



# RESILIENT REEFS NINGALOO

## THE RESILIENT REEFS INITIATIVE

Resilient Reefs is a global initiative to support coral reefs - and the communities that depend on them - to adapt to climate change and local threats. Ningaloo is one of just five World Heritage-Listed reefs to be part of the initiative, which seeks to bring together community members, reef managers and global resilience experts to strengthen the ability of our Reef, coastline and communities to adapt to change. Following the development of a Resilience Strategy for the Ningaloo Coast, up to \$1 million in seed funding is available to implement innovative solutions to the challenges that we are facing both now and in the future.

## WHAT IS RESILIENCE?

**Resilience is the capacity of reef ecosystems - and the individuals, businesses and communities that depend upon them - to survive, adapt and recover in the face of change.**

Healthy reef ecosystems depend on people and people depend on healthy reef ecosystems. Resilient Reefs focusses not only on ecological resilience, but also the resilience of the community that relies upon the reef for income, recreation and enjoyment.

In the future, reefs and communities may face challenges related to climate change, pollution, overfishing, changing population, increases or declines in tourism, and the need to balance conservation of the natural environment with a desire to build a more diverse and sustainable local economy.

By building resilience, we are strengthening the ability of communities to prepare for and recover quickly from disturbances, adapt to changing circumstances and plan for an uncertain future. This integrated approach puts people at the centre of decision making, drawing on a global resilience practice to innovate, build capacity and drive a whole-of-community approach to the challenges facing our treasured reefs.



Figure 1. The Reef Resilience Framework – Dimensions and Attributes

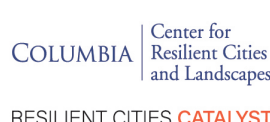
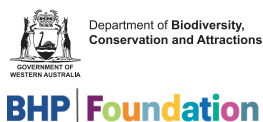
## WE WANT TO HEAR FROM YOU!

The development of the Resilience Strategy involves collaboration at all stages, generating innovative solutions in partnership with the local community, researchers, managers and global experts. The initiative is guided by a Working Group made up of representatives of the community, and engages directly with stakeholders through an interactive online platform, community workshops, interviews and surveys.

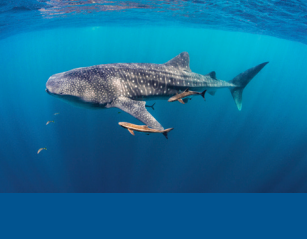
You can help us understand what community members value the most about living and working along the Ningaloo Coast, what they want for the future, and the key challenges and threats that we might face. We also want to hear innovative solutions for overcoming these challenges. This understanding will guide the actions and priorities within the Resilience Strategy. The following fact sheets outline the current state of our environment, community and governance system, as well as potential challenges for the future.

For more information and to have your say, visit [www.resilientreefsningaloo.com](http://www.resilientreefsningaloo.com)

Resilient Reefs is a collaboration between the Great Barrier Reef Foundation, UNESCO World Heritage Marine Programme, The Nature Conservancy, Columbia University's Center for Resilient Cities and Landscapes, Resilient Cities Catalyst and AECOM. The global initiative is enabled by the BHP Foundation. It is being delivered in Ningaloo by the Department of Biodiversity, Conservation and Attractions.



Great Barrier  
Reef Foundation



# Resilient Reefs Fact Sheet: ECOSYSTEM

## Current State of the Reef...

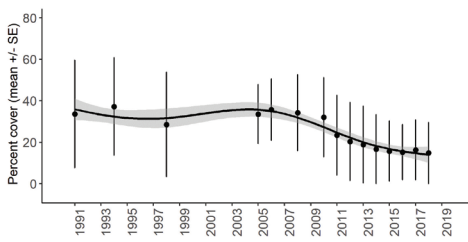
### A HEALTHY AND DYNAMIC MARINE ENVIRONMENT:

- Due to limited development and strong management frameworks, Ningaloo has **few local pressures** compared to many other reefs.
- Ocean currents and regional weather patterns provide **some protection from mass coral bleaching events**.<sup>[5]</sup>
- **Populations of iconic species** (like whales, whale sharks, mantas and adult turtles) are currently stable or increasing, as far as we know.
- Complex and diverse coral, seagrass and mangrove habitats support **high levels of abundance and diversity** of both tropical and temperate fish species.
- **Low occurrences of coral disease**, though outbreaks of *Drupella* have previously caused significant damage to parts of the reef.<sup>[1,3,11,23]</sup>
- **High diversity and abundance of herbivorous fish present**<sup>[38,39]</sup>, which help maintain the corals and assist in recovery.



