CYCLONE PLAN

GREAT BARRIER REEF PASSAGE

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A SPECIAL THANKS TO

BRUCE REIDY
CHRIS MRAKAS

IDEAS, SUGGESTIONS?

IF YOU HAVE SOMETHING THAT YOU WOULD LIKE TO CONTRIBUTE OR ASSIST IN THE PRODUCTION OF THIS IMPORTANT DOCUMENT, PLEASE CONTACT US ON

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CYCLONE PLAN

FOR YACHT RELOCATION PASSAGES

CAPE YORK TO CAIRNS AUSTRALIAN EDITION
SAILOR.COM.AU

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PREFACE

SAILOR.COM.AU IS AN AMAZINGLY AWESOME OFFSHORE YACHT RELOCATION BUSINESS BASED OUT OF AUSTRALIA. WE'RE DIFFERENT, WE'RE EASY, AND WE'RE AFFORDABLE. USE US, YOU WON'T BE SORRY, YOU'LL BE PLEASED.

We are also a champion for the adoption of comprehensive, science-based guidelines and contemporary approaches in the area of risk management for recreational yachts (that are cruising, racing or being relocated).

These guidelines are an evolving document, which will be updated periodically as new facts emerge revealing better ways to deal with the cyclones at sea.

This plan is primarily aimed at recreational yachts less than 16m in length. However, the principles outlined may be equally applicable to larger yachts or those who cruise offshore for lengthy distances.

A WELL-PREPARED VESSEL WITH FULLY FUNCTIONAL EQUIPMENT IS A KEY ELEMENT TO A SUCCESSFUL SAFETY PLAN. DURING A TROPICAL CYCLONE YOU ARE ON YOUR OWN.

WHY WE MADE THIS PLAN

> *"The well-prepared vessel is much more likely to come through a gruelling storm with only minor problems. Yet storms can be a tremendous test of endurance and, despite very careful preparation, much depends upon the cool judgment, courage, physical fitness and tenacity of the skipper and crew"*
>
> *Heavy Weather Sailing by K Adlard Coles, 1968.*

FEAR, UNCERTAINTY AND DOUBT. It is human nature to be wary of the things we do not understand or are unfamiliar with. The mention of tropical cyclones strikes fear in many people because of a lack of understanding of cyclones and how to deal with a cyclone at sea. Facing a cyclone is a rare event for many sailors. The best protection against the destructive forces of cyclones is to understand them, be prepared for them, to act early and decisively – and of course to know what to do.

The aim of this plan is to: -

A. Familiarise sailors with cyclones,
B. Reduce the risk of being blind-sided by encountering a cyclone at sea,
C. Improve the prospect to take available shelter or protection within a harbour or to take appropriate evasive or protective action; and
D. Improve the protection and survivability for the yacht and all crew.

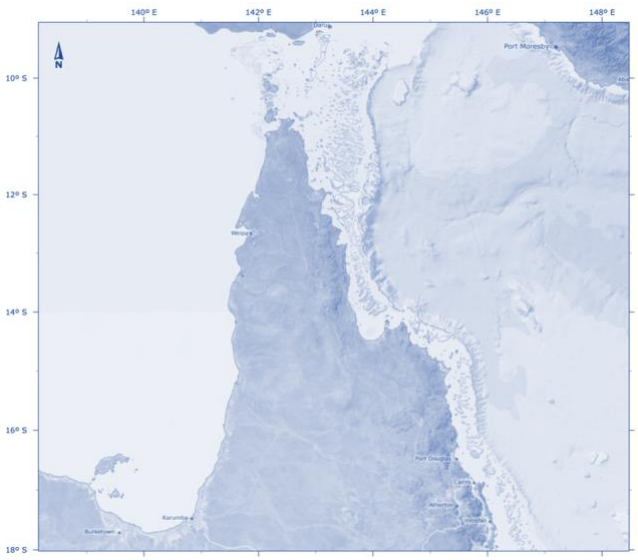
This cyclone plan assumes that your vessel is in a seaworthy state. Always maintain your vessel to ensure that postponed maintenance does not compromise the seaworthiness of your vessel at critical times – like when a gale strikes.

WHEN A CYCLONE EMERGES WOULD BE A BAD TIME TO REALISE THAT YOU SHOULD HAVE ATTENDED TO SOME IMPORTANT MAINTENANCE ITEM OR TO READ THIS PLAN FOR THE FIRST TIME.

CAPE YORK TO CAIRNS AREA

This area is prone to frequent tropical cyclone activity.

	January - February	March – April, or November - December	May - October
Cyclones	Likely	Possible	Unlikely
Weather Monitoring	Monitor 4 times daily	Monitor twice daily	Monitor once daily
Shore base Team / SKED24x7	3 times daily contact	twice daily contact	twice daily contact



Useful context for this area for navigation planning: -

1. Average number of TC per season 2.9 of which 34.5% are landfalling of these 56.4% are severe
2. TC lifetime is an average of 7.3 days
3. Mean latitude of genesis 13.6 deg; Mean Longitude of genesis 156; Mean latitude of dissipation 19.3
4. The mean speed is approximately 8.5kts maxim travel speed can go up to 42 kts.
5. During January–March there is a greater proportion of eastward moving TCs
6. The highest tropical storm frequency occurs in the land-Locked Gulf of Carpentaria, the Coral Sea and off the northwest Australian coast.
7. The relative proportions of hurricane to tropical storm occurrence are 20/80 in the Gulf of Carpentaria and 50/50 in the southwest Pacific.
8. The most intense hurricanes came from the recurving motion category. They typically originated near 10 S in the Coral Sea region
9. Tropical cyclones in the southwest Pacific region also move very differently to the classical pattern in other ocean basins. That is, the largest proportion tend to move eastward, or erratically; and, indeed, tropical storms move almost exclusively eastward.
10. The size of a tropical cyclone eye is not well correlated to intensity but the change in the size of the eye can give useful information about the intensity of the tropical cyclone

UNLESS BETTER INFORMATION IS AT HAND USE THE ABOVE ASSUMPTIONS FOR PLANNING PURPOSES

TROPICAL CYCLONES

Cyclones are powerful weather systems that can cause significant damage. They develop from low pressure systems that develop over warm oceans in the tropics, and generally intensify over several days, generating severe winds with heavy rain. Cyclones produce very strong and potentially destructive winds that rotate clockwise around the 'eye'. In the Australian region, the gale force winds must extend more than half-way around the centre and persist for at least six hours for the BOM to declare it a cyclone.

A storm surge is a rise along a shore resulting from strong onshore winds and / or reduced atmospheric pressure. Storm surges happen as a tropical cyclone as it comes ashore. The combination of storm surge and tide is known as a storm tide. When a storm surge arrives on top of a high tide, the storm tide can reach areas that might otherwise have been safe. This happened in Australia in 1899 when many people were blindsided by a cyclone.

> The deadliest recorded cyclone to hit Australia was tropical cyclone Mahina. Its pressure was recorded by barometer 914hPa (some say 880hPa) as the eye approached the coast at Bathurst bay at approximately 4.30 am on the 22nd March 1899. Over 300 persons lost their lives when a fleet of 55 pearling luggers and schooners were wrecked and sunk by the phenomenal seas. One of the most interesting aspects of this event was the eyewitness report of a 43-foot (13m) surge at Ninian bay adjacent to barrow point 30 km south of Bathurst bay which extended inland for 2–3 miles (3–5 km). Constable Kenny, camped on a ridge fully 40-foot above sea level, was inundated to his waist by a 'tidal wave' (storm surge and associated ephemeral sea level rise) at his camp site some 0.5 miles (800m) inland at approximately 5 am. This account suggests this surge was the largest ever recorded in Australia.
>
> *SOURCE: HOW HIGH WAS THE STORM SURGE FROM TROPICAL CYCLONE MAHINA? NORTH QUEENSLAND, 1899 BY JONATHAN NOTT, JAMES COOK UNIVERSITY, CAIRNS, & MATTHEW HAYNE, AUSTRALIA GEOLOGICAL SURVEY ORGANISATION, CANBERRA*

Cyclones may last for up to two to three weeks and the characteristic path of a cyclone is generally to curve eastward in a parabolic shape and travel at a speed of about 10 knots.

The Australian cyclone season officially runs from 1 November to 30 April, although very few have occurred in November with cyclones generally occurring from mid-December to April peaking in February.

UNDERSTANING CYCLONES

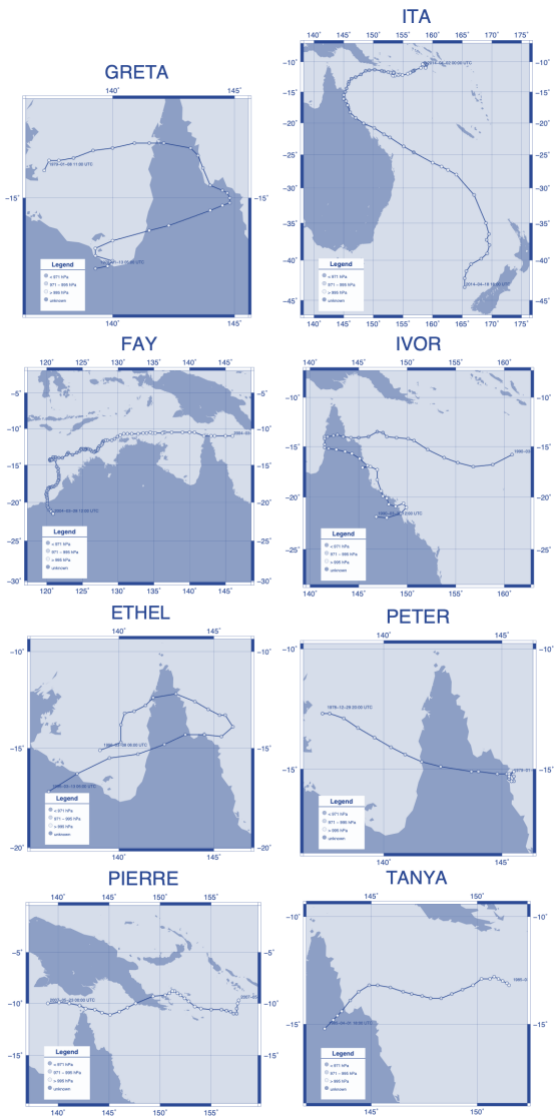
Cyclones usually originate between 5° and 15° from the equator and travel westward. They can't form in within 5° latitude of the equator due to the earth's deflecting force at those latitudes is too little to establish cyclonic circulation.

Cyclones usually follow an approximate parabolic path. In the Southern Hemisphere, they initially move towards the west, then to the south and can re-curve away out to the east.

AREAS TO WATCH FOR CYCLONES

Below are some good examples of cyclone tracks in the area covered by this plan. What is evident is that a cyclone can originate from the Gulf or the Coral Sea. It can make landfall and come back to sea like Ivor, Ethel, Peter and Greta. With Ethel the track went out to the Coral Sea heading east and the cyclone turned back into Cape Melville. Pierre came from Solomons Islands. Peter did a long trek overland to come out to the Coral Sea. Tanya went west.

KEEP WATCH IN THE GULF, CORAL SEA AS FAR AS SOLOMON ISLANDS



Source: BOM Southern Hemisphere Tropical Cyclone Data Portal
Link http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/history/tracks/

Other historical tracks available on IBTrACS - International Best Track Archive for Climate Stewardship.
http://ibtracs.unca.edu/

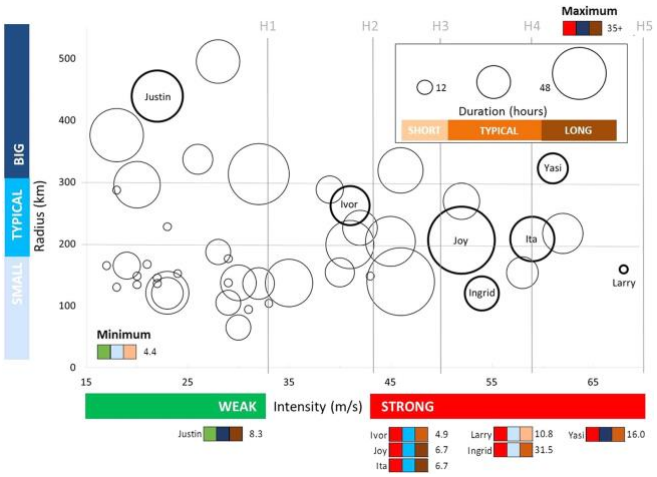
NOAA historical hurricane tracks
https://coast.noaa.gov/hurricanes/#map=4/32/-80

CYCLONE INTENSITY RANKINGS

RELATIVE INTENSITY, CIRCULATION SIZE, AND DURATION OF TCS NEAR THE GBR, 1985–2015

It is wind-generated waves not the winds themselves that cause the damage. The overall sea state created by wind on water over time depends both on the duration of winds of various speeds and on fetch - how much open water exists given the direction of incoming wind. A study analysed this for the Great Barrier Reef.

