RESEARCH NOTE

Rapid coral mortality following doldrums-like conditions on Iriomote, Japan [version 1; peer review: 1 approved, 1 approved with reservations]

Andrew H Baird ¹, Sally A. Keith^{2,3}, Erika Woolsey⁴, Ryuta Yoshida⁵, Tohru Naruse⁵

¹ARC Centre of Excellence for Coral Reefs Studies, James Cook University, Queensland, Australia

²Centre for Macroecology, Evolution and Climate, Natural History Museum of Denmark, University of Copenhagen, Copenhagen, Denmark

³Lancaster Environment Centre, Lancaster University, Lancaster, UK

⁴The Hydrous, San Francisco, CA, USA

⁵Iriomote Station, Tropical Biosphere Research Center, University of the Ryukyus, Taketomi, Okinawa, Japan

V1 First published: 22 Sep 2017, 6:1728
<https://doi.org/10.12688/f1000research.12660.1>
 Latest published: 12 Mar 2018, 6:1728
<https://doi.org/10.12688/f1000research.12660.2>

Abstract

Coral bleaching can be induced by many different stressors, however, the most common cause of mass bleaching in the field is high sea temperatures (SST). Here, we describe an unusual bleaching event that followed very calm sea conditions combined with higher than average sea surface temperatures (SST). Patterns of mortality differed from typical thermal bleaching in four ways: 1) mortality was very rapid; 2) the suite of species most affected was different; 3) tissue mortality in *Acropora* spp. was often restricted to the center of the colony; 4) the event occurred early in the summer. The two weeks prior to the event included 8 days where the average wind speed was less than 3 ms⁻¹. In addition, SSTs in the weeks preceding this event were 1.0-1.5°C higher than the mean for the last 30 years. We hypothesize that the lack of water movement induced by low wind speeds combined with high SST to cause colonies anoxic stress resulting in this unusual bleaching event.

Keywords

climate change, coral bleaching, coral reefs, disturbance

This article is included in the Ecology and Global Change gateway.

Open Peer Review

Approval Status

	1	2
version 2 (revision) 12 Mar 2018	 view	
version 1 22 Sep 2017	 view	 view

1. **Mikhail V. Matz** , University of Texas at Austin, Austin, USA

2. **Robert van Woesik** , Florida Institute of Technology, Melbourne, USA

Any reports and responses or comments on the article can be found at the end of the article.

Corresponding author: Andrew H Baird (andrew.baird@jcu.edu.au)

Author roles: **Baird AH:** Conceptualization, Data Curation, Funding Acquisition, Investigation, Methodology, Resources, Validation, Writing – Original Draft Preparation; **Keith SA:** Conceptualization, Funding Acquisition, Investigation, Methodology, Writing – Review & Editing; **Woolsey E:** Conceptualization, Investigation, Methodology, Writing – Review & Editing; **Yoshida R:** Investigation, Writing – Review & Editing; **Naruse T:** Conceptualization, Data Curation, Investigation, Resources, Writing – Original Draft Preparation, Writing – Review & Editing

Competing interests: No competing interests were disclosed.

Grant information: This work was funded by the Australian Research Council Centre of Excellence for Coral Reef Studies (CE140100020) and VILLUM FONDEN (10114).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Copyright: © 2017 Baird AH *et al.* This is an open access article distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

How to cite this article: Baird AH, Keith SA, Woolsey E *et al.* **Rapid coral mortality following doldrums-like conditions on Iriomote, Japan [version 1; peer review: 1 approved, 1 approved with reservations]** F1000Research 2017, 6:1728 <https://doi.org/10.12688/f1000research.12660.1>

First published: 22 Sep 2017, 6:1728 <https://doi.org/10.12688/f1000research.12660.1>

Introduction

Coral bleaching is a generalized response that can be induced by many different stressors^{1–3}. Whilst the most common cause of large scale bleaching on coral reefs is unusually high sea surface temperatures (SSTs)^{4,5}, prolonged periods of calm weather, known as the doldrums, have also been associated with mass bleaching events in the Caribbean^{6,7} and the Indo-Pacific^{8–10}. Experimental work has also confirmed that low water flow can exacerbate thermal bleaching^{11,12}.