### ...WHICH IS STARTING TO CHANGE:

- **Seawater temperature has increased** by ~1°C over the last 32 years, and coral bleaching is becoming more frequent.<sup>[1,11,12]</sup>
- **Coral cover seems to be declining** at some monitoring sites along the reef, which is correlated with rising water temperatures and marine heatwaves.<sup>[1,11,12,29]</sup>
- **Marine heatwaves in 2011 and 2013 caused significant bleaching in some areas.** Regionally, 75% of WA reefs are currently at (or near) their lowest recorded coral cover.<sup>[11,13,15,21]</sup>
- **The Reef takes at least 5-10 years to recover from disturbances**, due to highly variable recruitment and connectivity.<sup>[1,4,14,20,35,27,28]</sup>
- **Trends in fish stock are variable and uncertain:** Major local declines in some corallivorous fishes since 2011 are correlated with decreases in coral cover. However, estimations of fish species targeted by recreational anglers vary greatly - some studies find stable, or even increasing populations; others find overall declines in some species.<sup>[7,29,30]</sup>



Mean coral cover (±1 SE) at all sites located within the Ningaloo marine reserves.<sup>[12]</sup>

### CASE STUDY:

#### HOW MULTIPLE DISTURBANCES CAUSED REEF COLLAPSE AT BUNDEGI REEF

Reefs at Ningaloo have a natural capacity to recover from bleaching and cyclones, but may be overwhelmed by the increasing frequency and severity of 'disturbances' in the future.

At Bundegi, coral cover was as high as 70-80% in the late 1980's. Following damage by Tropical Cyclone Vance in 1999, coral cover declined to 11%, but recovered rapidly over the next 6 years to reach 32%, demonstrating strong natural recovery. It remained at that level until a marine heatwave and three cyclones in 2011 caused up to 80% of corals to bleach and die. Coral cover dropped to 17% that year, and to less than 1% after a second marine heatwave in 2013.

Since that time, there has been minimal recovery, and with limited connectivity to other reefs and few mature corals remaining, Bundegi may take decades to recover.



# Resilient Reefs Fact Sheet: ECOSYSTEM

## Looking to the Future...

### THE CLIMATE IS CHANGING:

- **Coral bleaching is likely to significantly impact the Reef:** Ningaloo is predicted to experience mass bleaching conditions twice per decade by 2041 (likely to cause significant mortality of corals), and annually by 2046. <sup>[16,18]</sup>
- **Oceans are acidifying**, reducing the ability of many corals, phytoplankton and zooplankton to form hard 'skeletons'. <sup>[8,17]</sup>
- **New coral diseases or predators** like Crown-of-Thorns Starfish may appear due to changing environmental conditions or shipping. <sup>[1]</sup>
- **The currents which sustain the diversity of life at Ningaloo may weaken** by 2060 due to climate change, which may impact productivity, species range, coral spawning, habitat distribution and recruitment success. <sup>[5,6,24,28]</sup>
- **The sea level is rising:** corals may not grow fast enough to keep pace. <sup>[37]</sup>

### THE RISK OF EXTREME EVENTS IS INCREASING:

- **More severe marine heatwaves** are likely to increase the rate of coral bleaching and impacts on other key habitats and species.
- **More severe cyclones** can cause physical damage to reefs, coastlines, mangroves and seagrass ecosystems. <sup>[1,2,6,8,15]</sup>
- Corals and ecosystems have **less time to recover as disturbances become more frequent**, potentially leading to ongoing declines.