TCs can be classified using intensity, size and duration: weak, big, long-lived – every 8.3 years; strong, big – every 16 years; strong and long-lived – every 6.7 years.



Grey lines show TC intensity rankings on the Saffir-Simpson scale. Intensity is shown on the x-axis as maximum wind speed (m s−1), and size on the y axis by the mean radius to gale force winds from the TC eye (km). The size of each circle shows the duration of gale force or higher winds (hours) within the GBR. (1 ms-1 = 1.94384 knots; 1 km = 0.539957nm)

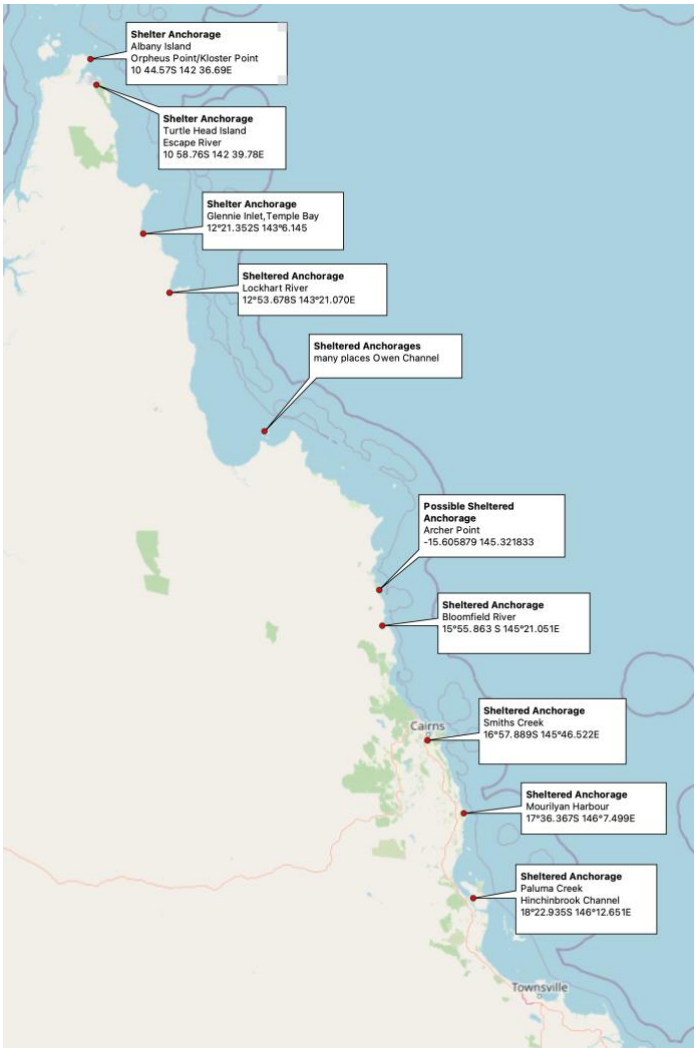
From: A robust operational model for predicting where tropical cyclone waves damage coral reefs

PLACES TO SHELTER

These anchorages should be checked by the Master for a passage for their suitability for the specific vessel, some vessels with deep drafts may not be able to access these locations. Also, Masters need to factor tides into the sortie location. You do not want to reach a location only to find that you can't make it in due to depth.

LATITUDE	PLACE
10 44S	Albany Island – Orpheus Point/Kloster Point 10 44.57S 142 36.69E Sheltered bay – Access good
10 58S	Turtle Head Island – Escape River 10 58.76S 142 39.78E Sheltered river – Watch for fish pens – shallows – No Mangrove
12 21S	Glennie Inlet, Temple Bay 12°21.352S 143°6.145 Excellent Mangrove Shelter - shallow
12 53S	Lockhart River 12°53.678S 143°21.070E Excellent Mangrove Shelter - shallow
14 10S	Flinders Group – Owen Channel 14 10.00S 144 14.27E Many options to shelter – if short of time
	Warning – this general location did have 14m storm surge in 1899.
15 36S	Archer Point 15°36'21.2S 145°19'18.6E (Limited Shelter E-SW unsheltered)
15 55S	Bloomfield River 15°55.863 S 145°21.051E Good Mangrove Shelter - shallow
16 57S	Smiths Creek 16°57.889S 145°46.522E Excellent Mangrove Shelter – shallow – could be crowded from vessels in Cairns
17 36S	Mourilyan Harbour 17°36.367S 146°7.499E Good Mangrove Shelter - shallow
18 22S	Paluma Creek, Hinchinbrook Channel 18°22.935S 146°12.651E Excellent Mangrove Shelter – shallow – many other options

MAP OF SHELTERED ANCHORAGES



Warning: Cape Melville area should be avoided (as shelter) if it is safe and time permits to go somewhere else. This area has the infamous record for the deadliest Australian cyclone as well as the record for largest storm surge. The area due its proximity to the continental shelf, topology and bathymetry amplify the force of waves in the area. There are mangroves in Owen Passage where a vessel can be lashed. With some forewarning this should be possible.

When planning sorties within the inner reef of the Great Barrier Reef (GBR) caution should be taken as this area is difficult to navigate at night. Good progress for a typical cruising yacht

travelling at an average speed of 6 knots would be 60nm per day or 110nm in a 24-hour period.

Travelling at night is not advised unless doing so with exceptional crew and navigation capabilities. Key to travelling at night in the inner reef is good preparation, excellent navigation tools, understanding where the hazards are and the capability of the crew. With the right setup it can be done safely.

The good news is that most sheltered anchorages are within 60nm (about 1-day passage in daylight) except for an area around Cape Melville where distance between Lockhart River Anchorage and Bloomfield River Anchorage is approximately 270nm. This area is the riskiest part of the inner reef in terms of being exposed to cyclones, it's also the area that you don't want to be in if a cyclone strikes. This high-risk area needs careful planning and weather monitoring before crossing from north to south or visa-versa,

In this 270nm high-risk area, if we put aside 60nm from each end - you will be exposed for approximately 150nm (270 – 120) to being out of range of sheltered anchorages, this means that you need at least 3 days warning of a cyclone to safely make your way to a shelter anchorage.

Should you be forced to seek shelter near Cape Melville there are several possible safe anchorages in Owen Passage in the Flinders Island group – this should only be used if you have no other safe option. Also, should you be near Cape Flattery or Lizard Island you should consider Archer Point Anchorage if Bloomfield River Anchorage is too far away. Archer Point bay offers some protection, but you will be exposed to the sea, but it will provide some shelter.

Avoid Lizard island as a place of shelter. Lizard Island does have its own purpose-built cyclone shelter at the research facility, this may be an option if you are out of time. Note they need to let you into the shelter.

OUTER OR INNER REEF

The choice of route is always up to the skipper. You should know the capability of your crew and vessel. The area covered by this plan is about 500nm with the outer reef being approximately 120nm at one end reducing in distance to less than 30nm at the other places.

The inner reef route is complex, not a straight line, but there are places to shelter nearby for cyclones. The outer reef has no place to shelter except for sea room to run-off or avoid the cyclone.

Heading for sheltered anchorages from the outer reef depends on many factors. Considerations would be the swells, waves and currents in the channels as well as the need to navigate reefs to get safely to an anchorage. There are many wrecks around these entrances from the sea into the Great Barrier Reef.

If taking the outer reef, you should consider increasing your provisions and fuel to cater for the possibility that you may need to run-off away from your destination. It may be in a direction that increases your passage distance by a week, or maybe longer.

The outer reef is faster with the right conditions versus the inner reef with right conditions. This means less time in the area to be exposed by cyclones but with the added risk of being in high seas.

PASSAGES BETWEEN SEA AND INNER REEF

The Great Barrier Reef is the world's largest coral reef system composed of more than 2,900 individual reefs and 900 islands stretching for more than 2,600 kilometres over an area of approximately 344,400 square kilometres. There are numerous channels to move between the inner to outer reef. Many of which have no soundings.

'The Barrier', the "Labyrinth" or The Great Barrier Reef name derives from the network of barely visible reefs, featureless coral islands and challenging currents that made passage from the Coral Sea through to the inner coastal lagoon a treacherous and regular fatal venture.

SHIPPING ROUTES

The main passages that shipping use in the GBR are: -

- Great North East Channel - Eastbound shallow draught - Goods Is PBG to Dalrymple Is PBG—via north of Alert Patches and west of Coconut Is.
- Hydrographers Passage - a deep-water shipping channel discovered by commander James Bond, commander of the RAN survey ship HMAS Flinders in 1981. The passage is between Blossom Bank and Tern Island, near Mackay.
- The inner route is also used.

SAILING PASSAGES

Other passages suitable for yachts are: -

- Bramble Cay Passage - located at the north-eastern edge of the Great Barrier Reef is the northernmost point of land of Australia. It is southeast of the mouth of the Fly River of Papua New Guinea.
- Flinders Entrance (9 40.23S)
- Yule Entrance (10 22.28S)
- Olinda Entrance 11 11.81S)
- Pandora Entrance (11 22.28S) HMS Pandora who in 1791 was involved in the capture of a group of mutineers from HMS Bounty.
- Raine Island Entrance (11 38.36S) - Raine Island Entrance had a reputation as being a "ship trap" in the past because it was viewed as being safe - because it was a government sanctioned route once. The waters around the island were treacherous for early European navigators with over 37 shipwrecks situated within the Raine Island region. Not an issue with modern yachts.
- Wreck Bay (12 09.47S)
- Quoin Entrance (12 24.30S)
- Hibernia Entrance (12 43.71S)
- Bligh Boat Entrance (21 51.98S)
- Second Three Mile Opening (13 01.51S)
- First Three Mile Opening (13 25.86S)
- Lowry Passage (13 55.61S)
- Waterwich Passage (14 11.06S)
- Two Mile Opening (14 23.45S) Near Lizard Island
- Cooks Passage (14 31.0S)
- Cruiser Pass (15 41.33S)
- Trinity Opening (16 20.09S)
- Grafton Passage (16 36.40S)

BEFORE DEPARTURE

ESSENTIAL THINGS TO HAVE ON BOARD BEFORE DEPARTURE

WHEN UNDERTAKING A PASSAGE IN THIS AREA DURING CYCLONE SEASON YOU MUST CARRY THE FOLLOWING ITEMS ON BOARD. IT IS LIKELY YOU WILL BE FACED WITH A CYCLONE AND YOU WILL NEED ESSENTIAL ITEMS TO MITIGATE THE RISKS.

For this area the vessel should be a compliant category-1 vessel that has passed a Cat-1 Audit refer to the cat-1 audit form at https://www.sailingresources.org.au/safety/equipment-auditing/

Aside from the expected Cat-1 items for a passage the following items must be on board and in working order to mitigate numerous risks associated with cyclones, there are: -

- ☐ A printed copy of this Cyclone Plan for reference
- ☐ (Paper) Charts with sheltered anchorages marked
- ☐ Printed satellite images of sheltered anchorages
- ☐ A satellite phone, like Iridium Go, SpotX; or less preferably some other long-range communications device like HF radio
- ☐ An appropriate drogue with all its lines, shackles, bridle
- ☐ At least 2 appropriate anchors and chain
- ☐ Plenty of line/warp to use in shelters (> 120m)
- ☐ A working depth sounder
- ☐ Storm sails – Storm Jib, Trysail
- ☐ Handheld GPS unit (as well as primary GPS)
- ☐ A working ships barometer

WEATHER PLANNING BEFORE DEPARTURE

WEATHER ROUTING MUST BE UNDERTAKEN PRIOR TO ANY PASSAGE.

This process of weather planning must include scanning for possible developing cyclones using weather model forecasting tools. The idea is to look for potential systems that may form into a tropical cyclone (that is before they are named).

ALWAYS USE WEATHER MODELS

Weather forecasting is very complex and there are many tools available that provide useful forecasts that provide good input into weather planning – you don't need to be an expert to use these tools.

The BOM should be regularly consulted. In addition to relying on the BOM weather models are useful for forecasts up to 7 days. Anything 3 days out is still uncertain.

Things that you should be aware of when using weather models

1. We suggest that you consider using the GFS, EC, UK and ACCESS-G models looking for developing lows.
2. Start monitoring the models early to obtain an understanding of the trends and their consistency within the model and between models.
3. Models run hot and cold between runs. It may be possible for a possible TC to appear or disappear between two runs on a single model. It may be possible for another model to do the opposite.
4. Use more than one model and compare the models for consistency. Where there is a contradiction between models you will need to go into more in-depth in the analysis to understand what is going on.
5. When various models start coming into alignment the forecast confidence improves. Where only one model shows a low developing, this should escalate a watch over that system to monitor how it develops. Use the majority rules approach if 3 of 4 models forecast something go with that but keep an eye on the 1 of the 4 that said something else (it may be right and other models eventually converge on that).
6. Small systems tend to be missed by the models.
7. When in doubt reach out to a meteorologist or person with lots of knowledge on how to use these tools.