The ecology of thermal coral bleaching is reasonably well documented. For example, colonies affected by high temperatures typically take between two to six weeks to bleach and bleached tissue can take another two to twenty weeks to die¹³. In addition, species vary in their susceptibility to thermal bleaching^{14,15}, resulting in a predictable hierarchy of response^{16,17}. Temporal patterns are also apparent with most high temperature induced mass bleaching events generally occurring towards the end of the summer months^{18,19}. Any change in this predictable bleaching ecology suggests an alternative cause (i.e., not thermal stress) for a given bleaching event.

Here, we describe an atypical bleaching event that we hypothesize was caused by an interaction of temperature with very calm sea conditions caused by an extended period of low winds. We identify a number of characteristic features of this doldrums bleaching that allow it to be distinguished from thermal bleaching in the field. Establishing the cause of specific bleaching events is vital in order to correctly attribute damage caused by climate change and other potential stressors.

Methods

The study site was on the reef crest (1 m depth) at Nata Reef, Iriomote, Japan (24.4282°N, 123.7955°E). Initial observations at the site were made between 26 and 29 May, 2016 at which point in time no bleached corals were noted. Surveys to quantify bleaching and mortality were conducted on 12 June, 2016. Twenty replicate 1m² quadrats were placed haphazardly on the reef crest, and the condition and species identity of all hard coral colonies with a maximum diameter greater than 5cm were recorded. Species were identified in the field following²⁰ and the names updated to the currently accepted names following²¹. Colonies were placed in one of six bleaching categories following²¹: (1) unbleached, (2) the entire colony pale, (3) 1–50% of the colony white, (4) 51–99% of the colony white, (5) 100% of colony white or fluorescent, or (6) recently dead. The data from the quadrats was pooled as the

data was collected. The bleaching mortality index was calculated following¹⁶. Data on environmental conditions leading up to the bleaching episode were obtained from the Japan Meteorological Agency, which allows for these data to be used as long as due credit is given.

Results

Bleaching and mortality was rapid. No colonies were bleached at the time of the first surveys (26 May, 2016) yet two weeks later (12 June, 2016), 5% of colonies were dead and a further 31% were bleached (Table 1).

Mortality was highest in *Montipora aequituberculata* and *Montipora efflorescens* (Figure 1A), and in an additional three species of the family Merulinidae, who were also badly affected (Table 1). Bleaching and tissue mortality were generally restricted to the center of colonies in the locally abundant species *Acropora digitifera* and *Acropora hyacinthus* (Figure 1B, C, D).

The bleaching event occurred early in June, the first month of the northern summer, following a period of low wind and higher than average sea surface temperature (SST). Eight days in the previous two weeks had average wind speeds of under 3 ms⁻¹ (Table 2). Winds were also mostly from the south, which is offshore at the study site and therefore likely to further reduce wave size and water motion (Table 2). Mean daily SSTs in the month preceding the second survey were 1.0–1.5°C higher than the mean for the previous 30 years (Table 3).

Discussion

This bleaching event was different to typical thermal bleaching in a number of important ways. In particular, rapid bleaching and tissue mortality restricted to the center of *Acropora* colonies, an atypical hierarchy of susceptibility, and the occurrence of the event in early summer, all distinguish this event from typical thermal bleaching. We hypothesize that unusually high SST combined with a lack of water flow due to low winds speeds resulted in anoxic stress to these colonies. This hypothesis is supported by doldrums like conditions (Table 2) combined with higher than average mean daily surface ocean temperatures (Table 3) in the weeks prior to the event.

In contrast to the typical thermal response, bleaching and mortality were very rapid, with a high proportion of colonies bleached and some dying within the two week period between the surveys (Table 1). Bleaching and, in particular, mortality typically take between 4–6 weeks to present in corals following thermal stress¹³.

