

# NINGALOO REEF

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Photo: Shutterstock

This study provides an introductory framework for using Ningaloo Reef as a case study for Ecosystems at Risk. A list of resource links is provided for filling in the detail needed to fully investigate each syllabus point.

The Ningaloo Coast is an interaction between coral reef and limestone karst geology seen in this image. Although the Great Barrier Reef tends to gain most of the nations' focus, Australia's "other reef" is no less spectacular. The Ningaloo Coast is placed at great risk by global changes to climate and ocean chemistry. However, its relatively low visitor numbers and remote location mean that it is in quite pristine condition which contributes to a high level of resilience. Potential threats arise periodically when plans for resource development, particularly oil / gas and ports to the north are proposed.

## SPATIAL PATTERNS AND DIMENSIONS

### Location and Altitude

Ningaloo Coast is located 1200km North of Perth on the Western Australian Coast, in the NW quadrant of Australia and bounded by the Indian Ocean. The reef's latitude ranges from 21°42'14"S - 24° 1'52"S (one of the highest for reefs) and the longitude between 113°25'E - 114° 15'E. The reef is found between shallow waters 0 and 30 metres below mean sea level and oceanic waters to a depth of 500 metres.

GIS maps on Google Earth can be found here <http://ningaloo-atlas.org.au/content/explore/maps>

Figure 1: General location map



Source: <https://hotgetaways.com.au/tour/sight-seeing/ningaloo-reef-humpback-whale-adventure/>

### Size and shape

As a fringing reef, Ningaloo is narrow and extends for 290 km along the West Australian coastline. It is the longest fringing reef in the world and one of only two on the west coast of a continent. The Ningaloo Reef area is a marine environment with Cape Range National Park on the adjacent coast. See Figure 1.

The Ningaloo Marine Park is 4587 km<sup>2</sup> in size, consisting of 2326 km<sup>2</sup> of commonwealth waters and 2261 km<sup>2</sup> of

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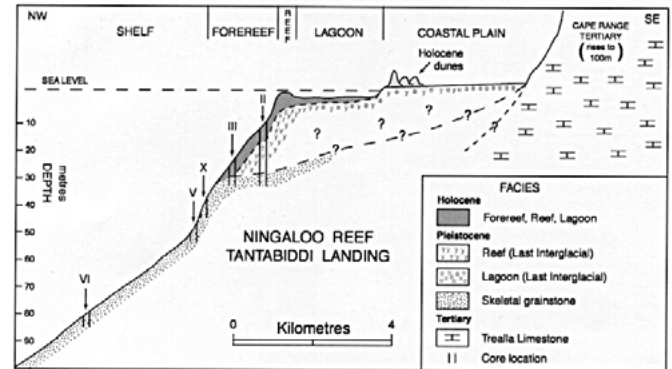
state waters. The World heritage site is 604 500 ha (6045 km<sup>2</sup>) of marine and terrestrial environments - demonstrating the integrated nature of the ecosystems.

## Continuity

The fringing reef is quite young, at only about 7- 8000 years old. The karst landscape adjacent to the reef owes its geological origin to previous reef activity and sea level change. See Figure 2.

Uplifted wave-cut terraces and fossil reefs fringe the Exmouth Peninsula and submerged fossil reef terraces form the substrate of the developing modern reef. These features contribute to the region's outstanding heritage value. Figure 2 shows the structure of the coastline where Ningaloo reef is building on a foundation laid by previous reefs. The source of this diagram can be used to further investigate the past geological history of the area.

**Figure 2: Idealised northwest-southeast cross-section of northern Ningaloo Reef based on transect core and seismic data.**



Sources: Collins, Lindsay & Zhu, Z. & Wyroll, K. & Eisenhauer, Anton. (2002). Geological evolution of the northern Ningaloo Reef System during the late Quaternary. 1. Ningaloo Marine Park – Reef Morphology and Growth History (WAMSI) – <https://www.wamsi.org.au/sites/wamsi.org.au/files/Node%203.4.1%20Reef%20Morphology%20and%20Growth%20History.pdf>

## Further reading

The following article provides a deeper insight into the continuity of coral reef formation along this section of the Western Australian coast. 'Travels in Geology: Twin coral reefs separated in time in Western Australia' <https://www.earthmagazine.org/article/travels-geology-twin-coral-reefs-separated-time-western-australia>

## BIOPHYSICAL INTERACTIONS

### Dynamics of weather and climate

Ningaloo has a hot and arid climate with an average annual temperature of 24.8°C and precipitation of 260 mm. This climate results in low run-off of very high, water quality for coral reef building. See Figure 3.