USEFUL TOOLS FOR WEATHER ANALYSIS

You should check for cyclone warnings on the following

JTWC Tropical Warnings
https://www.metoc.navy.mil/jtwc/jtwc.html?tropical

EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECAST
Tropical storm probabilities - Extended range forecast
Probability that a tropical storm, a tropical depression or a hurricane will strike within 300 km for weekly periods. Up to 46 days out.
https://www.ecmwf.int/en/forecasts/charts/catalogue/mofc_multi_tcyc_family_forecast?time=2020123100,576,2021012400&parameter=Forecast&intensity=Tropical%20storms&area=Australian%20Coast&facets=Parameters,Tropical%20cyclones

BOM CYCLONE OUTLOOK
http://www.bom.gov.au/qld/forecasts/cyclone.shtml
Also, BOM's Meteye also usually includes cyclones
http://www.bom.gov.au/australia/meteye/

The ACCESS ((Australian Community Climate and Earth-System Simulator) model from BOM is also useful
http://www.bom.gov.au/marine/wind.shtml

Operational tropical cyclone advisories and warning information from WMO Severe Weather Information Centre.
https://severeweather.wmo.int/TCFW/

NZ MET SERVICE
https://www.metservice.com/warnings/tropical-cyclone-activity

Levi Cowan's TROPICALTIDBITS.COM
https://www.tropicaltidbits.com/storminfo/
Has good analysis on developing TC

EARTH
https://earth.nullschool.net/

WINDY
https://www.windy.com/

CYCLONE CATEGORY

Both the Australia's Bureau of Meteorology (BoM) and U. S. National Weather Service use a 5-point scale to alert the public of tropical cyclones. However, the scales are very different in the boundaries between their respective categories – be aware of this when using different tools.

For further details about the Australian and Saffir-Simpson tropical cyclone category scales refer to:
http://www.bom.gov.au/cyclone/about/intensity.shtml
and https://www.weather.gov/ppg/cyclone respectively.

AUSTRALIAN CYCLONE SEVERITY SCALE

Category Aust	Peak gusts (km/hr)	Peak gusts (kts)	Central Pressure (hPa)
1	90 - 124	49 - 67	986 - 995
2	125 - 169	68 - 91	971 - 985
3	170 - 224	92 - 121	956 - 970
4	225 - 279	122 - 150	930 - 955
5	>= 280	>= 151	<= 929

KEY AUSTRALIAN TERMS:

- ☐ Tropical low/depression <34 knots
- ☐ Tropical cyclone (gale) 34-47 knots
- ☐ Tropical cyclone (storm) 48-63 knots
- ☐ Tropical cyclone (hurricane) Severe tropical cyclone >=64 knots

OFFICIAL CYCLONE WARNINGS & ALERTS

Bureau of Meteorology is responsible for the issue of all warnings and related advices and information for tropical cyclones affecting the Australian area of responsibility. This includes the coastal waters and land areas of Australia including Christmas Island, Cocos Island, Lord Howe Island and Norfolk Island.

Tropical Cyclone Advices are issued whenever a tropical cyclone is likely to cause winds in excess of 62 km/h (gale force) over Australian communities within the next 48 hours. The Tropical Cyclone Advice lets people know when they might be affected by issuing either a Watch or Warning for each community in the path of the cyclone.

- A **Tropical Cyclone Watch** is issued for coastal communities when the onset of gales is expected within 48 hours, but not within 24 hours.
- A **Tropical Cyclone Warning** is issued for coastal communities when the onset of gales is expected within 24 hours or are already occurring.

While the threat remains, a Tropical Cyclone Advice will be issued every six hours, increasing to every three hours when cyclone warnings are required. In some circumstances, when a cyclone approaching the coast is under radar surveillance, the advices may be issued hourly.

Tropical cyclones in Australia can have more unpredictable paths than in other parts of the world. They can last from a few days up to several weeks. There are five categories of cyclones with Category 1 the least severe and Category 5 the most severe.

PORTS - QUEENSLAND EMERGENCY SERVICES

In Queensland extreme weather event contingency plans for ports vary from region to region. Extreme weather event contingency plans are available for:

- Cairns, Cape Flattery, Cooktown, Half Moon Bay, Innisfail, Karumba, Mourilyan, Port Douglas, Port Kennedy and Weipa
- Townsville
- Mackay
- Gladstone and Bundaberg
- Brisbane and the Gold Coast.

These extreme weather event contingency plans are available at Maritime Safety Queensland or from the website at www.msq.qld.gov.au the following link provides the link to the contingency plans: -

https://www.msq.qld.gov.au/Safety/Preparing-for-severe-weather

Queensland uses a 3-tiered system for maritime purposes.

1. Yellow Alert - Destructive winds forecast within 24 hours.
2. Blue Alert - Destructive winds forecast within 12 hours.
3. Red Alert - Destructive winds forecast within 6 hours.

THE TYPICAL PROTOCOLS FOLLOWED BY THE PORTS ARE GENERALLY: -

YELLOW ALERT - DESTRUCTIVE WINDS FORECAST WITHIN 24 HOURS.

- ☐ Suspend operations and obtain a situation report on state of vessel condition.
- ☐ Inform ships' masters of situation and place a short notice to sail.
- ☐ Obtain information on length of time to bring ships to a readiness to sail.
- ☐ Inform Regional Harbour Master of situation.
- ☐ Small vessels move to designated cyclone mooring areas of the creeks and waterways within the mangrove areas.

BLUE ALERT -DESTRUCTIVE WINDS FORECAST WITHIN 12 HOURS.

- ☐ Sail all large merchant ships (note: It may already have been necessary to have sailed some ships due to tidal conditions).
- ☐ On water authorities prepare to depart.
- ☐ All small vessels should be moored in their designated area and final preparations and tying off completed.
- ☐ Owners of recreational vessels should be moored in the designated areas with final preparations and tying off complete
- ☐ Note: The anchoring of large vessels upstream is not recommended due to tidal surges that could inundate the area, which, with high winds, may well strand vessels inland of the river system, making any salvage extremely difficult.

RED ALERT - DESTRUCTIVE WINDS FORECAST WITHIN 6 HOURS.

- ☐ Port Closed
- ☐ Vessels are not to leave their cyclone moorings until the official all clear is given by the Regional Harbour Master (Cairns).

MONITORING EXTREME WEATHER EVENT AND MAINTAINING CONTACT

- Monitor Bureau of Meteorology (BOM) and Marine Rescue broadcasts for weather updates and any issue of cyclone warnings;
- Maintain contact with Marine Rescue to confirm progress and establish local conditions;
- Record barometric pressure and wind direction;
  - 1 hPa/hr fall - 10 knot increase in wind;
  - 3 hPa in 3 hours, place crew on alert
  - 2 hPa/hr fall - 20 knot increase in wind;
  - 6 hPa in 3 hours, gale-force winds within next 6 hours
  - 3 hPa/hr fall - beware-gale/storm conditions;
  - 9 hPa in 3 hours, gale to storm-force winds within 3 hours
  - 5h Pa/hr fall- cyclone probably within 200 nm;
- if wind 30 to 40 knots - cyclone probably within 100 nm;
- carry out radio communication checks on VHF Channels 16 and 14 and obtain SKEd24x7 reports by satellite phone.

USFUL CLUES THAT A CYCLONE MAY BE DEVELOPING OUT AT SEA

1 DAILY DIURNAL MOVEMENT OF THE BAROMETRIC PRESSURE STOPS

There are also “natural tides” in the atmosphere where the pressure falls from about 9am to about 3pm, rises to 9pm, falls to 3am and then rises again to 9am. This movement is called the "diurnal variation of pressure" and this is why the barometer must be read at the same time every day. When a storm centre is approaching, or developing, this diurnal movement ceases. At this stage, the storm may well be 12 to 18 hours or more away. The pressure itself will probably be slightly below normal (1013 hPa).

2 STRANGE BEHAVIOUR OF TIDES

Tides start to ebb and flow out of normal expected patterns. A memory story from traditional owners of Cape Melville passed between generations say that before 1899 Cyclone *Mahina* hit

> *“they were watching the tides because it wasn’t a normal tide, it would come in a lot earlier and went back and came back in again and just kept on to and fro, and they knew what was happening, there was going to be a cyclone coming up, so they moved back into the caves, you know. Right back into the hillsides.”*

3 INCREASING HEAVY OR UNUSUAL SWELL

A cyclone causes a swell that radiates out from the centre for hundreds of miles and this will be another indication that a change in weather is about to occur. The originating direction of this swell will give a fairly accurate bearing on the storm centre. This can be confirmed by standing facing to the wind and the centre of the low-pressure system will be 90° to 135° on your left hand. (Buys Ballot’s Law).

4 AN SIGNIFICANT CHANGE IN THE WIND DIRECTION AND STRENGTH

This would be noticeable if the South-East Trades ceased and the wind came away from a totally different direction.

Watching the wave action for unusual patterns is critical to identifying a potential Tropical Cyclone.

5 VERY HIGH RELATIVE HUMIDITY

A very high relative humidity – 80% to 95% with an air temperature around 30° to 32° can be experienced.

6 EXTENSIVE CIRRUS CLOUDS

An approaching cyclone may be proceeded by extensive cirrus clouds whose direction often being an indicator to the location of the storm centre. As the storm centre approaches, the clouds will be lower, overcast with sweep, with increasing wind and unceasing rain.

CYCLONE OR TROPICAL LOW HAS FORMED

On receipt of advice from the BOM or SKED24x7 confirming the declaration of a Cyclone Watch or barometric pressure records indicate gale/storm conditions undertake the following actions:

- ☐ Continue to record barometric pressure and wind direction more frequently;
- ☐ Record as accurately as possible the path of the cyclone using all available weather information from BOM and marine rescue;
- ☐ Plot the position and movement of the cyclone using the chart included in annexure a. Note that the position of the cyclone is reported in degrees and decimals of degrees; and
- ☐ Keep a log of barometric pressure and wind direction, so you can work out if the storm changes direction. Where the cyclone changes direction you will need to reassess your tactics.

WHAT TO DO WHEN A CYCLONE IS APPROACHING

- ☐ A - WORKOUT WHERE THE STORMS CENTRE IS
- ☐ B - ASSESS THE CLOSEST POINT OF APPROACH OF THE STORM
- ☐ C - SHOULD YOU RIDE IT OUT, RUN, OR SHELTER?
- ☐ D - IF YOU ARE WITHIN REACH OF SHELTER
- ☐ E - SELECTING A SAFE CYCLONE ANCHORAGE
- ☐ F - AVOIDANCE TACTICS
- ☐ G - HANDLING OF DISTRESS CALLS BY OTHER VESSELS
- ☐ H - USE SKED24x7 WEATHER ROUTING

A - WORKOUT WHERE THE STORMS CENTRE IS

Before you do anything, you need to know where the cyclone is in relation to the yacht.

The navigator must make an accurate estimation of the storm centre and its direction of travel. This is crucial to deciding what to do next.

The best way to obtain the position of the cyclone with accuracy is by having the information provided to you from the experts. This is why you should always have a satellite communications device – like Iridium or SpotX to do this, failing this the next best thing is HF radio.

SKED24x7 will relay this information as it develops. Which is an added comfort when out in remote areas with little communication.

The BOM will provide their CONFIDENCE IN THE CENTRE POSITION which is the certainty that they have in the position of the centre position of a tropical cyclone. This is normally expressed as the radius of the smallest circle within which the centre may be located by the analysts.

- POSITION GOOD - a radius of less than 30 nautical miles;
- POSITION FAIR - a radius of 30 to 60 nautical miles; and
- POSITION POOR - a radius of greater than 60 nautical miles

HERE ARE SOME GOOD POINTERS TO ASSIST IN WORKING OUT WHERE THE CENTRE IS WITHOUT COMMUNICATIONS

Should you not have working communications you can use a manual approach on the yacht to work out where the cyclone centre is from the vessel.

If you stand with your face to the wind the storm centre will be on your left and a bit behind. Along the outer edges of the storm, the wind is veered towards the centre, rather than pointing directly along the isobars. As you get close to the centre they run with the isobars.

The smallest amount of veering is ahead of the eye, and the greatest amount behind the centre. The angles range from 20 degrees to as much as 40 degrees from behind the eye.

When you start to be covered by thick clouds their movement should be noted as their track maps with the isobars surrounding the storm centre. If you draw an arrow (on your chart) representing cloud direction and take a bearing at right angles to this will be pointing at the eye.

B - ASSESS THE CLOSEST POINT OF APPROACH OF THE STORM

Once you establish the centre and the likely direction of the cyclone you need to next establish on which side you are and how much time and distance you have.

Your options will be constrained by which side you are on and how far the system is – factoring its size, speed.

If you are caught in open water and there is a cyclone within your vicinity, it is of vital importance to know whether you are:

1. In the dangerous quarter,
2. The navigable semi-circle;
3. Directly in the storm's path; or
4. At a safe distance

Diagram 1 shows the track of a cyclone. There is a dangerous semi-circle, a navigable semi-circle and dangerous quadrant.