### GREATER HUMAN PRESSURES:

- **Unmanaged increases in visitor numbers** may exacerbate physical damage at high use sites, pressure on fish stocks from recreational fishing, boat strikes, and damage to coastal habitat.
- **Off-shore extraction activities or coastal development** may impact habitats, species or behaviours due to light or noise pollution, sedimentation or damage to habitat.

*The best available science predicts that Ningaloo will experience annual mass bleaching by 2050*

### CHANGING DIVERSITY AND ABUNDANCE OF MARINE LIFE:

- **Declines in key coral species:** Ningaloo's most common corals (Acropora) are particularly susceptible to bleaching, cyclones and predators. Declines may limit the ability of the reef to recover and affect fish species which rely on them for habitat, food and reproduction. <sup>[13,26,33,40]</sup>
- As waters warm, some **temperate species** of fish, seagrass and rock lobster **may decline**. <sup>[6,25]</sup>
- **Possible declines in turtle populations:** increases in nest temperature by just a couple of degrees can produce all-female hatchlings. <sup>[31]</sup>

## The future of Ningaloo's coral reef may be threatened by:



### Climate change causing

- Warmer ocean temperatures
- Sea level rise
- Ocean acidification



### More frequent or severe extreme events

- Stronger cyclones
- More frequent and severe marine heatwaves causing mass coral bleaching



### Changes in the abundance and distribution of key species

- New or increased diseases and predators
- Potential declines in iconic species like corals and turtles
- Changes in the natural range of species (i.e. fewer lobsters and some species of fish)



### Unmanaged increase in human pressures

- Physical damage from increased visitation
- Significant increases in fishing pressure may impact fish stocks
- Threats from potential development or industrialisation



# Resilient Reefs Fact Sheet: COMMUNITY

## Current State of the Community...

*“A safe and inclusive community with strong community spirit, a family-friendly lifestyle in a world-class natural environment”*

- There is a strong connection to local marine environments and high levels of volunteering and environmental and community stewardship.
- There is a high level of support for current, and increased, levels of management and protection of the environment among locals and visitors. <sup>[9,10,22]</sup>
- The Reef and coastline contributes around **\$110 million annually** to the local economy and supports over 1000 jobs.
- Tourism brings jobs and revenue, but **increasing visitation is likely to result in increased pressure on environment** (e.g. damage to vegetation, illegal fishing, sewage and waste disposal, increased water demands and disturbance to wildlife).
- **Differing values sometimes lead to conflicting priorities:** Unsustainable behaviours and expectations

of unrestricted use and access exist within some sectors of the community and visitors

- **Limitations of available services:** Healthcare services are often swamped during the tourist season, and there can be long wait times associated with healthcare, driven by a low number of primary health professionals in the region.
- **The appropriate balance between sustainable economic development and environmental protection is an active debate.** Many in the community emphasise the need for diversification of the local economy and greater fulltime employment opportunities, but not at the expense of the natural environment.
- Oil spills are a **low-likelihood but high-consequence risk** to ecosystems and tourism.

## Exmouth 2030 Strategic Community Plan (Shire of Exmouth):

### WHAT DOES OUR COMMUNITY LOOK LIKE IN 10 YEARS?

- A stronger, more diverse local economy that can provide year-long employment opportunities.
- A community that is renowned for its stewardship of our environment and heritage.
- A well-managed tourism industry that has extended the peak season to include alternative ecotourism and other visitation activities.
- A service hub for the offshore oil and gas industry and marine services support.
- A best-practice example of innovation in providing sustainable environmentally friendly local facilities for water supply, recycling, renewable energy and waste management.
- To be innovative and proactive in addressing issues that are both environmentally sensitive and beneficial in providing affordable living costs and housing to the local community.
- An education and research hub with a strong focus on our natural environment.
- A community that is friendly, approachable, fair-minded and responsive and acts with honesty and integrity.