The area is subject to regular tropical cyclones with events expected every 2–3 years (BOM). The most severe storm on Australian record was tropical cyclone Vance which struck Exmouth in 1999. Cyclones cause strong destructive winds in excess of 100km/h and high levels of precipitation.

**Figure 3: Climate statistics and sea temperatures for Coral Bay**

CORAL BAY		CORAL BAY (5 meters)				
Month	Sea Water Temperature °C	Month	Average low (°C)	Average high (°C)	Precip. (mm)	Precip. days
January	24	January	23	38	26	
February	26	February	24	37	40	
March	26	March	23	36	40	
April	26	April	20	33	15	
May	26	May	16	28	41	
June	24	June	13	24	40	
July	23	July	11	24	22	
August	22	August	12	26	11	
September	22	September	14	29	2	
October	22	October	16	32	2	
November	23	November	18	34	2	
December	23	December	20	36	5	
		YEAR			246	

Source: <https://www.travelguide-en.org/coral-bay-climate/#>

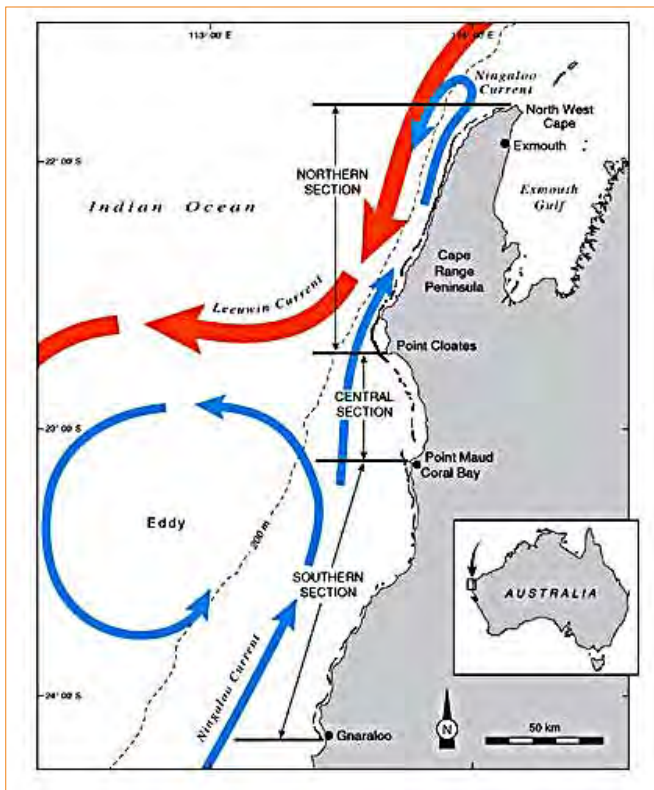
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## Geomorphic and Hydromorphic Interactions

The Leeuwin and Ningaloo Currents are a major determinant in Ningaloo Reef's location. The Leeuwin Current draws warmer water from the north allowing Ningaloo's reef-building corals to flourish. Most reef building coral species grow optimally in water temperatures between 23°–29°Celsius (NOAA).

However, the Ningaloo current also brings cooler water from the south which combines with the latitude of the area to place it on an ecotone, between tropical and temperate waters. This results in the Ningaloo Coast hosting an unusual diversity of marine species. See Figure 4

Figure 4: Ocean currents on the Ningaloo Coast



The Leeuwin Current brings warm waters south allowing for coral growth. The Northward Ningaloo Current comes closer to the Leeuwin Current between March and July creating an eddy of upwelling. This brings an abundance of zooplankton which attracts whale shark feeding congregation

Source: <https://www.latitudegeography.org/ningaloo-reef.html>

The arid climate is beneficial for coral. Most reef-building corals require very saline water ranging from 32 to 42 parts per thousand and water with very low turbidity to allow the maximum amount of light to penetrate. The average annual rainfall of 260mm supports these requirements. See Figure 3.