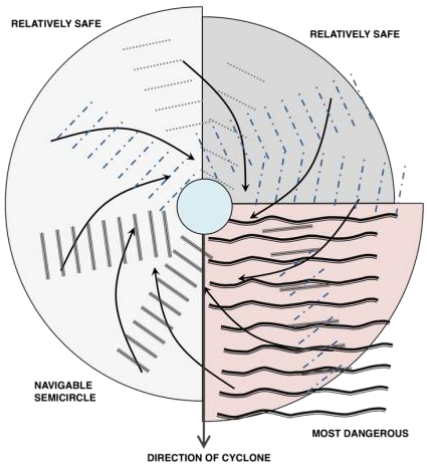


DIAGRAM 1- CYCLONE ZONES

If you are facing an oncoming cyclone, the dangerous semi-circle is on your right-hand side. Note that the winds do not come from where the cyclone centre is.

If you are in the dangerous quadrant the clockwise winds of the system will tend to blow any vessel on that side into the path of the storm where the highest winds will be experienced. You are going to have a pretty rough time. On the other side – the navigable semi-circle – the wind will be blowing you out of the cyclone's path. You are going to have a better time.

The dangerous quadrant is the most treacherous part of the cyclone. The dangerous quadrant is the one where the fetch of the cyclone has been causing waves for the longest duration. This means big, confused seas. We provide a wave height nomogram (in the Appendix B – NOMOGRAM) to assist you to calculate the effect of wind on waves.

C - SHOULD YOU RIDE IT OUT, RUN, OR SHELTER

Small yachts should never consider riding out a cyclone at sea if there is suitable shelter within reach. Your first option must be to seek a safe haven as early as possible. Knowing where to go for shelter is a task that should be undertaken when preparing for a voyage.

If you are in the inner reef of the Great Barrier Reef you need to avoid riding it out – you do not have the seaway and most likely be blown onto a reef or the shore.

If you are in the outer reef you don't have any options to shelter, you need to work out if you can make a sheltered anchorage – failing that you will need to take tactics describe further on.

D - IF YOU ARE WITHIN REACH OF SHELTER

A small vessel should never consider riding out a cyclone at sea if there is suitable shelter within close to hand.

Recreational craft normally avoid cyclone-prone areas during the cyclone season. Professional sailors, commercial and fishing vessels do not have that option. When operating in cyclone areas the Master should be vigilantly monitoring all weather schedules and keeping a cautious eye on the weather all the time.

The on-ground support crew, like SKED24x7 Watchkeeper, should be keeping attentiveness on weather and potential cyclone developing situations.

Before every passage the Master should mark on their charts various safe anchorages that could be used as cyclone shelters. This plan provides some suggested sheltered anchorages - these should be checked for their suitability for your particular vessel, for draft and suitability.

As good sailing practice where possible on coastal voyages sailors should investigate promising-looking anchorages making notes on the anchorage for future use. These anchorages should be widely reported to the sailing community. There is nothing better as local knowledge when making for land ahead of a rising storm, particularly when this has to be done in poor visibility and adverse weather conditions – and sometimes at night.

E - SELECTING A SAFE CYCLONE ANCHORAGE

Do not wait for a cyclone to familiarise where sheltered anchorages are. This plan has a list of safe anchorages that should be reviewed before sailing in this area. These can be found in the section “places to shelter”.

The ideal cyclone anchorage will have shelter from the sea and swell for as much of the 360° around the vessel as possible; it will have good holding ground, enough room to swing safely and, if you can manage it, a soft shoreline such as sand, mud or mangrove swamps.

MANGROVES ARE THE BEST SHIELD

The shelter of mangroves has provided cyclone protection for boats for generations from high winds and heavy sea surge. Wind cannot penetrate the wall of thick vegetation when sheltering in a mangrove-bordered river. Tying ropes to trunks and roots, and setting bow and stern anchors, many boats have ridden out severe weather in mangroves.

Wind and swell waves are rapidly reduced as they pass through mangroves, lessening wave damage during storms. Mangroves with aerial roots diminish waves in shallow water more rapidly than those without aerial roots. Where mangroves are extensive, they are able to reduce storm surge water depths as the surge flows inland by up to 50cm per kilometre width of mangroves.

The complex network of roots and branches can also trap moving vessels and debris. The dense mangrove forest canopies also prevent further development of wind and swell waves in and immediately behind the mangroves. The breakage or uprooting of mangrove trees is relatively rare in storms and these aerial roots should be used to secure lines to the vessel.

RISING SEAS

Air pressure has a direct influence on the sea level. Lower air pressure gives higher sea levels: a drop in air pressure of 1 hPa increases the water level by 1 cm. The sea level doesn't change instantaneously it responds to the average change in pressure over a larger area.

The average sea level air pressure is 1013 hPa. Since the air pressure normally varies between 950 and 1050 hPa during a year, the expected variation in sea level due to air pressure is between +63 cm and -37 cm around mean sea level.

Tropical Cyclones in Australia can drop air pressure by more than 100 hPa which would result in an increase of sea level by 1m. This should be taken into consideration in anchorages.

SEAFLOOR

The best anchoring is usually in sand, followed by clay, hard mud, shells, broken shells, and soft mud. Also, water can sometimes be blown out of the harbour, leaving boats stranded briefly. If this happens, your boat will settle onto whatever is on the bottom – a rocky bottom is not a good place to be with a falling sea.

Use your heaviest ground tackle and veer a maximum amount of cable. Have a second anchor ready to let go.

Secure all loose gear – the dinghy, awnings, cray pots, sail covers. A cyclone is capable of stripping your decks clear.

SECURING THE YACHT

Whenever anchorages like canals, rivers, or waterways are available, they serve as shelters – “cyclone holes”. A yacht should be secured in the centre with a spider web arrangement of sturdy lines ashore. The yacht should be facing the waterway’s entrance and be as far back from open water as possible. Besides sheltering the yacht, being away from the entrance should help with another consideration, which is the need to maintain a navigable waterway.

Securing yachts in wider waterways, yachts should be secured using a combination of anchors and lines tied to mangroves ashore. The more lines and anchors the better. Moor your boat away from the main channel. A cyclone hole has tidal restrictions. Plan on moving your boat early to avoid being thwarted by a low tide.

Don't put too many lines onto a single cleat even if it is backed properly. Two lines per cleat is a good rule of thumb. Also, a cleat is not reliable when lines are led perpendicular to the base and the cleat can be wrenched out by the tremendous loads. Two-hole cleats are more vulnerable than four-hole cleats.

All lines must be protected in a storm. If the chocks are large enough, fit a second, larger diameter hose around another hose that fits snugly to the line. Drill holes in both hoses and use cord to tie them securely to the line. If short on time you can use a single hose. If you need chafe protection quickly, use a lot of duct tape to secure several layers of heavy canvas to the lines. This won't be as rugged as hose, but it is certainly better than leaving the line unprotected.

Allow for a sufficient number of mooring lines so that you can double up your mooring arrangements. Have sufficient fenders for the anticipated mooring arrangements.

Check anchor chains, shackles and anchor warps for wear and replace if necessary. If you intend to utilise a swing mooring, ensure that the mooring chain has been recently inspected. Be aware that flooding events resulting from extreme weather events may result in build-up of debris around the mooring chain, compromising the integrity of the mooring arrangement.

It is also a good idea to notify SKED24x7 and your nearest coastal radio station about where you are anchored. Provide regular (three-hourly) reports of barometric pressure, wind direction and speed, cloud and rain reports, and any other information that will be of value to the meteorologists in completing the broad picture of the storm’s state and progress.

WHEN IN PORT NEAR MANGROVES WHILE YOUR VESSEL MAY BE IN DANGER, YOU DO HAVE THE OPTION OF GETTING ASHORE AND FINDING A SECURE PLACE IN WHICH TO RIDE OUT THE STORM.

F - AVOIDANCE TACTICS

The right tactics to use when facing a tropical cyclone depend on the capability of your vessel and crew. All of the factors in this plan rely on the preparation of your vessel and crew for handing an extreme storm.

If you have a solid rig, are confident in your yacht, have a variety of storm sails will provide you with a great foundation. A key factor is how well you know your yacht's handling characteristics in heavy weather. Crew experience in heavy weather is another important factor.

If all this is in place, then you are in good shape considering the situation and you have the most options available to you.

DANGEROUS QUADRANT

Should you find yourself in the dangerous quadrant you must steer to move as quickly as possible away from the storm's path. This can be challenging when land/islands/reefs are in the transit line.

On the dangerous side of the storm, as the centre approaches, (motor)sail as close on the wind on port tack as possible. As the centre comes abeam, the wind will back so that you are close reaching. Steering directly towards the navigable semi-circle (from dangerous side) may bring you closer to the dangerous quadrant.

The ideal course is to keep the wind on the port bow and gradually altering to port as the wind backs.

Depending on the direction of the cyclone this may present very real problems of having shorelines in the way, as you will be steering initially towards the land and may be forced into the decision of heaving-to and riding it out.

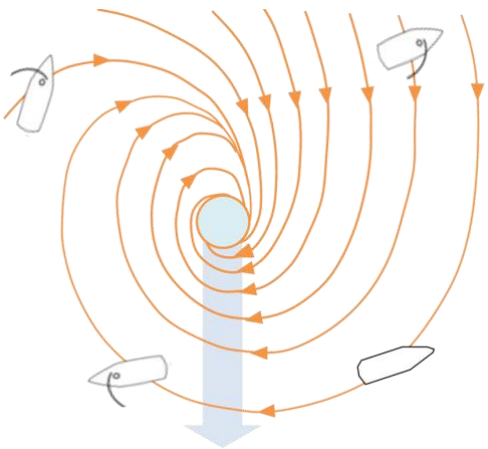


DIAGRAM 2 – PATHWAYS AWAY FROM CYCLONE

If you are in the navigable semi-circle or in the path of the cyclone, your best course will be with the wind on your port quarter, altering gradually to starboard as the wind veers.

if the wind direction remains the unchanged, and the barometer is falling steadily, then you are in the path of the cyclone. The swell direction and the point of convergence of the cirrus clouds will also indicate where the cyclone eye is located. If the swell or cirrus convergence maintains a constant heading the storm is coming toward you.

G - HANDLING OF DISTRESS CALLS BY OTHER VESSELS

You will need to determine how you will respond to a distress call. You should think about this before you receive the call.

During a cyclone you will be unable to do much except to relay information to others. You should record everything on your log to ensure that search and rescue parties can have relevant information. The opposite is also true – DURING THE STORM THERE IS LITTLE THAT ANYONE ELSE CAN DO FOR YOU. ONLY RELY ON YOUR VESSEL AND CREW.

H - USING SKED24x7 WEATHER ROUTING

The https://www.sailor.com.au/sked24x7 is proactive professional passage monitoring service for yacht owners embarking on lengthy passages. Watchkeeper provides constant support and surveillance for safety and wellbeing.

Once a cyclone appears SKED24x7 will produce a weather routing that will provide an objective third party's perspective of the best route that they believe to be the best passage to deal with the cyclone. SKED24x7 Watchkeeper will commence a contingency plan for cyclones.

Once this suggested route is received by the Master of the yacht needs to compare the suggested weather route with their own weather route. Where there is a contradiction between the weather routings the Master needs to establish what information, they may be missing that is causing this contradiction. It is critical to work out why there is a difference of opinions by professionals.

A shore-based weather router, like SKED24x7, has access to more macro information whereas a Master of a vessel has more information from the field. Combining information gaps may yield a better tactic and routing for the storm.

The Master of a vessel always makes the final decision as to the route and avoidance tactics that they wish to take in the current circumstances.

Once the cyclone protocol commences with SKED24x7 the Master should nominate a crew member to provide constant (30 minutes) weather and coordinate data this should include:

- ☐ Barometric Pressure
- ☐ True Wind Speed and True Wind Direction
- ☐ Position and Course Over Ground
- ☐ Sea state
- ☐ Speed Over Ground
- ☐ Range/Bearing to closest feature

This allows the Watchkeeper (who is on shore) to use this information and the resources they have access to recalculate viable solutions for your consideration. The Skipper or Navigator will need to consider this advice as part of their calculus of the chosen solution.

SOME INTERESTING IDEAS THAT COULD HELP YOU

NOTES ON HEAVY WEATHER SAILING

This Cyclone Plan focus is not about advising on heavy weather sailing, it assumes that the crew are well experienced in this. For many seasoned offshore sailors, heavy weather starts near or around 40kts, for some even higher. Here are some things to think about.

The 34-Knot Rule - vessels should make every effort to steer clear of 34-knot winds associated with a tropical storm. After 34kts the sea state becomes difficult. When this avoidance can't be achieved the well-known tactics are: -

The typical escalation stages for heavy weather sailing are: -

1. Reefing the sails 18 to 27 knots.
2. Park-it - Heaving-to 28 to 33 knots.
3. Lying a-hull 34 to 40 knots, with right sea conditions.
4. Running off 41 to 47 knots, with sea room.
5. Running off with drags 48 to 55 knots or more.
6. Greater than 55 knots - Don't give up it is going to be an emotional experience

The choice of your solution is up to the skipper when to use what tactic.

Lying a-hull is a very risky manoeuvre and done with caution watching the sea conditions.

