Guthrie Channel on the Great Barrier Reef, approximately 1000km north of Flat Rock in less than 3 months. All sharks stayed in shallow waters for most of their trips, negating the argument that more sharks remain unaccounted for in deeper waters. It was only a deep section between Fraser Island and Capricorn Channel that the tagged sharks

(that made it that far) spent time in deeper water (~60-100m). The GNS would stop-over at critical habitat sites along the way, staying close (within 50-100m) to the aggregation site. Average length of stay was 11 days (ranging from 1 day to 6 months) depending on water temperature, the sexual maturity of the shark and whether it was pregnant or not. Funding was provided by NSW DPI, Sea World, DEWHA, NRCMA and SRCMA (Otway *et al.*, 2009).

2009: Surveys by Bansemer (2009) estimates population size to be 1941 GNS

A total of 930 sharks were photo-identified between 2004 and 2008 at 23 aggregation sites between Wolf Rock (Rainbow Beach SEQld) and Montague Island (Southern NSW). Pregnant GNS were at Wolf Rock from February to October, although many left July. Pregnant GNS were also observed at North Moreton Island, Flat Rock and Fish Rock between June and November. The majority of immature sharks were recorded at mid-southern sites. Bansemer (2009) estimated the population size to be between 1491 and 2391 GNS with 756 males (95% CI = 590 – 922) and 1185 females (95% CI = 901 – 1469) cited in Bradford *et al.* (2018) as 1941 GNS.

2009: IUCN maintains GNS listing as vulnerable

Globally, it is suspected that the GNS has undergone a population reduction of >80% over the past three generations lengths (74 years) due to levels of exploitation, and it is assessed as Critically Endangered A2bd (IUCN, 2021).

2010: Surveys by Cardno Ecology Lab estimate population size at 2142 GNS

The Department of the Environment, Water, Heritage and the Arts (DEWHA) commissioned Cardno Ecology Lab to estimate the size of the east coast population of GNS. In 2010 they used photo-mark-recapture methods estimating the population size to be between 1146 and 1662 (Cardno Ecology Lab, 2010) or 2142 after accounting for potential site fidelity (Bradford *et al.*, 2018).

2011: Pop up satellite tags document movements of 15 GNS

From October 2003 to July 2008, 15 GNS individuals were tagged with Pop-up archival satellite tags (PATs) with varying deployments (60–150 days) and acoustic tags linked to an acoustic monitoring system providing accurate geolocation (Figure 1). Distances moved by individuals ranged from 5 to 1550 km and varied according to sex and season. Migrations north and south were punctuated *en route* by occupation of sites for varying periods of time. The deepest depth recorded was 232 m off South West Rocks on the New South Wales mid-north coast. On average, GNS spent at least 71% of their time in waters <40 m and 95% of their time in waters 17–24°C (Otway and Ellis, 2011).

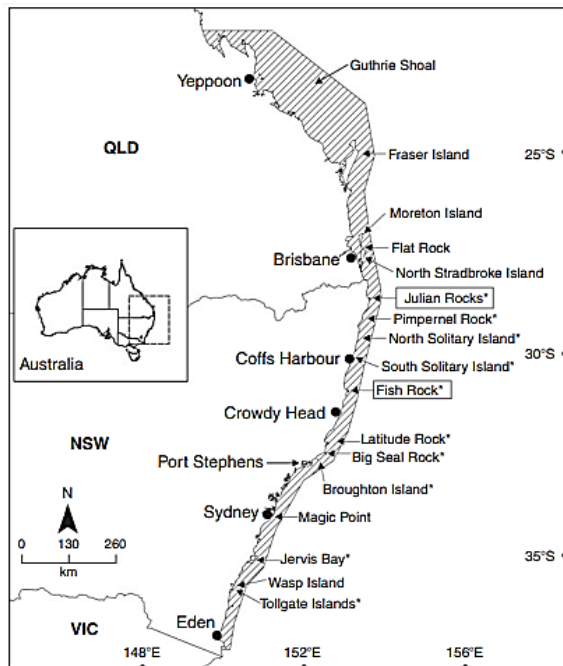


Fig. 1. Map of the SE coast of Australia showing the current range of *Carcharias taurus*, location of tagging sites (in boxes) and sites occupied during migratory movements of sharks tagged with pop-up archival satellite tags. Asterisks denote sites with SEACAMS acoustic listening stations.

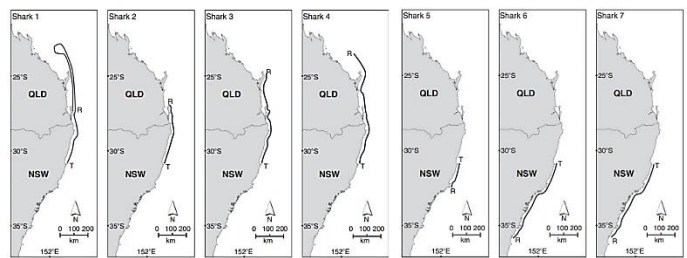


Figure 2: MALES tagged with PATs at Fish Rock during autumn-winter (sharks 1-4) and spring-summer (sharks 5-7) over 2003-2008.