## Looking to the Future...

Domestic tourism to Great Barrier Reef falls in wake of coral bleaching

Reef no longer among top 10 reasons for Australians to visit Cairns, says survey



▲ The report says towns should develop 'new tourism experiences' to compensate for lost visitors in the wake of the reef's coral bleaching. Photograph: Brett Monroe Garner/Greenpeace

### COMMUNITIES ARE HIGHLY RELIANT ON TOURISM AND THE REEF:

- **The local economy is reliant on tourism and vulnerable to external influences** (e.g. coral bleaching, increases in fuel prices, competition from other destinations, pandemics). For example, it was estimated that media coverage of 2016 bleaching on the Great Barrier Reef may have deterred 1 million visitors annually, risking 10,000 jobs.
- **Recreational fishing pressure may increase**, contributing to a decline in catch rates. This may be exacerbated by: non-compliance with fishing regulations; rates of shark depredation; a mentality of 'Filling the freezer' amongst some anglers; and technological advancements making it easier to find and access fish.

*Ngarnurra nhuna nhugurarrima Baiyungu,  
Thalanyji and Yinikurtura ganyarajari thanardi ngarrari  
~ We acknowledge Baiyungu, Thalanyji and Yinikurtura People  
as the original custodians of the land and water we manage.*



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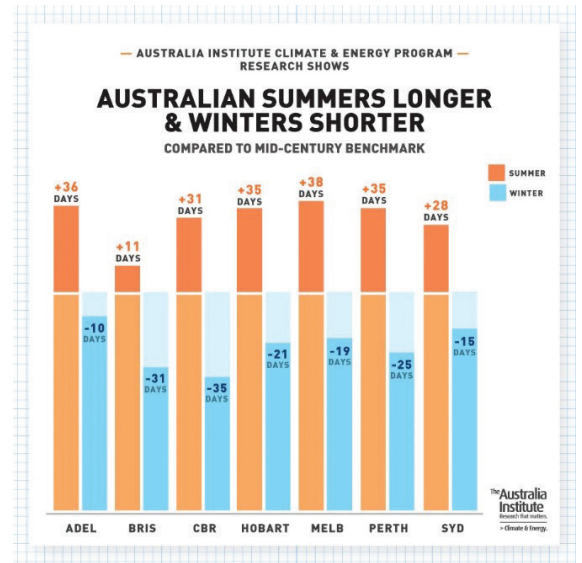




# Resilient Reefs Fact Sheet: COMMUNITY

## THE CLIMATE IS CHANGING:

- Across Australia, **summer seasons are lengthening** by almost a month due to a warming climate, which may extend the tourist off-season. <sup>[32]</sup>
- Higher temperatures also impact **liveability**, and may lead to increased seasonality of residency or permanent relocation.
- **Higher temperatures and more severe heatwaves threaten human health and wellbeing:** extreme heat causes more deaths in Australia than all other types of natural hazard combined. <sup>[36]</sup>
- **More frequent and severe extreme events** (storms, bushfires, cyclones, flooding) threatens lives and property, and is likely to place more pressure on emergency services.
- Changing environmental conditions will **challenge Traditional Owners' responsibility** to care for country, with significant spiritual and psychological effects.
- **Increased coastal erosion** may affect infrastructure and cultural sites.