WE DON'T ENDORSE THAT YOU SHOULD EMPLOY LYING A-HULL UNLESS YOU HAVE NO OTHER CHOICE.

Lying a-hull in nonbreaking seas the vessel moves with the surface water if done correctly with a "slick". This occurs until a breaking wave strikes the boat, once this happens the vessel will most likely capsize.

Risk factors associated with "running-off" is that of rudder reliability and fatigue of best helmsmen. The control of the vessel while running requires an effective rudder. Most forms of rudders tend to lose their grip on wave crests at differing degrees - right when one needs a maximum amount of bite and control. This is usually because the water is moving in the same direction as the boat.

Trying to keep the vessel under control using a rudder is for the very experienced helmsman which is made harder at night. For a superb helmsman to do this for more than a few hours in heavy seas is challenging – the concentration required can be extremely exhausting. This is why you need rested crew and a roster system that rotates the best helmsmen.

Many legendary sailors have managed to pull it off by keeping the waves to the hind quarter. Modern yacht design works better than the older designs. Whilst running off from a storm the last remaining option to increase the odds of successful escape is to use a speed-limiting drogue which is properly positioned behind the vessel on the wave trains. The idea of the drogue is to keep the yacht pointed in the right direction and slow it down to a relatively appropriate speed and position in the wave train.

A WORD OF WARNING – THROWING LINES OUTSIDE YOUR YACHT MAY CREATE OTHER PROBLEMS – FOULED RUDDER, OR PROPS.

THERE ARE MANY OFFSHORE SAILORS WHO ARE NOT FANS OF USING A DROGUE OR PARACHUTE ANCHORS.

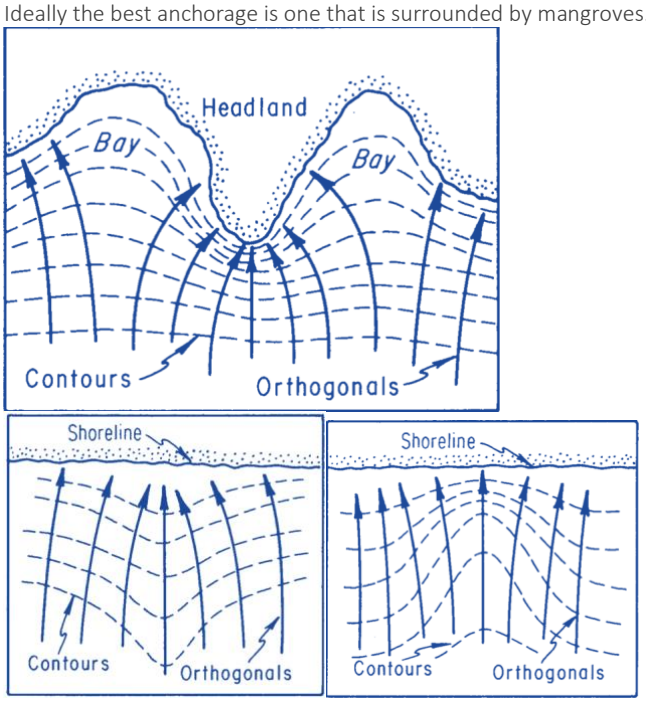
Before your passage you need to decide on the escalation process for heavy weather and ensure that all crew are versed in this and that the equipment is sufficient for the job. Many deploy a drogue only to find that the line is too short or drogue the wrong size.

NOTES ON BENDING OF WAVES

When seeking shelter in an anchorage it is important to understand that waves bend based on the shoreline and shape of the bottom (currents also affect waves). This is called refraction and a change in wave direction can cause a convergence or divergence of force.

If you have a choice of anchorage avoid seafloor ridges, headlands and seek seafloor canyons or bays. The diagrams below show how wavs will be bent based on the topology of the anchorage.

Ideally the best anchorage is one that is surrounded by mangroves.



Source: US Army Corps of Engineers Shore Protection Manual.

NOTES ON BREAKING WAVES

> *"In a breaking wave capsize, it is not the height of the wave but the mass and velocity, or kinetic energy, in the wave crest that causes the capsize. If the boat is driven to a high enough velocity (both sideways and rolling) by the striking wave, it will capsize. If it remains below this critical velocity, it will not be rolled all the way down. If we apply the similarity relationships to a breaking wave, we find that the kinetic energy necessary to capsize any specific design will vary as the fourth power of the boat's length (L^4). Thus a 60-footer must receive sixteen times as much kinetic energy from a moving wave crest as a 30-footer in order to capsize."*
>
> Source: Donald J. Jordan SEAHORSE, May/June 1983

Breaking waves are formed by the fierce winds and strengthened by the energy of the other waves they pass. A 'rogue' wave cutting

across a series of other waves will disperse most of its energy. Therefore, it is unlikely for a breaking storm wave to approach from a different direction to the prevailing wind waves.

As a breaking wave approaches a vessel the water flow causes the vessel to yaw until it is abeam to the wave. Since this yawing motion is difficult to perceive by the helmsman, they will reason that it came from a different direction, when what really happened was that the yacht yawed.

It is not the crest of a breaking wave that does the damage as it is aerated and has little mass. The kinetic energy of the breaking wave lifts the vessel forward close to the wave velocity. The damage happens when the boat is thrown ahead of the wave and impacts the hard green water in the trough on its side and deck area. Imagine a car falling from a 40 ft rooftop parking spot. You can't outrun a 40 ft breaking wave as it will be moving around 23 knots.

SHOULD YOU ANCHOR FROM THE STERN OR BOW IN A STORM

Depends on the design of the vessel. Understand the vessel's stability characteristics: -

> "If an anchored sailing yacht is stable it will lie quietly; if it is unstable it will develop a violent motion under high wind conditions. An object is said to be stable if, when a force is applied to deflect the object, an opposing force is generated to return the object to the original course. A tethered boat will be stable if, when the boat yaws, forces will be created that act to reduce the yaw and return the boat to its original course — or in this case, turn the boat into the new wind direction…… Modern sailing yachts have short, deep keels and a cutaway forefoot. They also have powerful rudders and are lightweight. The single mast is tall and located forward of the center of the boat. These features are necessary to obtain good upwind performance and agility when coming about. However, they make the boat highly unstable when tethered from the bow in a strong wind. Fortunately, the more unstable a boat is when tethered from the bow, the more stable it will be when tethered from the stern."

Source: Should you anchor from the stern in a storm? By Donald J. Jordan, Soundings May 2006

SOME CHECKLIST RESPONSE SCENARIOUS

READY THE VESSEL FOR EXTREME STORM CONDITIONS

OBJECTIVE

To ensure that the vessel is ready for winds and sea state associated with 30kt to 50kts.

Key Steps
a) Reduce windage
b) Switch to storm configuration
c) Check and Ready safety gear

A - REDUCE WIND LOADINGS ON VESSEL

Remove all deck gear including lifebuoys, dodgers, Bimini covers, clears and so on and store below. Remove sails, self-furling sails and covers. If this is not possible, double wrap or tie these components in such a way that the wind cannot tease any ends out and allow flapping of gear to commence.

Remove cowl ventilators and seal the openings. Use duct tape to cover instrument gauges. Duct tape should also be used around hatches, ports, lockers, etc. to prevent water damage below.

Close all but the cockpit drains, seacocks and bang a plug into the engine's exhaust ports (if in an anchorage). If the boat does take on water, it will sit lower, and water could back-up into the cylinders. Remember to remove the plug before starting the engine when the storm has passed.

B - SWITCH TO STORM CONFIGURATION

- ☐ Shorten sail and prepare to set storm sails;
- ☐ Rigging secure and appropriately tensioned;
- ☐ Extra stays in place if available.
- ☐ Secure furled sails by lashing down or removing sails from stays. Remove sails, self-furling sails and covers. If this is not possible, lash-down/double wrap or tie these components in such a way that the wind cannot tease any ends out and allow flapping of gear to commence.
- ☐ Gybe preventer operational;
- ☐ Reduce wind loadings on vessel
- ☐ Remove all deck gear including lifebuoys, dodgers, Bimini covers, clears and so on and store below.
- ☐ Ensure engine is running and ready for operation when required;

C - CHECK AND READY SAFETY GEAR

Check that all bilge pumps are operational and that all self-draining openings are clear and will remain so. Make sure all safety equipment is available and in working order. Check all cleats and associated fittings for integrity. Generally, mooring lines are stronger than these.

Check all mooring lines and warps for chafing and deterioration and replace if necessary. Man-made synthetic fibres such as polyethylene, polypropylene and polyester deteriorate in the sunlight and may show little signs of deterioration prior to failure.

- ☐ All anchors for emergency deployment;
- ☐ Check steering system operational, steering cables taught
- ☐ Emergency steering ready for use;
- ☐ Life jackets in good condition with crutch strap and co^2 cylinder in place; jackstays in good condition and well secured;
- ☐ Safety harnesses including tethers in good condition; storm drogue ready for deployment;
- ☐ Make sure bilge pump is operational, not blocked and remove any bilge;
- ☐ Charge all batteries; check all torches and handheld equipment;
- ☐ Cover electrical equipment to protect from water;
- ☐ Close and secure all hatches;
- ☐ Close all thru valves on skin fittings except those necessary for the operation of the engine;
- ☐ Check all safety gear and ensure accessible;
- ☐ Clear deck and stow and store all moveable gear below deck;
- ☐ Prepare rations, boil water & store, warm drinks and water;
- ☐ Rest best helmsmen – assign roles;
- ☐ Secure your tender. They need to be securely lashed inverted on deck to prevent filling with water. Do not tow tenders. If left on purpose-built davits, tenders should be cleaned out and securely lashed and bungs removed;
- ☐ Check fuel and confirm steaming range; and
- ☐ Report position to marine rescue and contact port masters to confirm closest available safe port with cyclone moorings.

DETERMINE ESCAPE

OBJECTIVE

Assess what your escape course will be

Key Steps
d) Determine closest point of cyclone approach
e) Decide on escape action
f) Communicate intentions

If in port you will need to decide whether you remain/go to sea (sortie) or seek refuge near land in a sheltered anchorage.

The classical doctrine held by most mariners is that ocean-going ships should leave port which are threatened by a hurricane. Despite this natural caution, ships do continue to be damaged in port or after leaving port, as a result of encounters with tropical cyclones. This stems mainly from the relative unpredictability of tropical cyclone movement, how yachts dealt with the situation (how they played their hand) and there are some elements of chance.

Due to possible storm re-curvature and forecasting errors, vessels will usually need to run almost 200 nmiles to evade approaching major tropical cyclones (a thirty-three-hour transit at 6 knots with operating 24 hours around clock) to reach the recommended Cyclone Evasion Point.

This transit will be in challenging sea states, depending on direction, due to rapid swell in advance of tropical cyclones.

In the inner reef of the Great Barrier Reef will be challenging at night.

While some ports have cyclone proof protections. Most don't. And other vessels may break their moorings.

If your vessel is in port, you will most likely be ordered by the Harbour Master to seek shelter in rivers or mangroves following a contingency plan drawn up by the port. If your vessel is unattended

usually it will be moved for you (at a fee) and this process may accidently damage the yacht.

STEPS

- ☐ Fix position on chart and make a log entry;
- ☐ Determine current position relative to the cyclone (refer appendix A:
- ☐ The approximate direction of the centre of the cyclone will be between 90 and 135 degrees to the left of the wind as you face it);
- ☐ The vessel will be in the more dangerous non-navigable semicircle if the wind shift over time is anticlockwise (backing) or in the less dangerous navigable semicircle if the wind shift over time is clockwise (veering); and
- ☐ The vessel will be in the direct path of the cyclone if the wind direction is unchanged;
- ☐ Contact harbour master at the closest ports and confirm mooring arrangements before making way to port or safe haven; and
- ☐ Contact marine rescue and advise position and course to closest port or safe haven.
- ☐ Contact SKED24x7 watchkeeper and advise and seek additional information

FIRST WORK OUT HOW MUCH SEA ROOM

A fundamental rule of offshore sailing is when the weather is bad you want appropriate sea room. When you think a storm is likely it's time to think of your sea room space. You require 50-100nm sea room depending on the strength and duration of the expected storm.

Following determination that the cyclone is tracking or likely to track towards the vessel, undertake the following actions:

IF NOT ABLE TO SEEK SHELTER IN PORT OR A SHELTERED ANCHORAGE:

- ☐ Give the cyclone a wide a berth as possible;
- ☐ Plot a clearing course outside of the zone formed by an arc with a radius of 50 times the travel speed of the cyclone and extending 40-degree angle on each side of the centre of the cyclone;
- ☐ Confirm preparations and current position with marine rescue and SKED24x7 watchkeeper; and
- ☐ Continue to record as accurately as possible the path of the cyclone using all available weather information from BOM and marine rescue and plot the position and movement of the cyclone.