The main terrestrial feature of the Ningaloo Coast is the extensive karst system which is the product of millions of years of marine fauna skeletons that were deposited

in what is now ancient regressed seas, uplifted terrain and network of underground caves and water courses of the Cape Range. The karst system includes hundreds of separate features such as sinkholes, caves, dolines and subterranean water bodies and supports a rich diversity of highly specialised subterranean species (UNESCO).

Sediment formation on the Ningaloo coast is also highly biological as broken coral pieces are further eroded by wave action, Parrotfish "chew" coral and deliver fine sediment in their faces and mollusc shell pieces are eroded.

## Biogeographical Interactions

The Ningaloo Coast is notable for its very high biodiversity. Over 300 documented coral species of coral are present on the Ningaloo Coast. Reef building corals are the keystone species as they provide the habitat for all other species in the ecosystem. Coral polyps have a symbiotic relationship with algae *zooxanthellae*.

Over 700 reef fish species, roughly 650 mollusc species, as well as around 600 crustacean species and more than 1,000 species of marine algae all live within the reef. The high numbers of 155 sponge species and 25 new species of echinoderms add to the significance of the area (UNESCO).



Ningaloo Reef has high levels of biodiversity. Source: Shutterstock

The flora and fauna of the Ningaloo Coast have developed a range of adaptations to inhabit ecological niches. These physiological and behavioural adaptations include camouflage, symbiosis, territoriality and distinct breeding patterns. An example of this is the annual coral spawning that occurs approximately 10 days after the full moon in March or April. Predator relationships, such as the *Drupella* snail are thought to have a positive effect on the diversity of their prey by pruning faster growing corals.

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Ningaloo also forms the habitat for several high value species including marine mammals such as dugongs, whale sharks (Rhincodon typus), manta rays, many species of turtle (including Loggerhead and Green turtles).

The whale shark is known to migrate globally making Ningaloo an important site ecologically. Whale sharks congregate at Ningaloo between March and July. While the exact purpose of these congregations are unknown, it is believed to be a feeding event (Tourism Western Australia).



Whale sharks are a major tourism attraction. Source: Shutterstock.



Image source: Wikimedia Commons

## Further reading

The following article is about research in 2020 that discovered previously unknown species on the reef: *'Rare pictures uncover diverse marine life at Ningaloo Reef'*

<https://www.news.uwa.edu.au/2019091011602/research/rare-pictures-uncover-diverse-marine-life-ningaloo-reef>

## THE NATURE AND RATE OF CHANGE and ECOSYSTEM FUNCTIONING

Tropical cyclones are a key natural stress for the Ningaloo coast. The strong winds and waves damage coral structures and the high rainfall can result in freshwater pooling. In response the outskirts of reefs tend to grow less delicate branching corals. Areas that have been destroyed are also able to be recolonised by neighbouring coral and the annual coral spawn.

Corals thrive in locations that also happen to be near their physiological limits, making them sensitive to stresses caused by sea temperature anomalies resulting in the phenomenon known as coral bleaching (AIMS). When stressed by high temperatures the symbiotic relationship between coral polyps and the zooxanthellae algae breaks down and is expelled resulting in **bleaching** events. This is not necessarily lethal for the coral; however, repair may take 10–20 years and greater frequencies of coral bleaching will result in the death or the decline of the coral cover.

Predator-Prey dynamics are common factors affecting coral reefs globally. Ningaloo's reefs are not heavily affected by the crown of thorns starfish. However, outbreaks of *Drupella* (a type of snail) have drastically reduced coral cover, destroying 90% of corals in parts of the northern reef at Ningaloo Reef in 1997. More on [Drupella snail outbreaks](#).

### The nature and rate of change which affects ecosystem functioning

Coral polyps are a finely tuned species with a very narrow range of tolerance. This makes them quite vulnerable.

There are a wide variety of changes which affect the ecosystem. These might be natural or man-made and might be very gradual or rapid and catastrophic.

#### Rapid Changes

i. Tides:

- Tides affect the vertical extent of the coral.
- Tides are a response to the sun and moon's gravitational pull on the earth's water.

ii. Weather:

- Weather changes daily and the Ningaloo area is prone to heat waves in summer months.
- Heat stress causes the coral to exclude the zooxanthellae algae which can result in coral bleaching.
- Increased bleaching will cause starvation, killing the coral.

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## iii. Tropical cyclones:

- Tropical cyclones cause extreme wind and wave action and potentially, storm surges.
- This violent action can damage the reef structure.
- Fresh water pooling can also cause stress on coral.