## Potential Impacts of Climate Change on Ningaloo

**Increasing average temperatures**

**Heavier extreme rainfall events, but decrease to overall rainfall**

**Increases to cyclone intensity**

**Rising sea levels**

**Increasingly frequent & intense marine heatwaves**

**Ocean acidification**

	Increasing average temperatures	Heavier extreme rainfall events, but decrease to overall rainfall	Increases to cyclone intensity	Rising sea levels	Increasingly frequent & intense marine heatwaves	Ocean acidification
ENVIRONMENT	<ul style="list-style-type: none"> <li>• Some species of fish and lobster are moving south</li> <li>• Possible decline in turtle populations</li> <li>• Possible increase in coral disease or predators</li> </ul>	<ul style="list-style-type: none"> <li>• Increased sedimentation following flood events for some areas</li> </ul>	<ul style="list-style-type: none"> <li>• Damage to tidal habitats, reefs, and sea grass</li> <li>• Potential declines in key species due to loss of habitat</li> </ul>	<ul style="list-style-type: none"> <li>• Possible damage to reefs from increased wave action</li> <li>• Increased coastal erosion</li> <li>• Loss of seabird and turtle nesting areas</li> </ul>	<ul style="list-style-type: none"> <li>• Recurring mass coral bleaching</li> <li>• Loss of seagrass and macroalgae</li> <li>• Possible changes to reproduction and recruitment of marine species</li> </ul>	<ul style="list-style-type: none"> <li>• Declines in coral growth</li> <li>• Reduction of phytoplankton and zooplankton which are a key food source</li> </ul>
COMMUNITY	<ul style="list-style-type: none"> <li>• Impacts on human health and wellbeing</li> <li>• Potentially longer 'off-season' and increased seasonality of residency</li> </ul>	<ul style="list-style-type: none"> <li>• Flooding of property and infrastructure</li> <li>• Potential water scarcity</li> <li>• Road access cut more frequently</li> </ul>	<ul style="list-style-type: none"> <li>• Damage to property and infrastructure</li> <li>• Reduced productivity of fisheries</li> </ul>	<ul style="list-style-type: none"> <li>• Higher storm surge and related flooding</li> <li>• Loss of recreation areas and property</li> <li>• Damage to cultural sites along the coast</li> </ul>	<ul style="list-style-type: none"> <li>• Decline in tourism if major bleaching occurs</li> </ul>	<ul style="list-style-type: none"> <li>• Decline in tourism if the reef is degraded</li> </ul>



# Resilient Reefs Fact Sheet: GOVERNANCE

## Current State of Governance Systems...

*The way that we manage people, environments and communities along the Ningaloo Coast.*

- Ningaloo is a highly-managed area with significant regulatory and legislative protection at the local, State and Federal level. World Heritage status provides international leverage to ensure environmental protection.
- Residents have a **strong understanding of, and support for, the current rules and regulations** associated with the Ningaloo Marine Park [9,22]. However, regulations related to sanctuary zones and recreational fishing are highly complex, that many incidents involving visitors result from confusion over the rules.
- In general, users are **confident that the marine park is well managed**. Levels of support for sanctuary zones and increased management activities at Ningaloo are among the highest within marine parks in Australia. [9,22]
- **Strong cooperation at an operational level:** The Ningaloo Coast is actively managed by multiple agencies through joint- and co-management arrangements. There is cooperation between key governance bodies (DBCA, Fisheries, Shire of Exmouth, Parks Australia and Traditional Owners) in day-to-day management.
- Traditional Owners, community conservation groups, and local commercial operators play key roles in **collaborating with governance agencies and facilitating collective action** for reef stewardship.



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Thalanyji and Yinikurtura ganyarajari thanardi ngarrari  
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Department of Biodiversity,  
Conservation and Attractions





# Resilient Reefs Fact Sheet: GOVERNANCE

## Looking to the Future...

### PROACTIVE AND ADAPTIVE PLANNING:

- Management plans and governance arrangements could be updated more proactively in response to changing environmental conditions.
- An overarching climate change risk management and adaptation plan for the region, and integration of climate change into all management plans, would enable coordinated action.
- Management would benefit from securing long-term funding for resilience actions into the future.