Table 1. Bleaching categories of hard corals at Nata Reef on 12 June 2016. BMI = Bleaching Mortality Index.

taxa	unbleached	moderate	severe	dead	BMI	n
<i>Acropora aspera</i>	100	0	0	0	0	1
<i>Acropora digitifera</i>	81	19	0	0	6	32
<i>Acropora gemmifera</i>	100	0	0	0	0	1
<i>Acropora hyacinthus</i>	71	29	0	0	10	7
<i>Acropora nasuta</i>	50	50	0	0	17	2
<i>Acropora selago</i>	0	0	0	100	100	1
<i>Astrea annuligera</i>	100	0	0	0	0	1
<i>Cyphastrea serailia</i>	100	0	0	0	0	3
<i>Dipsastraea rotumana</i>	0	100	0	0	33	1
<i>Dipsastrea pallida</i>	30	50	20	0	30	10
<i>Favites abdita</i>	100	0	0	0	0	3
<i>Favites halicora</i>	86	14	0	0	5	7
<i>Favites magnistellata</i>	100	0	0	0	0	2
<i>Galaxea fascicularis</i>	82	18	0	0	6	11
<i>Goniastrea pectinata</i>	0	50	50	0	50	2
<i>Goniastrea retiformis</i>	86	14	0	0	5	14
<i>Milleporidae</i>	17	33	50	0	44	6
<i>Montipora aequituberculata</i>	0	0	0	100	100	3
<i>Montipora crassituberculata</i>	46	32	18	4	26	28
<i>Montipora digitata</i>	71	0	29	0	19	7
<i>Montipora efflorescens</i>	0	27	27	45	73	11
<i>Montipora monasteriata</i>	100	0	0	0	0	4
<i>Montipora turgescens</i>	0	100	0	0	33	1
<i>Pavona decussata</i>	100	0	0	0	0	2
<i>Pavona venosa</i>	57	43	0	0	14	7
<i>Platygyra pini</i>	75	25	0	0	8	4
<i>Platygyra ryukyuensis</i>	25	50	25	0	33	4
<i>Platygyra verweyi</i>	67	0	0	33	33	3
<i>Pocillopora damicornis</i>	67	22	11	0	15	9
<i>Porites annae</i>	60	40	0	0	13	5
<i>Porites cylindrica</i>	77	23	0	0	8	13
<i>Porites lichen</i>	100	0	0	0	0	3
<i>Porites lutea</i>	100	0	0	0	0	1
<i>Porites rus</i>	100	0	0	0	0	6
<i>Psammocora contigua</i>	100	0	0	0	0	1
total	64	23	8	5	216	18

Figure 1. (a) Dead and dying *Montipora aequituberculata* colonies (b) *Acropora hyacinthus* colony with bleached and dying tissue in the middle of the colony (c) a second *A. hyacinthus* colony (d) close up of the colony in (c).

Table 2. Mean daily wind speeds in the 12 days prior to the first observations of bleaching on 12 June 2016. Data from Japan Meteorological Agency.

date	Mean wind speed (m/s)	Mean wind speed (knots)	wind direction
30/05/2016	2.1	4.1	ENE
31/05/2016	1.8	3.5	SE
1/06/2016	3.4	6.6	W
2/06/2016	3	5.8	NE
3/06/2016	2.1	4.1	SW
4/06/2016	2.1	4.1	ENE
5/06/2016	3.2	6.2	NE
6/06/2016	2.5	4.9	NE
7/06/2016	1.6	3.1	SE
8/06/2016	1.9	3.7	ESE
9/06/2016	2	3.9	ENE
10/06/2016	3	5.8	SSW
11/06/2016	6.4	12.4	SSW
12/06/2016	8.2	15.9	SSW

Table 3. Sea surface temperature anomalies in the weeks preceding the bleaching event on Nata Reef. Values are the degrees in centigrade above the 30 year average for this site in each time interval. Data from the Japan Meteorological Agency.

Week ending	Sea surface temperature anomaly (°C)
27 April 2016	+1.5
9 May 2016	+1.5
19 May 2016	+1.0
30 May 2016	+1.5
9 June 2016	+1.5

In addition, the hierarchy of susceptibility was very different to that following thermal bleaching. Here, the worst affected species included two *Montipora* spp. and a number of merulinids (Table 1), when typically *Acropora* spp. and *Pocillopora* spp. are the most severely affected following thermal bleaching^{5,15,22}.