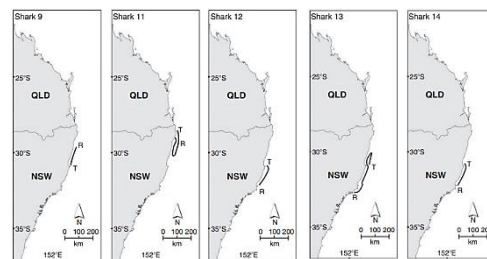


Figure 3: FEMALES tagged with PATs at Fish Rock and Julian Rocks (Byron Bay) during autumn-winter (Sharks 9-10) and spring-summer (Sharks 12 and 14).

2001-2011: Unpublished, detailed GNS data from Wolf Rock Dive Centre

Figure 7 – Aggregation of pregnant female grey nurse sharks at Wolf Rock on 2 June 2007 (at least 40 pregnant females were observed on this day by the core researcher).



Examples of observations recorded:

Jan 12th 2007: Saw the girl with scoliosis, hook in the tail and another with 20cm of line coming from right gills. Observed at least 4 sharks coming to surface for air while at surface interval.

March 18th 2007: 1 girl has a hook in the right side of her mouth and she also has a growth/lice attached to the bottom of her tail fin. The girl that lost her tag is still there but the trace has become infected. Another one that was tagged months and months ago is there and there is now a bit of growth on the remnants of it (in the dorsal fin).

May 19th 2007: Scoliosis, girl with line protruding from 'Kloakkar' and blind girl with hook in her mouth were all there.

Oct 25th 2009: Scoliosis appears to have returned. The boy with the gang hooks in his mouth was seen....

2014: Grey Nurse Shark Recovery Plan replaces 2002 version

Replacing the 2002 Recovery Plan and to be read in conjunction with the Issues Paper for the Grey Nurse Shark (Australian Government, 2014b), the plan aims to assist the recovery of the grey nurse shark to eventually remove it from threatened species list in the EPBC Act and ensure anthropogenic activities do not hinder its recovery (Australian Government, 2014a). Threats to GNS identified in the plan include: mortality related to incidental

(accidental and/or illegal) capture by commercial and recreational fisheries, mortality related to shark control activities such as beach meshing or drumlining, impacts from ecotourism, collection for public aquaria, pollution and disease and ecosystem effects as a result of habitat modification and climate change—including changes in sea temperature and ocean acidification. Objectives of the plan include: quantitative monitoring of population status (abundance and distribution), quantify and reduce accidental and/or illegal catch by commercial and recreational fishers, where practicable minimize impact of shark control activities on GNS, investigate and manage impact of ecotourism on GNS (including a code of conduct fully implemented and adopted by industry, and an assessment undertaken of the use and effectiveness of the code of conduct by dive operators), manage impact of aquarium collection on GNS, improve understanding of the threat of pollution and disease to GNS, continue to identify and protect habitat critical to its survival and reduce the impact of threatening processes within these areas (important habitats such as pupping, nursery, foraging and migration areas for GNS are identified and mapped, and criteria are developed and applied to characterise such habitats as habitats critical to the survival of the species; PLUS scientific information on GNS behaviour and distribution is improved to allow new biologically important areas to be defined, particularly habitat critical to the survival of the grey nurse shark), continue to develop and implement research programs to support its conservation, and lastly, promote community education and awareness in relation to GNS conservation and management. The Minister must review the operation of a management plan not later than 10 years after its approval (State of Qld, 2021). The purpose of a review is to summarise the actions undertaken against those specified in the recovery plan, and to assess whether: (1) there is an ongoing need for a recovery plan under the EPBC Act and, (2) whether the recovery plan needs to be varied to ensure further protection for the species (Australian Government, 2014a). Stakeholders involved in the review of its performance, include organisations likely to be affected by the actions proposed in the plan such as government departments (Federal, State and Local), industry and non-government organisations.

2017: Surveys using genetic fingerprinting estimate pop. size to be 2167-3078

Bradford *et al.*, (2018) used a Close-Kin Mark Recapture (CKMR) model to estimate population size whereby genetic fingerprinting is used rather than physical marks or tags. This survey took 513 tissue samples and used DNA sequencing to identify related individuals (more relatives = smaller population). The model reports a growing population of approximately 3.4 to 4.5% per annum (95% confidence interval 1.2% – 5.7%). However, despite this, Bradford *et al.* (2018) clearly states the model has many shortcomings (e.g. it uses age growth curves from age-at-length data from USA populations which may not reflect the growth of eastern Australian GNS) and that “*further work on the level of risk facing the recovering population would be required before it would be appropriate to alter the range of existing protective measures*” (Bradford *et al.*, 2018).

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