### INCREASED ENGAGEMENT AMONG MANAGEMENT AGENCIES, USERS AND RESEARCHERS

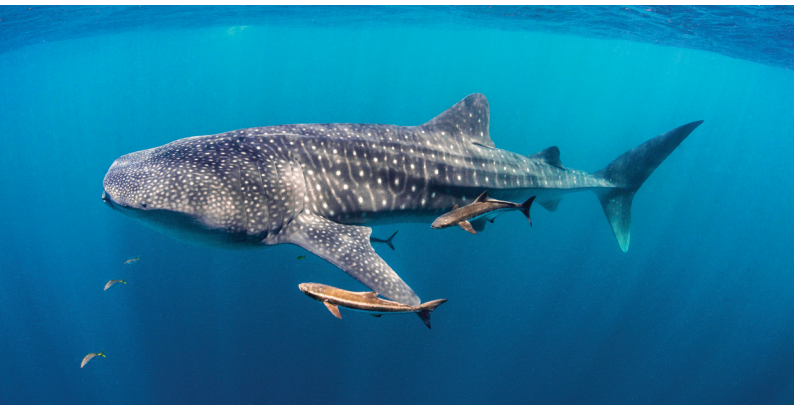
• **Enhancing trust between users and managers:** Perceived trade-offs between conservation priorities and access and recreation has historically led to tensions between users and management agencies. While current levels of support for management activities are generally high, enhancing the levels of trust would enable more proactive management. <sup>[9]</sup>

• **Empowering the community:** community members indicate that they would like to have more opportunities to provide input into the management and conservation of the area. <sup>[9]</sup>

• **Enhancing cooperation and collaboration:** Collaborative management planning between agencies may improve management outcomes for adjacent tenures.

• **Opportunities for more responsive or visible compliance activities:** Community perceptions about compliance may be improved through more effective communication.

• **Co-design and communication of research could be improved:** the community recognise opportunities for more effective 'knowledge transfer' between researchers, managers and the public. Increased engagement and co-design of projects between researchers and managers may increase the proportion of research that directly informs management.