## Medium Changes

### i. Climate change:

- The issue of the climate change of significant for marine park and World Heritage management of the reef. The key issues for Ningaloo are likely to be coral bleaching, increased storminess, increased sea-level and ocean acidification.
- As with the Great Barrier Reef, Ningaloo can be aided to be more resilient to climate change impacts by ensuring that local impacts from mining and tourism don't create too much strain.

### ii. Ocean acidification:

- Ocean water naturally has a pH of 7.5–8.5. Coral polyps exude an exoskeleton of limestone. The coral skeleton forms the structure of the reef which many other organisms use as their habitat.
- Ocean pH is subject to change as it forms a dynamic equilibrium with atmospheric CO<sub>2</sub> (increasing acidification is a threat to coral survival)

### ii. Sea surface temperatures:

- Ocean/Atmospheric exchanges (La Niña/El Niño). Strong La Niña events push water south from Indonesia creating far higher temperatures than the seasonal average and a very large coral bleaching event resulted.

## Slow Changes

- Sea level change

## Further reading

Scientists Pinpoint How Ocean Acidification Weakens Coral Skeletons – <https://www.who.edu/press-room/news-release/scientists-identify-how-ocean-acidification-weakens-coral-skeletons/>

## Human Impacts

Tourism puts pressure on preservation of the reef while mineral exploration places the extraction of resources at higher value.

As most people know little about Ningaloo Reef, its anonymity and distant location benefit it.

### i. Development (-ve)

- Proposed development of “Maud’s Landing” was highly controversial as it threatened to disturb loggerhead turtle breeding areas. Although it did

not proceed it was partly responsible for the World Heritage listing.

- Any development of the region places additional pressure on numerous aspects of local ecology:
  - The water cycle is disturbed, and wastewater / sewage are generated
  - Construction and dredging activities generate turbidity.
  - Additional human activity is generated and pushed into remote areas
  - Animal breeding habits may be disturbed.
- In 2012 Tony Abbott made an election promise to “develop the north” and encourage future development in the region. This approach was favoured by both sides of politics. Colin Barnett the Western Australian Premier has also long held a pro development stance. The [Gascoyne Development Commission](#) is a Western Australian Government statutory authority dedicated to the economic and social development of the region.
- In 2020 a proposed oil and gas pipeline fabrication facility (Subsea 7) and towing operation in the nearby Exmouth Gulf was out on hold until June 2021.

## Further reading

Pipeline near WA’s Ningaloo put on hold – <https://www.canberratimes.com.au/story/6900650/pipeline-near-was-ningaloo-put-on-hold/>

### ii. Tourism (-ve/+ve)

- Tourism is the number one economic driver in Gascoyne region, followed by fishing, retail, mining, horticulture and pastoral industries.
- Tourism in the area is primarily self-drive and there is limited air access.
- The reef is rarely more than a few kilometres offshore and in many places is directly off the beach - possible for tourists to wade out to.
- Ningaloo’s pristine environment ironically attracts people which has a damaging effect on the reef. Snorkelling and fishing are the main tourist activities, and both can be highly sustainable if managed well. The remoteness of Ningaloo reef tends to attract a nature loving type of tourist.

### iii. Military Activity (-ve)

- Learmonth Air Weapons Range Facility covers about 18,954 hectares is used for military exercises and as a bombing range.
- It was one of Australia’s most active bombing ranges until around 1990. Exmouth also has a significant history of US naval presence. The Federal

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Government's 2016 Defence White Paper allocates an investment of over \$400 million into Exmouth to develop missile defence and space capabilities; including the relocation of a space surveillance telescope to be set up near the Harold E Holt Naval Communication Station and the Learmonth RAAF Base.

- Future bombing activities on the Learmonth Air Weapons range may pose a potential threat, in particular to the Bundera sinkhole which is located on Defence land. A 2009 review of Department of Defence ranges recommended its continued use in the future.
- Although Defence land within the heritage site is subject to the EPBC Act, the act may be countermanded if this is "in the interests of Australia's defence or security, or in relation to a national emergency".