The pattern of tissue bleaching and mortality was also unusual. In *Acropora* colonies the typical pattern following thermal stress is for the whole colony to bleach¹³. In contrast, mortality was restricted to the center of most *Acropora* colonies in this event (Figure 1a, b, c). Tissue mortality beginning in the center of the colony typically indicates anoxia, which often occurs in aquaria with inadequate flow or oxygenation (pers obs). This pattern of mortality is also superficially similar to feeding scars caused by *Acanthaster planci* or *Drupella* spp.²³ and a naïve observer might well have attributed this mortality to either of these corallivores²⁴. A thorough search of the site, including underneath these and adjacent colonies, indicated that neither of these corallivores were present.

The timing of the bleaching event in early summer is also unusual. Thermal bleaching typically occurs much later in the summer. For example, recurrent seasonal bleaching on Magnetic Island, Australia, occurs in the last month of the austral summer i.e., February¹⁸. Similarly, the 1998 mass bleaching event in Japan was first noticed in the latter part of the summer i.e., late July²⁵. In contrast, this doldrums event occurred early in June, the first month of the northern summer.

Doldrums-like conditions (defined by NOAA as days with average wind speeds of less than 3 ms⁻¹) have previously been linked to mass bleaching events^{6–9}. However, the capacity of the doldrums to cause more localized damage outside of the typical thermal bleaching window in late summer has not previously been recognized. In addition, the potential link to anoxia, while tested in the laboratory²⁶, has not been made in the field. This observation is especially important in the context of the continuing increase in the scale and frequency of mass bleaching events²⁷ because it would generally be assumed that this small-scale phenomenon might presage a larger mass bleaching event. Determining the cause of specific bleaching events is vital in order to accurately distinguish the effects of climate change versus other causes of degradation on coral reefs.

Data availability

The pooled raw bleaching data is provided in Table 1.

Source data for Table 2 are available from the Japan Meteorological Agency, at: <http://bit.ly/2hck2G6>, <http://bit.ly/2wAVhcg>.

Source data to generate the values in Table 3 are available from the Japan Meteorological Agency, at: <http://bit.ly/2y8qIBw>.

Competing interests

No competing interests were disclosed.

Grant information

This work was funded by the Australian Research Council Centre of Excellence for Coral Reef Studies (CE140100020) and VILLUM FONDEN (10114).

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgements

We thank the staff at the Iriomote Tropical Biosphere Research Station, University of the Ryukyus, for their assistance.