# REFERENCE LIST

1. Babcock, R, Donovan, A, Collin, S & OchiengI Ertemeijer, C, 2017, Pilbara Marine Conservation Partnership – Final Report. CSIRO Oceans & Atmosphere, Published Brisbane.
2. Babcock, RC, Bustamante, RH, Fulton, EA, Fulton, DJ, Haywood, MDE, Hobday, AJ, Kenyon, R, Matear, RJ, Plagányi, EE, Richardson, AJ, & Vanderklift, MA, 2019, Severe Continental-Scale Impacts of Climate Change Are Happening Now: Extreme Climate Events Impact Marine Habitat Forming Communities Along 45% of Australia's Coast, *Frontiers in Marine Science*. 6:411. doi: 10.3389/fmars.2019.00411.
3. Bessey, C, Babcock, RC, Thomson, DP & Haywood, MDE 2018, Outbreak densities of the coral predator *Drupella* in relation to in situ *Acropora* growth rates on Ningaloo Reef, Western Australia, *Coral Reefs* 37, 4, 985-993, Doi: 10.1007/s00338-018-01748-7
4. Boschetti, F, Babcock, R, Doropoulos, C, Thomson, D, Feng, M, Slawinski, D, Berry, O & Vanderklift, M 2019, Setting priorities for conservation at the interface between ocean circulation, connectivity, and population dynamics. *Ecological Applications* in press.
5. Brinkman, R 2011, Oceanic conditions at Ningaloo Reef—analysis of downscaling ocean climate into the Ningaloo Reef Tract.
6. Caputi, N, Feng, Pearce, A, Benthuisen, J, Denham, A, Hetzel, Y, Matear, R, Jackson, G, Molony, B, Joll, L & Chandrapavan, A 2015, Management implications of climate change effect on fisheries in Western Australia, Part 1: Environmental change and risk assessment. FRDC Project No. 2010/535. Fisheries Research Report No. 260. Department of Fisheries, Western Australia. 180pp.
7. Cresswell, AK, Langlois, T.J, Wilson, SK, Claudet, J, Thomson, DP, Renton, M, Holmes, TH 2019, Disentangling the response of fishes to recreational fishing over 30 years within a fringing coral reef reserve network, *Biological Conservation*, 237, pp.514-524. <https://doi.org/10.1016/j.biocon.2019.06.023>.
8. CSIRO and BOM 2015, Rangelands Cluster Report.
9. Cvitanovic, C, van putten, I, Hobday, A, Kelly, R, Mackay, M, McDonald, J, Waples, K & Barnes, P. 2018. Building trust among marine protected area managers and community members through scientific research: Insights from the Ningaloo Marine Park, Australia. 10.31230/osf.io/uarve.
10. Cvitanovic, C, van Putten, EI, Kelly, R, Feldman, H, van Steveninck, TJ, Mackay, M, Badullovich, N, Gourlay, T n.d., Engaging more effectively with visitors to coastal regions for improved management outcomes: Insights from the Ningaloo Coast, Australia. Manuscript.
11. Department of Biodiversity, Conservation and Attractions (DBCA) 2017, Ecological monitoring in the Ningaloo marine reserves 2017, Department of Biodiversity, Conservation and Attractions, Perth.
12. Department of Biodiversity, Conservation and Attractions (DBCA) 2019, Ningaloo Marine Park Monitoring 2018-19 [unpublished internal report], Department of Biodiversity, Conservation and Attractions, Perth.
13. Depczynski, M, Gilmour, J, Ridgway, T, Barnes, H, Heyward, A, Holmes, TH & Wilson, S 2013, Bleaching coral mortality and subsequent survivorship on a West Australian Fringing Reef. *Coral Reefs*, 32(1), 33-238. <https://doi.org/10.1007/s00338-012-0974-0>
14. Feng, M, Colberg, F, Slawinski, D, Berry, O & Babcock, R 2016, Ocean circulation drives heterogeneous recruitments and connectivity among coral populations on the North West Shelf of Australia *Journal of Marine Systems*, 164, pp.1–12
15. Gilmour, J, Cook, K, Ryan, N, Puotinen, M, Green, R, Shedrawi, G, Hobbs, J, Thomson, D, Babcock, R, Buckee, J, Foster, T, Richards, Z, Wilson, S, Barnes, P, Coutts, T, Radford, B, Piggott, C, Depczynski, M, Evans, S, Schoepf, V, Evans, R, Halford, A, Nutt, C, Bancroft, K, Heyward, A & Oades, D 2019, The state of Western Australia's coral reefs. *Coral Reefs*, 38(4), pp.651–667.
16. Heron, SF, Eakin, CM & Douvère, F 2017, Impacts of Climate Change on World Heritage Coral Reefs: A First Global Scientific Assessment. Paris, UNESCO World Heritage Centre.
17. Hoegh-Guldberg O, Poloczanska ES, Skirving W & Dove S 2017, Coral Reef Ecosystems under Climate Change and Ocean Acidification. *Front. Mar. Sci.* 4:158. doi: 10.3389/fmars.2017.00158.
18. Hughes, T, Kerry, J, Álvarez-Noriega, M et al. Global warming and recurrent mass bleaching of corals. *Nature* 543, 373–377 (2017). <https://doi.org/10.1038/nature21707>