## iv. Mining (-ve)

- Both BP and Royal Dutch Shell have bid to conduct test drills for hydrocarbon resources as close as 48 kilometres from the Commonwealth marine park boundary.
- Shell was given approval for exploration 50km west of Ningaloo in July 2011 and Fortescue Metals submitted an application to explore for minerals along a 500km stretch of WA coastline but later recalled the application.
- In addition to the increased risk of oil spills the seismic vibrations impact on sea turtles, fish and whales that frequent the area.
- Hydrocarbon mining also bring an increased frequency of shipping activity which raises the risk from oil spills and exotic introductions from ballast water.
- The Exmouth gulf has also faced plans for a salt mining operation. This has been protested by WWF and a group called Halt the Salt! - primarily on the grounds of damage to associated ecosystems like mangroves forests.
- As with the GBR, there is now an interesting debate about whether Australia should be developing hydrocarbon industries. Global carbon pricing may result in the creation of "stranded assets" and prevent Australia from transitioning to other industries in a timely manner. Students can use this to explore opportunity cost.

## v. Fishing, Snorkelling and other water activities (-ve)

- The Ningaloo Marine Reserve is multi use zone with many commercial activities, such as fishing not permitted. However, multiple small-scale operators can also have an impact.

- Anchor drop is a major impact that results from fishing, diving and snorkelling vessels and can result in significant damage to coral structures. Cruise ship anchor activity has significantly larger impacts. This damage is easily avoided with mooring buoys.
- Reef walking and snorkelling are both highly ranked tourism experiences, but both are high impact activities.
- Tourism activities disturb breeding patterns, although strict behaviour is required when encountering animals such as Whale Sharks. See Figure 8

## vi. Feral Animals

- Weeds, cats and foxes are all common feral species on the Ningaloo coastline. They reduce vegetation which lowers water quality and affect various trophic levels.
- Exotic predation places stress on species unaccustomed to predators.
- Foxes are a significant problem for turtle hatching and the area is also likely to be within the distribution of cane toads in the future.

## vii. Climate change and Sea level rise (-ve).

See Figure 5

- Probably the biggest threat to the reef
- Extreme heat bleaches coral. See Figure 6
- Climate temperature rises enhance the frequency and severity of tropical cyclones
- Greater stress makes coral more susceptible to pest out breaks like Crown of Thorns
- Sea level rises mean coral cannot adapt quickly enough
- Ocean acidification (changes negatively from around 8) mean that coral cannot build its limestone structures and prevents growth and repair.

## viii. Environmental Management (+ve)

- The scientific management of ecosystems is improving, and Ningaloo coast's isolation meant there were fewer visitors in the era of poorly behaved tourism. Tourists and development now face stricter controls.
- The Ningaloo Collaboration Cluster is a major research project that commenced in the region in 2007.
  - The project involves researchers from the CSIRO, Sustainable Tourism Cooperative Research Centre and a range of Australian Universities including Uni of Western Australia, ANU and Uni of Queensland.

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- The project will deliver a dynamic model of Ningaloo incorporating socioeconomic and environmental load implications of human activity in the region that can be integrated with an ecological model of the region with the aim of developing planning tools and management models to ensure sustainable use of the region.