IF ALREADY IN THE PATH OF CYCLONE AND IT'S TOO LATE TO EVADE:

- ☐ If the vessel is in the more dangerous non-navigable quadrant (wind backing) place wind on port bow for evasion track or hove-to subject to conditions;
- ☐ If the vessel is in the less dangerous navigable semicircle (wind veering) place wind on port quarter for evasion track;
- ☐ Avoid being trapped on the dangerous side of the cyclone if possible;
- ☐ Monitor vessel and regularly check steering system, engine, rigging and bilge;
- ☐ Confirm preparations and current position with marine rescue and SKED24x7 watchkeeper; and
- ☐ Continue to record as accurately as possible the path of the cyclone using all available weather information from BOM and marine rescue and plot the position and movement of the cyclone – using the cyclone tracking sheet.

IF IN PORT OR A SHELTERED ANCHORAGE:

- ☐ If in port, follow instructions from Harbour Master;
- ☐ Avoid anchoring near other vessels if in a safe haven or port without cyclone moorings;
- ☐ Look for tall mangrove trees in the river to provide firm shelter in times of high winds and heavy seas.
- ☐ Secure vessel fore, aft and athwartships where possible and allow for surge.
- ☐ Ensure your mooring arrangements are up for the job at hand

AFTER THE STORM

If your yacht was damaged, you'll want to contact the yacht's owner so they can contact the insurance company immediately. As soon as it is safe, here are some things you should do to protect your boat and reduce potential problems.

- ☐ Protect the boat from weather exposure, leaks, mildew, dry mud.
- ☐ Regardless of the boat's condition, it should be cleaned and dried out.
- ☐ If the engine and other machinery have been submerged or gotten wet, it should be "pickled" by flushing with fresh water and then filling with diesel fuel or kerosene.
- ☐ If your yacht is sunk or must be moved by a salvage company, let the insurance company assist with the arrangements.
- ☐ Do not sign any salvage or wreck removal contracts without first getting approval from the insurance claims staff.

USEFUL TABLES

WINDS TO PRODUCE 4M SIGNIFICANT WAVE HEIGHTS

Conditions required to generate 'very rough' seas characterised by significant wave heights (Hs) equal to 4 metres. These are based on relationships between wind speed, wind duration and fetch established by the US Army Corps of Engineers and reported in their Shore Protection Manual.

Wind waves are formed by wind blowing along the water's surface. Their wave height is dependent on wind speed, fetch length (fetch being the distance the wind blows over water with similar speed and direction) and the duration the wind blows consistently over the fetch.

WIND		DURATION	FETCH	
m s^{-1}	knots	hours	km	nm
15	29	15.00	275	148
16	31	14.00	250	135
17	33	12.25	220	119
18	35	10.00	175	94
19	37	8.25	145	78
20	39	7.25	120	65
21	41	6.00	95	51
22	43	5.00	77	42
23	45	4.60	71	38
24	47	4.00	66	36
25	49	3.70	59	32
26	51	3.30	57	31
27	52	3.00	49	26
28	54	2.70	43	23
29	56	2.40	38	21
30	58	2.25	36	19
31	60	2.00	44	24
32	62	1.90	29	16
33	64	1.75	28	15

DOUGLAS SCALE

WAVE EXPLANATIONS			
Description	Height (metres)	Effect	WMO Sea State code
Calm (glassy)	0	No waves breaking on beach	0
Calm (rippled)	0 - 0.1	No waves breaking on beach	1
Smooth	0.1 - 0.5	Slight waves breaking on beach	2
Slight	0.5 - 1.25	Waves rock buoys and small craft	3
Moderate	1.25 - 2.5	Sea becoming furrowed	4
Rough	2.5 - 4	Sea deeply furrowed	5
Very rough	4-6	Sea much disturbed with rollers having steep fronts	6
High	6-9	Sea much disturbed with rollers having steep fronts (damage to foreshore)	7
Very high	9-14	Towering seas	8
Phenomenal	over 14	Precipitous seas (experienced only in cyclones)	9

SWELL EXPLANATIONS			
Description	Wavelength	Period	Wave Height
Low swell of short or average length	0 - 200 m	Less than 11 sec	0-2 m
Long, low swell	over 200 m	Greater than 11 sec	0-2 m
Short swell of moderate height	0-100 m	Less than 8 sec	2-4 m
Average swell of moderate height	100-200 m	Greater than 8 sec, < 11 sec	2-4 m
Long swell of moderate height	over 200 m	Greater than 11 sec	2-4 m
Short heavy swell	0-100 m	Less than 8 sec	over 4 m
Average length heavy swell	100-200 m	Greater than 8 sec, < 11 sec	over 4 m
Long heavy swell	over 200 m	Greater than 11 sec	over 4 m

FURTHER SUGGESTED READING

The Bathurst Bay Hurricane: Media, Memory and Disaster
By Ian Bruce Townsend 2019
https://espace.library.uq.edu.au/view/UQ:ac39e2f

Tropical Cyclones in the Australian/Southwest Pacific Region
By Greg J. Holland P.I. William Gray
https://mountainscholar.org/bitstream/handle/10217/72/0363_Bluebook.pdf?isAllowed=y&sequence=1

NATIONAL SEARCH AND RESCUE MANUAL
https://natsar.amsa.gov.au/natsar-manual.asp
The National Search and Rescue Manual is the standard reference document for use by all search and rescue authorities and other organisations that provide search and rescue services in Australia.

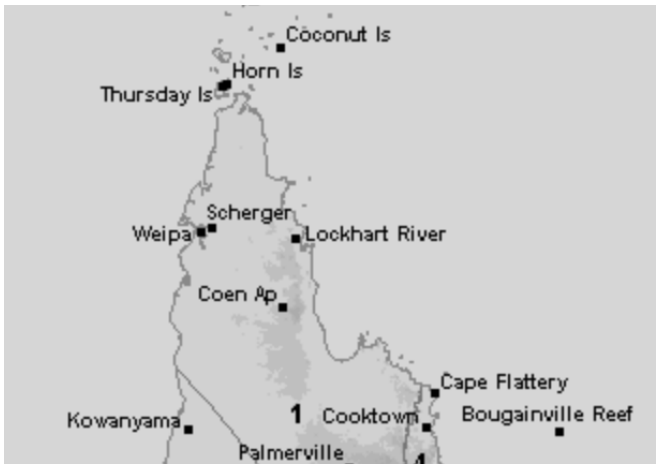
TROPICAL CYCLONE TRACK DIRECTION CLIMATOLOGY AND ITS INTRASEASONAL VARIABILITY IN THE AUSTRALIAN REGION
Sally L. Lavender and Andrew J. Dowdy
https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2016JD025562

A ROBUST OPERATIONAL MODEL FOR PREDICTING WHERE TROPICAL CYCLONE WAVES DAMAGE CORAL REEFS
Marji Puotinen, Jeffrey A. Maynard, Roger Beeden, Ben Radford & Gareth J. Williams
https://www.nature.com/articles/srep26009

TROPICAL CYCLONE OPERATIONAL PLAN FOR THE SOUTH-EAST INDIAN OCEAN AND THE SOUTHERN PACIFIC OCEAN 2020 (PDF Report). World Meteorological Organization. RA V Tropical Cyclone Committee (October 8, 2020).
https://community.wmo.int/tropical-cyclone-operational-plans

IMPORTANT CONTACT INFORMATION

BUREAU OF METEOROLOGY



BOM WEATHER STATIONS LINKS

- CAPE WESSEL (NT) – APPROACHING WEATHER http://www.bom.gov.au/products/IDD60801/IDD60801.94147.shtml
- COCONUT ISLAND - CAPE York http://www.bom.gov.au/products/IDQ60801/IDQ60801.94182.shtml (been down for 72 hours)
- HORN ISLAND - CAPE York http://www.bom.gov.au/products/IDQ60801/IDQ60801.94174.shtml
- THURSDAY ISLAND http://www.bom.gov.au/products/IDQ60801/IDQ60801.94181.shtml
- CAPE FLATTERY http://www.bom.gov.au/products/IDQ60801/IDQ60801.94188.shtml
- BOUGAINVILLE Reef http://www.bom.gov.au/products/IDQ60801/IDQ60801.95288.shtml
- ARLINGTON REEF http://www.bom.gov.au/products/IDQ60801/IDQ60801.94284.shtml
- CAIRNS http://www.bom.gov.au/products/IDQ60801/IDQ60801.94287.shtml

BOM MARINE WEATHER SERVICES (LITE)
http://www.bom.gov.au/marine/lite/

- Marine Weather Charts (lite) Marine http://www.bom.gov.au/marine/lite/charts.shtml
- High Seas Forecast Marine (lite) http://www.bom.gov.au/marine/lite/forecast/northern.shtml

Coastal Waters Forecast for Queensland

- Northern Zones: Torres Strait to St Lawrence http://www.bom.gov.au/marine/lite/forecast/north-queensland-coastal-waters.shtml
- Southern Zones: St Lawrence to Point Danger http://www.bom.gov.au/marine/lite/forecast/south-queensland-coastal-waters.shtml

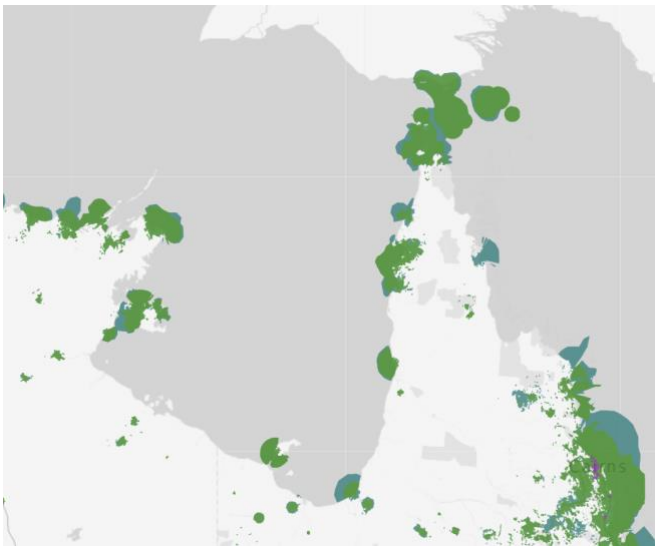
AIRFIELDS & AIRSTRIPS

Here is a list of airstrips that could be used for an emergency.

- Darnley Island Airport
- Murray Island Airport
- Yorke Island Airport
- Coconut Island Airport
- Yam Island Airport
- Badu Island Airport
- Kubin Island Airport
- Horn Island Airport +61740691336
- Northern Peninsula Airport (ABM) +61740904100 10°56S 142°27E
- OK Village Airstrip, Turtle Island
- Skardon River Airport 11°51S 141°59E (Gulf)
- Lockhart River Airport +61740607121
- Silver Plains 13°58S 143°34E (Inland)
- Lizard Island Airstrip Lizard Island is serviced by 2 light aircraft flights per day to/from Cairns and fortnightly by barge from Cairns for food and equipment freight.
- Cooktown Airport +61740695360
- Cow Bay Airstrip Cape Tribulation Rd, Cow Bay QLD

INTERNET MOBILE 4G COVERAGE

Internet and mobile phone access in limited areas through the Telstra network only. Optus mainly is starts from Cooktown southwards.



VHF WEATHER ACCESS NORTH QUEENSLAND/TORRES STRAIT

VOLUNTEER MARINE RESCUE QLD

VMR MASIG
Yorke Island Yorke Island,
in the north eastern part of the Torres Straits
http://marinerescueqld.org.au/locations/vmr-masig-yorke-island/
Call Sign: VMR MASIG
Phone: 0438 028 428
Emergency After Hours: 07 4069 1520 (Thursday Island Police)
yorkeisl@marinerescueqld.org.au

VMR ST PAULS
Moa Island, north of Thursday Island in the Torres Strait.
http://marinerescueqld.org.au/locations/vmr-st-pauls/
Call Sign: VMR ST PAULS
Phone: 07 4069 4124

Fax: 07 4069 4100
Emergency After Hours: 07 4069 1520 (Thursday Island Police)
stpaul@marinerescueqld.org.au

VMR THURSDAY ISLAND

Thursday Island in the Torres Straits.
http://marinerescueqld.org.au/locations/vmr-thursday-island/
Call Sign: VMR 422
Phone: 0477 040 440
Emergency After Hours: 07 4069 1520 (Thursday Island Police)
thursdayisl@marinerescueqld.org.au

VMR COOKTOWN

Cooktown Harbour provides monitoring of VHF channel 16/14 and 21. A local Volunteer Marine Rescue group (VMR 416) is manned from 0600–1800 on weekends and public holidays and provides radio coverage on VHF channels 16 and 21 and 2524, 4125 and 6215 on HF radio. They may also be contacted on +61 7 4069 5655 during these hours.