References

- Glynn PW: **Coral reef bleaching in the 1980s and possible connections with global warming.** *Trends Ecol Evol.* 1991; 6(6): 175–9.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Brown BE: **Coral bleaching: causes and consequences.** *Coral Reefs.* 1997; 16: S129–S38.
[Publisher Full Text](#)
- Baird AH, Bhagooli R, Ralph PJ, et al.: **Coral bleaching: the role of the host.** *Trends Ecol Evol.* 2009; 24(1): 16–20.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Glynn PW: **Coral reef bleaching: Ecological perspectives.** *Coral Reefs.* 1993; 12(1): 1–17.
[Publisher Full Text](#)
- Hughes TP, Kerry JT, Álvarez-Noriega M, et al.: **Global warming and recurrent mass bleaching of corals.** *Nature.* 2017; 543(7645): 373–7.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Jiménez C: **Bleaching and mortality of reef organisms during a warming event in 1995 on the Caribbean coast of Costa Rica.** *Rev Biol Trop.* 2001; 49(Suppl 2): 233–8.
[PubMed Abstract](#)
- Miller J, Muller E, Rogers C, et al.: **Coral disease following massive bleaching in 2005 causes 60% decline in coral cover on reefs in the US Virgin Islands.** *Coral Reefs.* 2009; 28(4): 925–37.
[Publisher Full Text](#)
- Fisk DA, Done TJ: **Taxonomic and bathymetric patterns of bleaching in corals, Myrmidon Reef (Queensland).** *Proc Fifth Inter Coral Reef Congress.* 1985; 6: 149–54.
[Reference Source](#)
- DeCarlo TM, Cohen AL, Wong GT, et al.: **Mass coral mortality under local amplification of 2 °C ocean warming.** *Sci Rep.* 2017; 7: 44586.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Raymundo LJ, Burdick D, Lapacek VA, et al.: **Anomalous temperatures and extreme tides: Guam staghorn Acropora succumb to a double threat.** *Mar Ecol Prog Ser.* 2017; 564: 47–55.
[Publisher Full Text](#)
- Nakamura T, van Woessik R: **Water-flow rates and passive diffusion partially explain differential survival of corals during the 1998 bleaching event.** *Mar Ecol Prog Ser.* 2001; 212: 301–4.
[Publisher Full Text](#)
- Nakamura T, Yamasaki H, van Woessik R: **Water flow facilitates recovery from bleaching in the coral Stylophora pistillata.** *Mar Ecol Prog Ser.* 2003; 256: 287–91.
[Publisher Full Text](#)
- Baird AH, Marshall PA: **Mortality, growth and reproduction in scleractinian corals following bleaching on the Great Barrier Reef.** *Mar Ecol Prog Ser.* 2002; 237: 133–41.
[Publisher Full Text](#)
- Jokiel PL, Coles SL: **Response of Hawaiian and other Indo-Pacific reef corals to elevated temperature.** *Coral Reefs.* 1990; 8(4): 155–62.
[Publisher Full Text](#)
- Loya Y, Sakai K, Yamazato K, et al.: **Coral bleaching: the winners and the losers.** *Ecol Lett.* 2001; 4(2): 122–31.
[Publisher Full Text](#)
- McClanahan TR, Baird AH, Marshall PA, et al.: **Comparing bleaching and mortality responses of hard corals between southern Kenya and the Great Barrier Reef, Australia.** *Mar Pollut Bull.* 2004; 48(3–4): 327–35.
[PubMed Abstract](#) | [Publisher Full Text](#)
- Swain TD, Vega-Perkins JB, Oestreich WK, et al.: **Coral bleaching response index: a new tool to standardize and compare susceptibility to thermal bleaching.** *Glob Chang Biol.* 2016; 22(7): 2475–88.
[PubMed Abstract](#) | [Publisher Full Text](#) | [Free Full Text](#)
- Jones RJ, Berkelmans R, Oliver JK: **Recurrent bleaching of corals at Magnetic Island (Australia) relative to air and seawater temperature.** *Mar Ecol Prog Ser.* 1997; 158: 289–92.
[Publisher Full Text](#)
- Fitt WK, McFarland FK, Warner ME, et al.: **Seasonal patterns of tissue biomass and densities of symbiotic dinoflagellates in reef corals and relation to coral bleaching.** *Limnol Oceanogr.* 2000; 45(3): 677–85.
[Publisher Full Text](#)
- Veron JE: **Corals of the World.** The Australian Institute of Marine Science, Townsville, 2000.
[Reference Source](#)
- Hoeksema BW: **Scleractinia.** Bourne, 1900. Accessed through: World Register of Marine Species.
[Reference Source](#)
- Marshall PA, Baird AH: **Bleaching of corals on the Great Barrier Reef: differential susceptibilities among taxa.** *Coral Reefs.* 2000; 19(2): 155–63.
[Publisher Full Text](#)

23. Pratchett MS, Schenk TJ, Baine M, *et al.*: **Selective coral mortality associated with outbreaks of *Acanthaster planci* L. in Bootless Bay, Papua New Guinea.** *Mar Environ Res.* 2009; **67**(4–5): 230–6.
[PubMed Abstract](#) | [Publisher Full Text](#)
24. Baird AH, Pratchett MS, Hoey AS, *et al.*: ***Acanthaster planci* is a major cause of coral mortality in Indonesia.** *Coral Reefs.* 2013; **32**(3): 803–12.
[Publisher Full Text](#)
25. Kayanne H, Harii S, Ide Y, *et al.*: **Recovery of coral populations after the 1998 bleaching on Shiraho Reef, in the southern Ryukyus, NW Pacific.** *Mar Ecol Prog Ser.* 2002; **239**: 93–103.
[Publisher Full Text](#)
26. Ulstrup KE, Hill R, Ralph PJ: **Photosynthetic impact of hypoxia on *in hospite* zooxanthellae in the scleractinian coral *Pocillopora damicornis*.** *Mar Ecol Prog Ser.* 2005; **286**: 125–32.
[Publisher Full Text](#)
27. Hughes TP, Barnes ML, Bellwood DR, *et al.*: **Coral reefs in the Anthropocene.** *Nature.* 2017; **546**(7656): 82–90.
[PubMed Abstract](#) | [Publisher Full Text](#)

Open Peer Review

Current Peer Review Status:

Version 1

Reviewer Report 04 December 2017

<https://doi.org/10.5256/f1000research.13707.r26305>

© 2017 van Woesik R. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Robert van Woesik

Department of Biological Sciences, Florida Institute of Technology, Melbourne, FL, USA

The manuscript by Baird and colleagues is a useful contribution to the literature. There are however a few minor edits that are necessary to make this short contribution publishable.