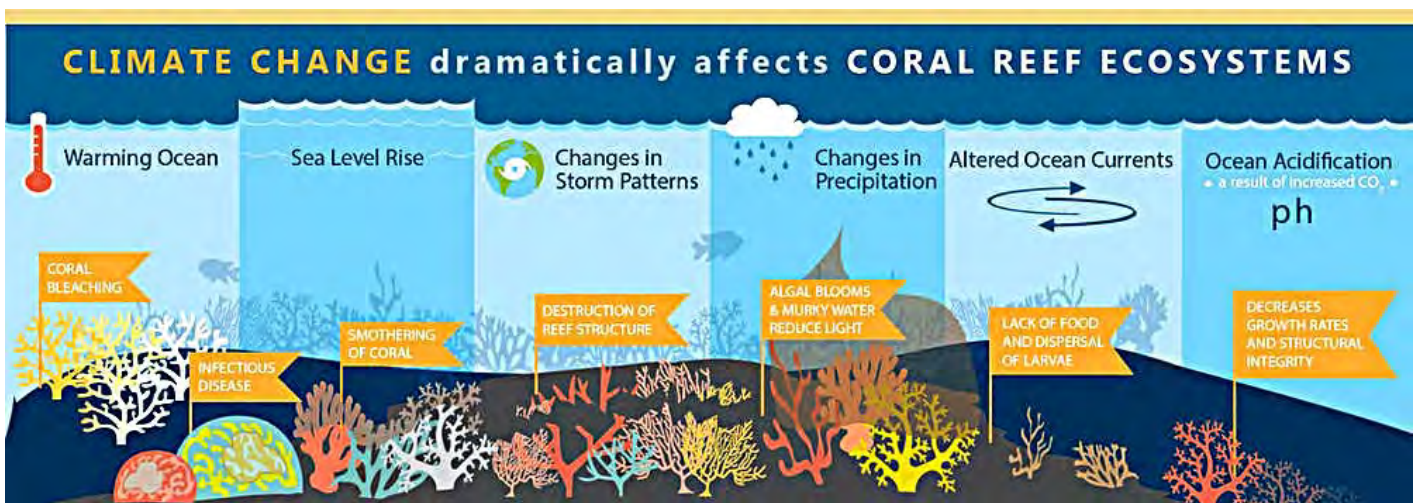


Source: <http://www.ningaloo reefboathireexmouth.com.au/gallery.html>

## ix. World Heritage Listing (+ve)

- Inscribed in 2011
- World heritage status places international pressure on government to protect the area.

Figure 5: Impacts of Climate Change



Source: <https://reefci.com/2017/10/20/climate-change-and-coral-reefs-2/>

## MANAGEMENT STRATEGIES

### Traditional Management

- Aboriginal occupation of area evident for 32 000 years through middens, fish traps and burial grounds.
- Jinigudira people occupied most of Ningaloo Coast from Northern tip. Baiyungu people occupied the southern portion of the reef coast.
- Under traditional law, Aboriginal people are responsible for, and obliged to protect, preserve and manage areas, sites and objects of Aboriginal significance associated with their country.
- Traditional management includes protection and preservation of physical sites and objects as well as the traditional knowledge and practices pertaining to them.
- The "meaning" of the land is also important as it reveals the record of creation and the history (The events of Dreamtime).
- These responsibilities and obligations are of continuing importance to Aboriginal people, particularly with respect to teaching cultural heritage to the young.

Figure 6: Coral Bleaching



Source: <https://climatechange.ita.gov/climate-impacts/coral-reef-degradation/>

- The Gnulli Native Title claim (represented by the Yamatji Land and Sea Council) may also see this land management continued.
- Hunting of dugong and turtle are an example of finding a balance between contemporary and traditional management practices

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- Coral Coastal Park demonstrates cooperation between Gnulli Working Group, Baiyungu traditional owners and CALM to facilitate Aboriginal involvement in management of the Ningaloo Marine Park and the Cape Range National Park.
- A Draft plan of management for Ningaloo Coast Reserves that include part of the marine park was released for consultation in 2019.

## Further reading

For insight into Aboriginal cultural heritage, managing traditional values and the contribution of traditional owners to the planning for the *Nyinggulu* (Ningaloo) coastal reserves by the WA Department of Biodiversity, Conservation and Attractions read:

Nyinggulu (Ningaloo) coastal reserves, Red Bluff to Winderabandi, Draft Joint Management Plan. (Pages 9–23) <https://www.dpaw.wa.gov.au/images/documents/conservation-management/managementplans/Ningaloo%20coastal%20reserves%20draft%20joint%20management%20plan%202019.pdf>

## Contemporary Management

Maps showing management zones can be found here <http://ningaloo-atlas.org.au/node/215>

- The Ningaloo coast is managed jointly by WA (along shoreline) CALM and the Commonwealth (over deeper waters) Department of Environment
- Management uses multiple reserve zones and restricted use areas. See Figure 10
- Area is managed for conservation and recreation and management plans have been developed to protect environmental, social and economic values.
- There are numerous State/Commonwealth legislation governing Ningaloo reef:
  - Wildlife Conservation Act (1950),
  - Environmental Protection Act (1986),
  - The Aboriginal Heritage Act (1972) and the Conservation and Land Management Act (exception: pastoral leaseholds) (1984).
  - The entire marine component is subject to the Fish Resources Management Act (1994).
- World Heritage Listing in 2011 provides additional pressures on Governments to protect the reef.
- Designation as a Hope Spot by Mission Blue. See Figure 7
- Research and scientific investigation are utilised to ensure management plans are effective. Plans are redrawn as needed. The Ningaloo Collaboration Cluster is a major CSIRO research project.