19. Loneragan, NR, et al. 2013. Impact of cyclones and aquatic macrophytes on recruitment and landings of tiger prawns *Penaeus esculentus* in Exmouth Gulf, Western Australia. *Estuarine, Coastal and Shelf Science* 127 (2013): 46-58.
20. Long, SC 2007, Disturbance and recovery of coral communities in Bill's Bay, Ningaloo Marine Park: Field survey 16-23 October 2006. Technical and Data Report MBI-2007/05. Marine Science Program, Department of Environment and Conservation, Perth, Western Australia (unpublished report)
21. Moore, J, Bellchambers, L, Depczynski, M, Evans, R, Evans, S, Field, S, Friedman, K, Gilmour, J, Holmes, T, Middlebrook, R, Radford, B, Ridgway, T, Shedrawi, G, Taylor, H, Thomson, D & Wilson, S 2012, Unprecedented Mass Bleaching and Loss of Coral across 12° of Latitude in Western Australia in 2010–11, *PLoS ONE*, 7(12), p.e51807.
22. Navarro, M, Kragt, M, Hailu, A & Langlois, T 2018, Recreational fishers' support for no-take marine reserves is high and increases with reserve age, *Marine Policy*, 96, pp.44–52.
23. Onton, K, Page, C., Wilson, SK, Neale, S & Armstrong, S 2011, Distribution and drivers of coral disease at Ningaloo reef, Indian Ocean. *Marine Ecology Progress Series*. 433. 75-84. 10.3354/meps09156.
24. Pattiaratchi, C 2005, Variability in the Leeuwin Current. *Climate Note 10/05*. Indian Ocean Climate Initiative.
25. Pecl, GT, Ward, T, Doubleday, Z, Clarke, S, Day, J et al. 2011. Risk assessment of impacts of climate change for key marine species in south eastern Australia. Part 1: Fisheries and Aquaculture Risk Assessment. Fisheries Research and Development Corporation, Project 2009/070.
26. Thomson DP, Babcock RC, Haywood MDE, Pillans R, Vanderklift MA, Boschetti F. 2017. 10-year declines in *Acropora* and *Turbinaria* corals and a shift toward more generalist life-history traits at northern Ningaloo Reef, Western Australia. In RC Babcock et al. eds. *Pilbara Marine Conservation Partnership – Final Report Vol.2: 492-509*. CSIRO, Brisbane.
27. Underwood, J, Wilson, S, Ludgerus, L. & Evans, R 2013, Integrating connectivity science and spatial conservation management of coral reefs in north-west Australia. *Journal for Nature Conservation*, 21(3), 163-172. <https://doi.org/10.1016/j.jnc.2012.12.001>
28. Vanderklift, TJ, Babcock, RC, Barnes, PB, Cresswell, AK, Feng, M, Haywood, MDE, Holmes, TH, Lavery, PS, Pillans, RD, Smallwood, CB, Thomson, DP, Tucker, AD, Waples, k & Wilson SK n.d., The marine oceanography and ecology of the World Heritage listed Ningaloo Coast, Submitted to *Oceanography & Marine Biology: An Annual Review*
29. Vanderklift, MA, Babcock, RC, Boschetti, F, Haywood, M, Pillans, RD & Thomson, DP 2019, Declining abundance of coral reef fish in a World-Heritage-listed marine park, *Scientific reports*, 9(1), 15524. doi:10.1038/s41598-019-52016-9
30. Simpson, C & Waples, K 2012, Western Australian Marine Science Institution (WAMSI) Node 3: Managing and Conserving the Marine Estate Final Summary Report
31. Stubbs, JL & Mitchell, NJ 2018, The Influence of Temperature on Embryonic Respiration, Growth, and Sex Determination in a Western Australian Population of Green Turtles (*Chelonia mydas*). *Physiological and Biochemical Zoology*, vol. 91, no. 6, pp. 1102-1114. <https://doi.org/10.1086/700433>
32. Swann T & Ogge M 2019, Out of Season Expanding summers and shrinking winters in subtropical and temperate Australia. Discussion Paper. The Australia Institute, ACT.
33. Wilson, SK, Depczynski, M, Fisher, R, Holmes, TH, O'Leary, RA, Tinkler, P 2010, Habitat Associations of Juvenile Fish at Ningaloo Reef, Western Australia: The Importance of Coral and Algae. *PLOS ONE* 6(1) <https://doi.org/10.1371/journal.pone.0015185>.
34. Wilson, SK, Babcock, R., Risher, R, Holmes, TH, Moore, J & Thomson, DP 2012, Relative and combined effects of habitat and fishing on reef fish communities across a limited fishing gradient at Ningaloo, *Marine Environmental Research* 81: 1-11. DOI: 10.1016/j.marenvres.2012.08.002.
35. Wilson, SK, Graham, NAJ, Holmes, TH, MacNeil, MA & Ryan, NM 2018, Visual versus video methods for estimating reef fish biomass. *Ecological Indicators*, 85, 146-152. <https://doi.org/10.1016/j.ecolind.2017.10.038>
36. Between 1990 and 2011, extreme heat caused 4555 fatalities, compared with 1285 for cyclones, 1221 for flood and 866 for fires (data from the PerilAUS database).

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