COAST GUARD

QF25 CAPE YORK

https://coastguard.com.au/flotilla/qf25-cape-york/
NPA Emergency Services
Seisia, Queensland 4876
Phone: (07) 4069 3695
Mobile: 0409 001 375
Call Sign: VMR 25
Call Sign Name: Coast Guard Cape York
FREQUENCIES MONITORED

- 27mhz: 1
- VHF: 16 & 82
- HF: 1

QF16 COOKTOWN

https://coastguard.com.au/flotilla/qf16-cooktown/
Cooktown, Queensland 4895
Phone: (07) 4069 5655
Mobile: 0417 075 695

AUSTRALIAN MARITIME SEARCH AND RESCUE INCIDENT

A maritime SAR incident is considered imminent or actual when any of the following conditions exist:

a) A surface vessel or craft has requested assistance.
b) A surface vessel or craft has transmitted or displayed a distress signal.
c) It is apparent that a surface vessel or craft is in distress.
d) A surface vessel or craft is reported to be sinking or to have sunk.
e) The crew is reported to have abandoned ship or is about to do so.
f) Reports indicate that the operating efficiency of the craft is so impaired that the craft may sink, or the crew may be forced to abandon.
g) The surface vessel or craft is overdue or unreported (and initial evaluation has failed to resolve the incident).
h) Persons are in the water and require assistance.
i) A distress beacon has been activated.
j) A MEDEVAC is required on medical advice.

EMERGENCY FREQUENCIES

All Australian Navy ships can monitor 156.8 MHz FM HF/VHF DSC, VHF Channel 16

Limited Coast Radio Stations (LCRS) are located in nine locations: Sydney, Gladstone, Cairns, Darwin, Port Hedland, Fremantle, Adelaide, Melbourne and Hobart and maintain a continuous radio watch by monitoring the following distress frequencies:

- 4125, 6215, and 8291 kHz with 8176 kHz used to broadcast weather and warnings at regular times;
- 156.8 MHz (VHF CH16). Channel 16 is monitored in various other locations in each State/Territory;
- Channel 67 is used to broadcast weather and warnings.

Limited Coast Stations operated by fishing cooperatives and volunteer SAR organisations. Depending on the capability of its equipment, a Limited station may monitor 2182/2524 kHz, VHF CH16 and 27.88 MHz for pleasure craft, and 2182/2112/4535/4620 kHz and VHF CH16 for fishing craft.

The majority of voluntary organisations equipped with HF SSB equipment are capable of responding to calls on the 2 MHz, 4 MHz and 6 MHz marine bands. 2182 kHz is normally monitored continuously as the internationally recognised primary Distress frequency on HF. However, 2524 kHz as the calling and working frequency for shore stations and pleasure craft, is still traditionally preferred and monitored by many operators.

STATE AND TERRITORY MARINE SAFETY AGENCIES

AGENCY NAME	LINKS
Roads and Maritime Services New South Wales and Australian Capital Territory	13 12 36 rms.nsw.gov.au
Maritime Safety Queensland	13 74 68 msq.qld.gov.au
Transport Safety Victoria	1800 223 022 transportsafety.vic.gov.au
Marine and Safety Tasmania	1300 135 513 mast.tas.gov.au
Department of Planning, Transport and Infrastructure South Australia	1300 183 046 sa.gov.au
Department of Transport Western Australia	1300 863 308 transport.wa.gov.au
Department of Infrastructure, Planning and Logistics Northern Territory	08 8924 7100 nt.gov.au

SOME USEFUL GBR WAYPOINTS

The tables below provide some useful waypoints some passages within the inner reef.

These have been sourced from AMSA - Australian Maritime Safety Authority (AMSA) the authority responsible for the regulation and safety oversight of Australia's shipping fleet and management of Australia's international maritime obligations.

HYDROGRAPHERS PASSAGE - EASTBOUND - TERN ISLAND TO BLOSSOM BANK PBG					
No	Waypoint	Latitude s	Longitude e	Course	Distance
1	Tern Island	20 46.40	149 54.80	061	24.5
2	Creal South	20 34.48	150 17.68	025	8.26
3	Creal North	20 27.00	150 21.43	347	21.1
4	Bugatti	20 06.49	150 16.17	008	11.07
5	Bond	19 55.53	150 17.80	022	4.75
6	Ferris	19 51.12	150 19.68	038	9.69
7	Blossom Bank PBG	19 43.47	150 26.00		
	Total Distance				79.37

source https://www.amsa.gov.au/safety-navigation/navigating-coastal-waters/uniform-waypoints-hydrographers-passage

GREAT NORTH EAST CHANNEL - EASTBOUND SHALLOW DRAUGHT - GOODS IS PBG TO DALRYMPLE IS PBG—VIA NORTH OF ALERT PATCHES AND WEST OF COCONUT IS					
No	Waypoint	Latitude S	Longitude E	Course	Distance
1	Goods (S) / Goods Island PBG	10 34.12	142 04.36	087	3.33
2	Harrison (S)	10 33.97	142 07.74	050	2.89
3	Mecca	10 32.13	142 10.00	055	2.58
4	Hammond	10 30.63	142 12.14	088	2.88
5	Nardana	10 30.53	142 15.07	068	5.79
6	Alert NW	10 28.37	142 20.53	085	2.12
7	Marina	10 28.18	142 22.68	099	4.34
8	Twin	10 28.83	142 27.04	066	26.54
9	Kircaldie	10 18.00	142 51.67	038	8.59
10	Bet	10 11.20	142 57.00	033	12.37
11	Dove	10 00.80	143 03.80	028	14.54
12	Arden	09 48.00	143 10.80	044	19.45
13	Dalrymple Island PBG	09 34.00	143 24.50		
	Total Distance				105.41

source https://www.amsa.gov.au/safety-navigation/navigating-coastal-waters/uniform-waypoints-great-north-east-channel

INNER PASSAGE - SOUTHBOUND—SHALLOW DRAUGHT - GOODS IS PBG TO CAIRNS—VIA SOUTH OF HERALD PATCHES, MILES REEF & PETHEBRIDGE					
No	Waypoint	Latitude S	Longitude E	Course	Distance
1	Goods (S) / Goods Island PBG	10 34.12	142 04.36	087	3.33
2	Harrison (S)	10 33.97	142 07.74	050	2.89
3	Mecca	10 32.13	142 10.00	055	2.58
4	Hammond	10 30.63	142 12.14	088	2.88
5	Nardana	10 30.53	142 15.07	068	2.03
6	Hood	10 29.77	142 16.98	090	1.45
7	Ince	10 29.77	142 18.45	116	14.32
8	Alpha (NW)	10 35.92	142 31.60	121	2.89
9	Alpha (S)	10 37.40	142 34.12	140	10.02
10	Albany (S)	10 45.10	142 40.64	114	7.32
11	Wyborn (W)	10 48.08	142 47.45	166	27.33
12	Cairncross	11 14.60	142 54.18	178	10.4
13	Orford	11 25.00	142 54.48	164	10.39
14	Hannibal (W)	11 35.00	142 57.35	138	30.36
15	Nob (W)	11 57.63	143 18.02	180	0.87
16	Clerke (W)	11 58.50	143 18.02	212	7.65
17	Moody (W)	12 04.98	143 13.86	175	8.86
18	Piper	12 13.80	143 14.70	148	13.04
19	Eel (W)	12 24.90	143 21.70	151	29.08
20	Wye (S)	12 50.40	143 36.02	120	2.8
21	Frederick (W)	12 51.78	143 38.52	140	6.58
22	Hudson (W)	12 56.78	143 42.90	160	22.05
23	Wideawake (W)	13 17.55	143 50.50	151	27.78
24	Creech (S)	13 41.75	144 04.53	139	15.53
25	Corbett (S)	13 53.37	144 15.14	141	16.2
26	Pipon Buoy	14 06.00	144 25.60	115	9.33
27	Singleton	14 09.98	144 34.30	143	3.36
28	Rocky (W)	14 12.65	144 36.40	153	10
29	Barrow (S)	14 21.55	144 41.10	131	8.64
30	Bewick (S)	14 27.25	144 47.80	122	9.69
31	Miles (S)	14 32.32	144 56.33	135	14.99
32	Pethebridge (N)	14 42.90	145 07.30	129	18.5
33	Flattery	14 54.43	145 22.26	167	7.25
34	Two Isles (S)	15 01.50	145 23.92	182	39.7
35	Gubbins (N)	15 41.17	145 22.22	157	4.43
36	Hope	15 45.25	145 24.00	162	47.01
37	Low Isles (W)	16 30.00	145 39.00	150	11.54
38	Cairns	16 40.00	145 45.00		
	Total Distance				463.03

source https://www.amsa.gov.au/safety-navigation/navigating-coastal-waters/uniform-waypoints-inner-route-north-and-south

GLOSSARY

AVERAGE WIND SPEED, SUSTAINED WIND SPEED: Speed of the wind averaged over the previous 1 or 10 minutes.

CENTRAL PRESSURE: Pressure at the centre of the tropical cyclone as measured or estimated.

CENTRE OF THE TROPICAL CYCLONE: The estimated position of the surface centre.

CONFIDENCE IN THE CENTRE POSITION: Degree of confidence in the centre position of a tropical cyclone expressed as the radius of the smallest circle within which the centre may be located by the analysts. "**Position good**" implies a radius of less than 30 nautical miles (55 kilometres), "**Position fair**", a radius of 30 to 60 nautical miles (55 to 110 km) and "**Position poor**", a radius of greater than 60 nautical miles (110 km).

DEPRESSION: A synoptic low-pressure area with extra-tropical characteristics where the average wind speed may exceed 33 knots (63 km/h or 38 mi/h) or Beaufort Force 7.

DIRECTION OF MOVEMENT OF THE TROPICAL CYCLONE: The direction towards which the centre of the tropical cyclone is moving.

EYE OF THE TROPICAL CYCLONE: The relatively clear and calm area inside the circular, convective wall clouds.

GALE FORCE WIND: Average surface wind speed of 34 to 47 knots (63 to 87 km/h, 39 to 54 mi/h or wind force of 8 or 9 in the Beaufort scale).

GALE WARNING: Meteorological message intended to warn those concerned of the occurrence (or expected occurrence) and potential impact (for land areas) of gale force winds.

GUST: Sudden, brief increase of the wind speed over its average value.

CYCLONE CATEGORY: The Australian tropical cyclone category scale is largely used across the South Pacific and South-East Indian Ocean, except in American Samoa where the Saffir-Simpson category scale is used. The tropical cyclone category will be included in all bulletins, where appropriate.

HURRICANE OR SEVERE TROPICAL CYCLONE: A tropical cyclone with hurricane force winds. The term hurricane is used in American Samoa for public warnings

HURRICANE-FORCE WIND: Average surface wind of 64 knots (118 km/h, 74 mi/h or Beaufort Force 12) or more.

HURRICANE-FORCE WIND WARNING: Meteorological message intended to warn those concerned of the occurrence (or expected occurrence) and potential impact (for land areas) of hurricane force winds.

HURRICANE LOCAL STATEMENT: A discussion preparedness product, with an overview of the storm, which conveys a succinct message on local impacts from a tropical cyclone.

MONSOON DEPRESSION, MONSOON LOW: A tropical depression (or tropical low) embedded in the monsoon trough.

MONSOON TROUGH: A shear zone with westerly monsoon winds on the equatorial side and easterly trade winds on the poleward side.

SPECIAL WEATHER BULLETIN: Bulletins issued to place threatened communities on alert, to give progress reports on developments or to give specific warnings of tropical cyclones or other disturbances and their potential impacts.

SPEED OF MOVEMENT OF THE CYCLONE: Speed of movement of the centre of the tropical cyclone.

STORM-FORCE WIND: Average surface wind of 48 to 63 knots (88 to 117 km/h, 55 to 72 mi/h or Beaufort Force 10 or 11).

STORM SURGE: The difference between the actual sea level under the influence of a weather disturbance (storm tide) and the normal astronomical tide.

STORM TIDE: The actual sea level as influenced by a weather disturbance. The storm tide consists of the normal astronomical tide, storm surge and wave setup.

STORM-FORCE WIND WARNING: Meteorological message intended to warn those concerned of the occurrence (or expected occurrence) and potential impact (for land areas) of storm force winds.

TROPICAL CYCLONE: A warm-core, non-frontal synoptic scale low pressure system, originating over tropical or subtropical waters with gale force winds (sustained winds of 34 knots or greater) that are likely to continue near the centre. Note: In the Australian region, the gale force winds must extend more than half-way around the centre and persist for at least six hours.

TROPICAL CYCLONE ADVICE: A tropical cyclone watch and/or a tropical cyclone warning.

TROPICAL CYCLONE ALERT: A special weather bulletin providing information on the progress of a cyclone still some distance away and with a significant probability of causing gales or stronger winds in a community in the next 24 to 48 hours.

TROPICAL CYCLONE SEASON: The typical period of the year when tropical cyclone occurs. In the South Pacific and South-East Indian Ocean, it is the period from 1 November to 30 April. (Note: cyclones occasionally occur outside of this period).

TROPICAL CYCLONE YEAR: 1 July to 30 June (in UTC time).

TROPICAL CYCLONE WARNING: A warning of gales or stronger winds and their potential impact associated with a tropical cyclone expected to occur within 24 hours.

TROPICAL CYCLONE WATCH: A forecast message of gales or stronger winds and their potential impact associated with a tropical cyclone occurring after 24 hours and before 48 hours.