- Technology aids ecological management
  - Robot sensors used to scan sea floor
  - Tourist photos of whales and sharks to create a movement database
  - remote underwater stereo-video (stereo-BRUV)
  - Lidar photography (bathymetry)
- Visitors to the area are educated through signs and guides. Such as rules for whale shark and whale watching. See Figure 8
- Activism: Interest Groups such as [Protect Ningaloo](#) advocate for protection and seek community support to oppose proposed developments such as [Subsea 7](#). See Figure 9

**Figure 7: Hope Spot naming**

The world heritage-listed Ningaloo Reef and adjacent Exmouth Gulf were together named a Hope Spot by international marine science organisation Mission Blue, which is run by legendary oceanographer Dr Sylvia Earle. Hope Spots are natural environments which contain significant marine ecological values that are threatened, and it was decided the coastline around Exmouth met the criteria on the back of a scientific review released by Dr Ben Fitzpatrick in July. Dr Fitzpatrick said a Hope Spot listing would help to achieve broader recognition of the ecological values and better protection of the area.

Source: <https://www.pilbaranews.com.au/news/pilbara-news/ningaloo-reef-exmouth-gulf-named-global-hope-spots-ng-b881289003z>

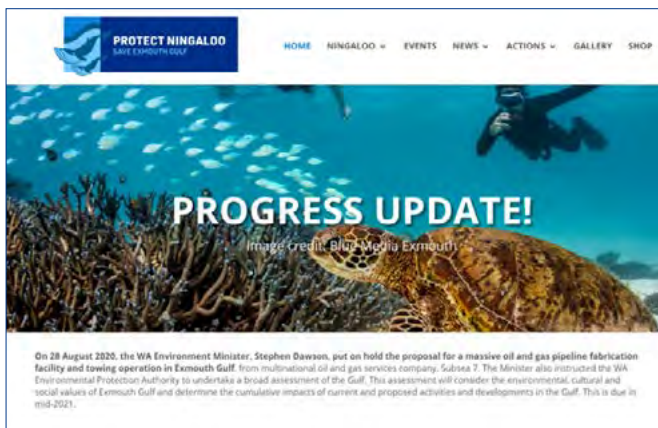
**Figure 8: Rules for wildlife tourists**



Whale shark management in WA  
Source: <https://www.dpaw.wa.gov.au/plants-and-animals/animals/whale-sharks?showall=&start=2>



Figure 9: Activism: Protect Ningaloo



Source: <https://www.protectningaloo.org.au/stop-subsea-7/>

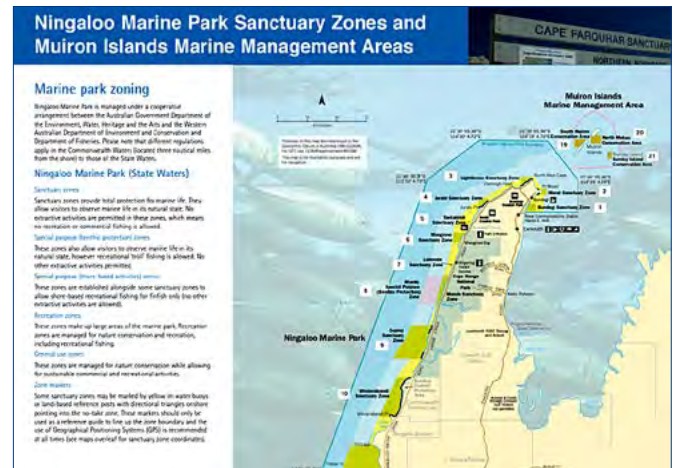
## Evaluation of management

- Traditional Management has proven extremely sustainable. However, it is no longer possible and relies on extremely detailed ecological knowledge being woven into every aspect of culture.
- Contemporary management is only as effective as the will to protect the ecosystem. As with other ecosystems, this may require the utility values from tourism and ecosystem biological values to achieve higher value than is being derived from mineral extraction in order for protection and management of the reef to be taken seriously.
- International involvement, such as the World Heritage listing, places additional requirements on Governments to protect the coastline. However, international threats also pose the greatest risk to the ecosystem and it is most threatened by climate change, which is beyond the control of Australian governments. The Coalition government has taken little direct action to address climate change.