Firstly, the title is inaccurate, or at least misleading. Doldrums is a maritime term that refers to the low-pressure area affected by the Intertropical Convergence Zone, where the prevailing winds are generally calm. The doldrums are considered to lie between 10°N and 10°S. Using the term doldrum-like conditions, instead of calm conditions, for a reef that is located at latitude 24 north confuses the terminology. I understand that NOAA, the US agency, has been using the term to refer to atypically calm periods irrespective of latitude, but again that doesn't make it correct because they are also misusing the term. Change the title to reflect a short, atypically calm period.

Table 1 should not simply have the corals in alphabetical order, but instead sort the table from most to least impacted.

Introduction

Again, revise the use of the term doldrums.

Methods

Several periods are missing at the ends of sentences in the Methods section.

Specify the aspect of the site. Which direction is the site facing?

Data were pooled and were collected, not data was.

Results

Delete the word "who" in the sentence "who were also badly affected (Table 1)"

Discussion

"was different from...", not different to

Revise doldrums-like conditions in several places.

Again, different from, not different to.

Periods are missing from the ends of sentences in several places of the Discussion.
Split infinitive: change to : has not been previously...

Data availability

Data are provided, not, data is provided

Is the work clearly and accurately presented and does it cite the current literature?

Yes

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 05 October 2017

<https://doi.org/10.5256/f1000research.13707.r26307>

© 2017 Matz M. This is an open access peer review report distributed under the terms of the [Creative Commons Attribution License](#), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Mikhail V. Matz

Department of Integrative Biology, University of Texas at Austin, Austin, TX, USA

This is a compact report of an unusual bleaching episode, presenting an interesting hypothesis that it could have been caused by anoxia during atypical doldrums conditions. Both are valuable for improving our understanding of factors affecting coral survival in times of changing climate. While there is no way to rigorously prove that the doldrums hypothesis is true, it certainly seems reasonable (and the wording throughout the paper is appropriate – there is never a claim that doldrums actually caused the observed bleaching).

That said, the paper would greatly benefit from expanded characterization of the doldrums episode, beyond tables 1 and 2. Is it possible to make wind speed and temperature graphs for broader range of dates (start in April) and compare that to conditions in the same time in previous years? This might show what was actually the most unusual – early temperature anomaly, low wind anomaly (by the way absolute values in Table 2 are not very informative without knowing how much below typical they are), or a combination of the two? Come to think of it, wave height could be a better proxy of water movement on the reef than wind speed, if it is possible to get that data (from satellite?).

Minor things:

“Tissue mortality beginning in the center of the colony typically indicates anoxia, which often occurs in aquaria with inadequate flow or oxygenation (pers obs)” – I am not quite happy with the word “typically” used in a statement supported by nothing but personal observation... Can you please try once more to look up literature on this? (this is why my answer in “partly” to the literature citing question). This would also strengthen the doldrums case.

“The bleaching mortality index was calculated following [16]” – as far as I can see, this index is not actually used for anything in the paper, so maybe it is not necessary? If keeping it, please expand a little: “The bleaching mortality index was calculated by [doing this and that], following [16].”

Is the work clearly and accurately presented and does it cite the current literature?

Partly

Is the study design appropriate and is the work technically sound?

Yes

Are sufficient details of methods and analysis provided to allow replication by others?

Yes

If applicable, is the statistical analysis and its interpretation appropriate?

Not applicable

Are all the source data underlying the results available to ensure full reproducibility?

Yes

Are the conclusions drawn adequately supported by the results?

Yes

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

The benefits of publishing with F1000Research:

- Your article is published within days, with no editorial bias
- You can publish traditional articles, null/negative results, case reports, data notes and more
- The peer review process is transparent and collaborative
- Your article is indexed in PubMed after passing peer review
- Dedicated customer support at every stage

For pre-submission enquiries, contact research@f1000.com

F1000Research