TROPICAL DEPRESSION, TROPICAL LOW: A tropical disturbance with a clearly defined cyclonic wind circulation in which the central position can be estimated, and the maximum 10-minute average wind speed is less than 34 knots near the centre. There may be gale force or stronger winds in one or more quadrants but not near the centre.

TROPICAL DISTURBANCE: A non-frontal system of synoptic scale originating over the tropics with persistent enhanced convection and/or some indications of cyclonic wind circulation.

TROPICAL DISTURBANCE ADVISORY/BULLETIN/SUMMARY: A message for exchanging information, internationally, on a range of disturbances including tropical depressions and tropical cyclones.

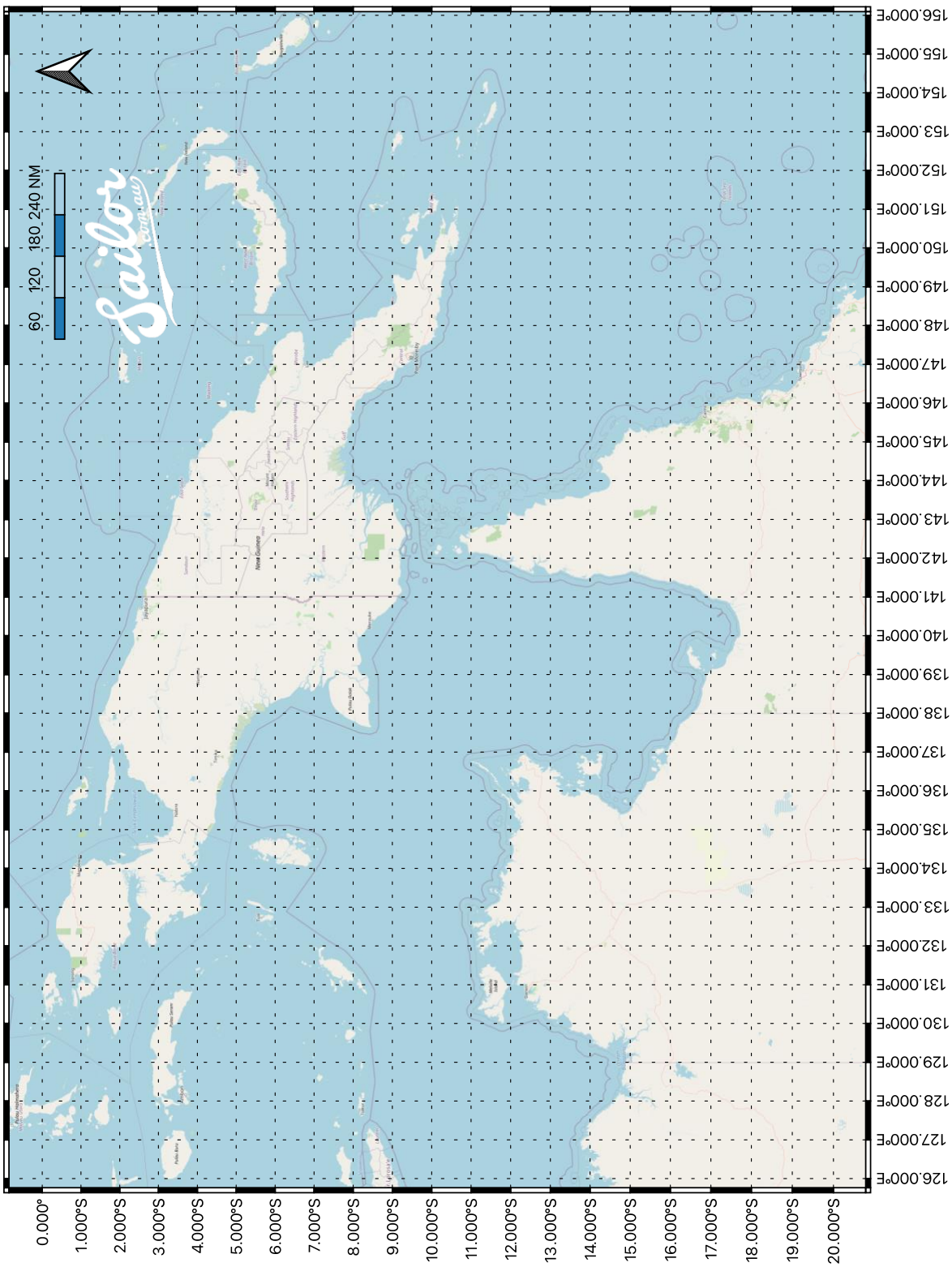
TROPICAL STORM: A tropical cyclone with gale or storm force winds. This term is used in American Samoa.

TROUGH OR TROUGH OF LOW PRESSURE: An elongated zone of low pressure; the axis of a trough is known as the trough line.

WAVE SETUP: Localised increase in the still-water sea level produced by breaking waves close to the shore.

SOURCE: Tropical Cyclone Operational Plan for the South-East Indian Ocean and the Southern Pacific Ocean 2020. World Meteorological Organization. https://community.wmo.int/tropical-cyclone-operational-plans

APPENDIX A - CYCLONE TRACKING CHART



APPENDIX B - NOMOGRAM

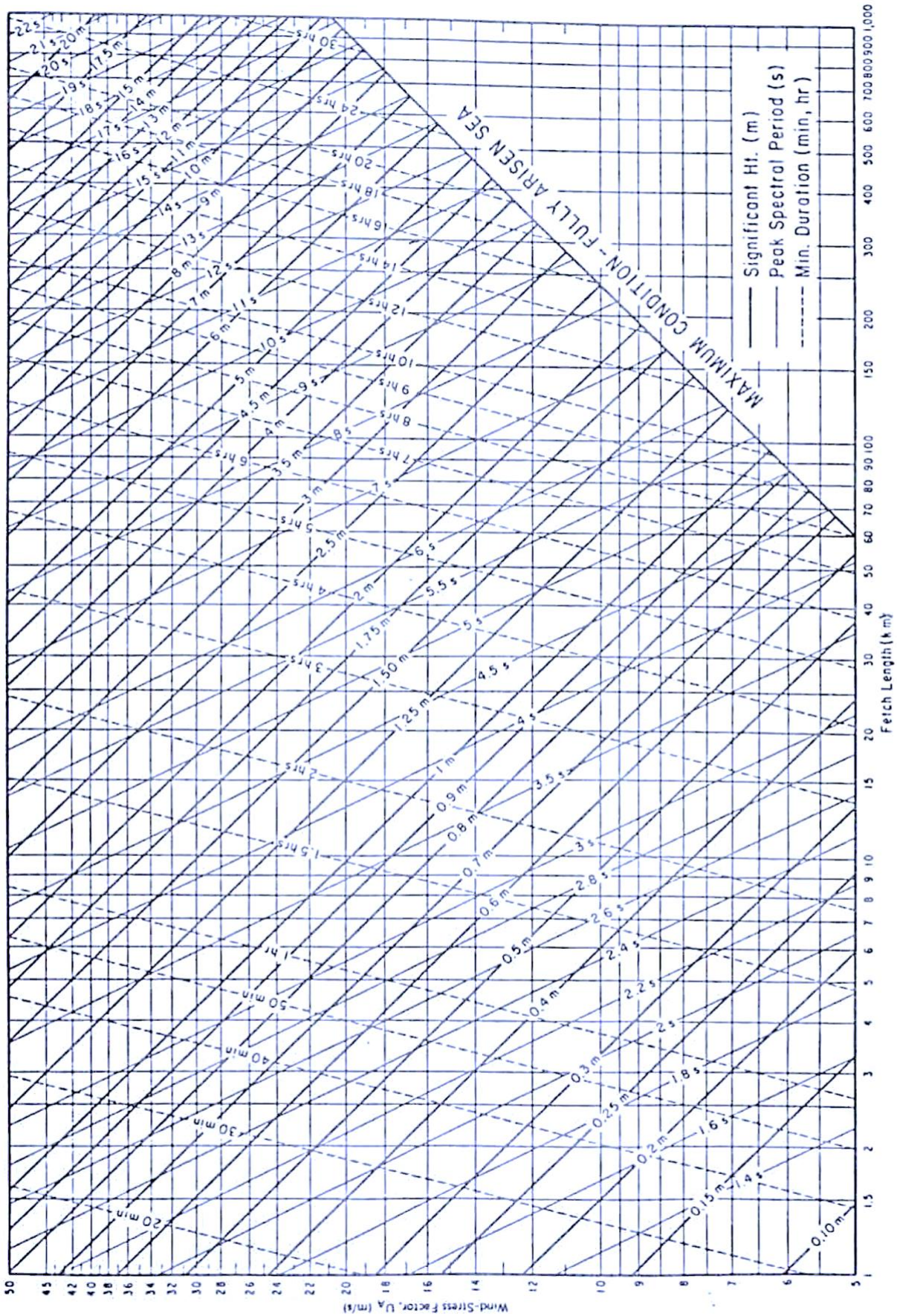
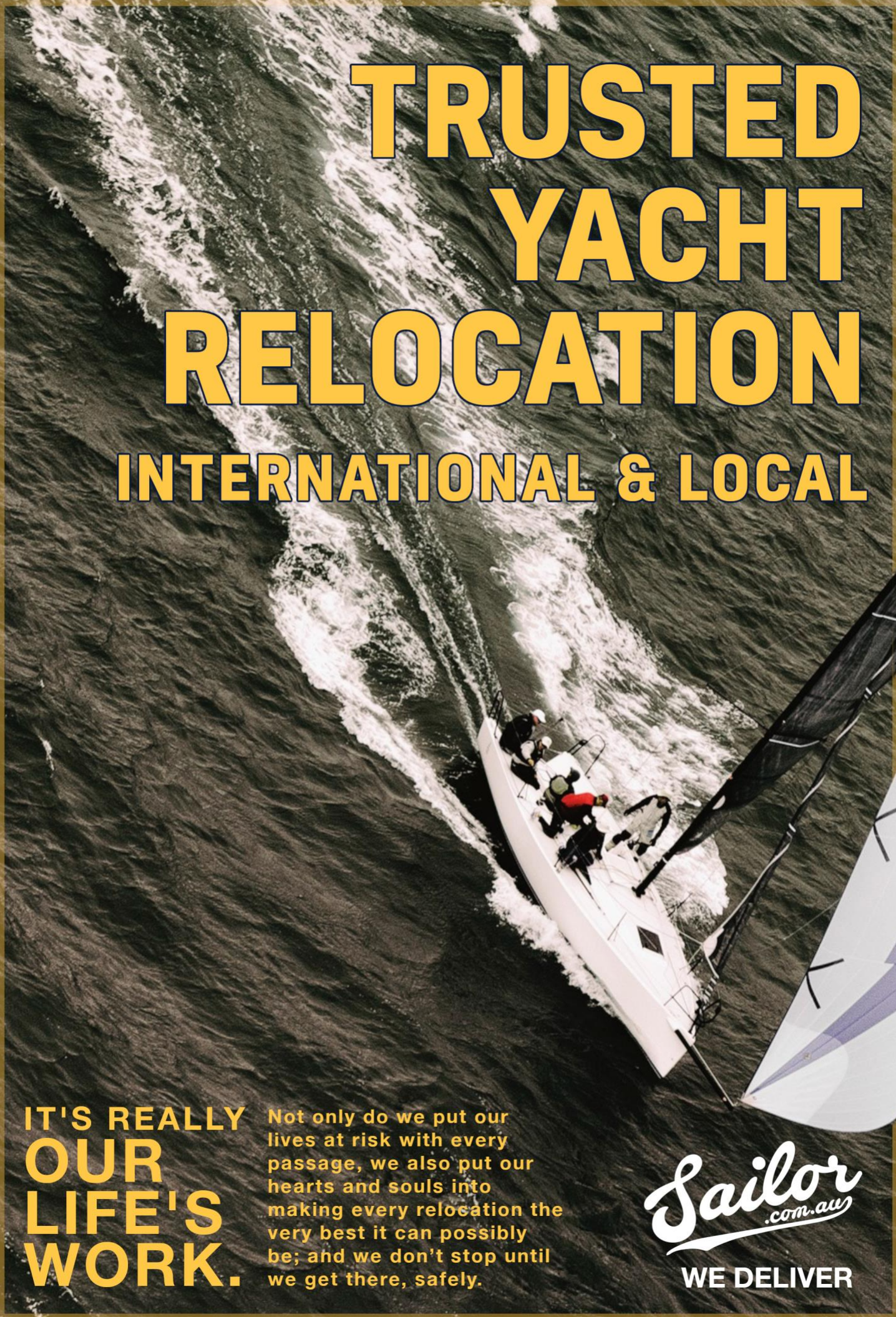


Figure 7. Nomograms of deepwater significant wave prediction curves as functions of wind speed, fetch length, and wind duration


TRUSTED
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RELOCATION
INTERNATIONAL & LOCAL
IT'S REALLY
OUR
LIFE'S
WORK.
Not only do we put our lives at risk with every passage, we also put our hearts and souls into making every relocation the very best it can possibly be; and we don't stop until we get there, safely.
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