**The verdict:** The Ningaloo coast is one of the best-preserved reef systems in the world however sustainability is not ensured. Sustainability requires continued valuing by the Australian community and businesses operating within or near the reef such as Live Ningaloo. Global forces such as climate change and ocean acidification are major threats that are beyond local control.

Read an interesting commentary of the management of Ningaloo over time from author Tim Winton here: 'Saving Ningaloo Again' <https://www.themonthly.com.au/issue/2018/december/1543582800/tim-winton/saving-ningaloo-again#mtr>

Figure 10: Marine Park Management Zoning



Ningaloo Marine Park Sanctuary Zones and Muiron Islands Marine Management Areas (Screen capture) Source: [http://ningaloo-atlas.org.au/sites/default/files/Ningaloo%20Marine%20Park%20\(State%20Waters\)%20brochure.pdf](http://ningaloo-atlas.org.au/sites/default/files/Ningaloo%20Marine%20Park%20(State%20Waters)%20brochure.pdf)

## Resources

- TED: Ningaloo Reef and why it is important (Natural resource exploitation threats) <https://www.youtube.com/watch?v=CtcGlr7utTM>
- Ningaloo reef is unique (CSIRO) <https://research.csiro.au/ningaloo/>
- Ningaloo Atlas <http://ningaloo-atlas.org.au/>
- Ningaloo Marine Park <https://parksaustralia.gov.au/marine/parks/north-west/ningaloo/>
- Ningaloo Marine Park <https://www.marineconservation.org.au/ningaloo-marine-park/>
- Ningaloo Coast World Heritage Area <https://www.dbca.wa.gov.au/parks-and-wildlife-service/world-heritage-areas/ningaloo-coast-world-heritage-area>
- Map: Ningaloo Coast World Heritage Area [https://www.environment.gov.au/system/files/pages/31a9e336-d04a-48cb-810b-76a2b53751ac/files/ningaloo\\_coast\\_map.pdf](https://www.environment.gov.au/system/files/pages/31a9e336-d04a-48cb-810b-76a2b53751ac/files/ningaloo_coast_map.pdf)
- Guidelines for interacting with wildlife (whale sharks, whales, manta rays, dugong) [http://ningaloo-atlas.org.au/sites/default/files/Ningaloo%20Marine%20Park%20\(Commonwealth%20Waters\)%20visitors%20guide.pdf](http://ningaloo-atlas.org.au/sites/default/files/Ningaloo%20Marine%20Park%20(Commonwealth%20Waters)%20visitors%20guide.pdf)
- Backgrounder: Climate change and the tropical marine environment <http://www.aims.gov.au/docs/research/climate-change/position-paper.html>
- NOAA Ocean Services (Infographics) <https://oceanservice.noaa.gov/facts/coralreef-climate.html>
- CSIRO: Ningaloo Outlook <https://research.csiro.au/ningaloo/outlook/>

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- Ningaloo Reef could be wiped in 30 years <https://thewest.com.au/news/environment/ningaloo-reef-could-be-wiped-in-30-years-warns-intergovernmental-panel-on-climate-change-ng-b88984088z>
- Dive into Ningaloo on Streetview, 2020 <https://australia.googleblog.com/2020/06/dive-into-ningaloo-on-google-street-view.html>
- Ningaloo Marine Park – Reef Morphology and Growth History Final Report <https://www.wamsi.org.au/sites/wamsi.org.au/files/Node%203.4.1%20Reef%20Morphology%20and%20Growth%20History.pdf>
- Travels in Geology: Twin coral reefs separated in time in Western Australia <https://www.earthmagazine.org/article/travels-geology-twin-coral-reefs-separated-time-western-australia>
- Ningaloo Reef, Exmouth Gulf named global Hope Spots <https://www.pilbaranews.com.au/news/pilbara-news/ningaloo-reef-exmouth-gulf-named-global-hope-spots-ng-b881289003z>
- Coral bleaching and reef degradation <https://climatechange.lta.org/climate-impacts/coral-reef-degradation/>
- Whale shark management (Government of WA) <https://www.dpaw.wa.gov.au/plants-and-animals/animals/whale-sharks?showall=&start=2>
- Ningaloo survey finds deep treasures worth protecting National Science Environment Program: Marine Biodiversity Hub. <https://www.nespmarine.edu.au/news/ningaloo-survey-finds-deep-treasures-worth-protecting>
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