

Coral Stress Response Plan for the Coral and Marine Aquarium Fish Fisheries

May 2009



PROVISION REEF
Promoting Sustainable Reef Harvest



Australian Government
Great Barrier Reef
Marine Park Authority



Queensland Government

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On 26 March 2009, the Department of Primary Industries and Fisheries was amalgamated with other government departments to form the Department of Employment, Economic Development and Innovation.

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1. Purpose

This plan outlines a strategy being adopted by fishery/marine resource managers and industry members of the Marine Aquarium Fish Fishery (MAFF) and the Queensland Coral Fishery (QCF) to minimise impacts on coral reef systems showing signs of stress. Stress comes from a range of sources; however, the key driver of this Coral Stress Response Plan has been the occurrence of significant bleaching¹ events on the Great Barrier Reef (GBR) as a result of increased sea temperatures and/or freshwater incursions.

The Coral Stress Response Plan represents a collaborative, multi-jurisdictional initiative between managers and industry. The plan helps improve the resilience² of reef ecosystems, letting them recover from stress events, while allowing commercial fisheries to operate in some capacity (where possible).

2. Introduction

Recent assessment (Johnson & Marshall 2007) of the potential impacts of climate change on the GBR highlights such issues as rises in sea level and sea temperature, changes to ocean chemistry, increased storm prevalence and intensity, altered rainfall patterns and resulting effects on water salinity.

These changes have been shown to act as stressors on corals, which can cause widespread bleaching events and, if the corals die, a degradation of the coral skeletons that build the reef. This in turn compromises the important ecological functions (i.e. structure, food, shelter) and physical protection of coastal habitats that corals provide. Corals that bleach but do not die may suffer substantial reduction in growth and reproductive outputs, which may also compromise their resilience to disease or other chronic pressures.

The effects of coral bleaching (and other stresses) are potentially devastating to ecosystems and to the communities and industries that depend on them. Consequently, understanding the effects and implications of how corals respond to stress, and identifying strategies to reduce stress and mitigate its impact on ecosystems, are important challenges for reef managers and users.

The interactions between fishing activities and coral bleaching are complex and largely not understood. What we do know is that high-value fishery species are impacted both directly and indirectly by coral bleaching events, and that the maintenance or recovery of coral reef habitats may rely on the presence of a wide range of species.

The QCF targets a diverse number of live coral species for display and some of these species can be directly impacted by bleaching (Marshall & Baird 2002). The wide range of species targeted in the MAFF has a high degree of habitat association with coral reef ecosystems. Many target species in the MAFF rely on corals for food and shelter—some provide protection to anemones during bleaching events, while others are grazers and prevent overgrowth of algae on bleached coral skeletons, thus aiding in the recovery process. Around 60% of the MAFF and 99% of the QCF operate in the Great Barrier Reef Marine Park (GBRMP), a multi-use marine park and World Heritage Area.

1 Bleaching describes the action of corals expelling their symbiotic zooxanthellae in response to stress of varying kinds (e.g. increased sea surface temperature (SST), exposure to ultraviolet radiation, sedimentation, disease, freshwater flows). 'Mass bleaching events' describes the large scale phenomenon of many species of coral bleaching simultaneously over significant spatial scales (multiple reefs to global). To date, the primary causal factor for mass bleaching has been demonstrated to be prolonged elevation of SST.

2 'Resilience' relates to the ability of the system to maintain key functions and processes in the face of stresses or pressures by either resisting or adapting to change. For coral reefs this generally means maintaining the dominance of hard corals and/or morphological diversity, rather than shifting to a mainly algal system and/or reduced coral morphological diversity (Marshall & Shuttenberg 2006).

Recent coral bleaching events in localised parts of the GBR have raised concerns from some stakeholders over the potential for QCF and MAFF operations to negatively impact on the resilience of reef systems showing stress from coral bleaching. Consultation between concerned stakeholders and fishery operators has helped improve the understanding of fishery operations during bleaching events. However, the situation has highlighted the need to establish a clear process for determining and implementing relevant fishery responses to future ecosystem stress events on the GBR, based on the best available information.

Mass bleaching events on the GBR are predicted to increase in frequency and severity. Two widespread mass bleaching events have already occurred on the GBR (in 1998 and 2002). During these events at least half the reefs in the GBR bleached, with up to 5% of reefs suffering serious damage (i.e. more than 50% of bleached corals dying).

The best available science indicates that coral reefs with good biodiversity, intact trophic structure (including diverse predators and herbivores), good water quality, good current flow, good connectivity with other reef habitats and minimal human impacts will be the most resilient in the face of mass bleaching events. Some factors associated with coral bleaching or other ecosystem stress events can be strongly influenced by management and stakeholder intervention at a local scale and this in turn can improve the likelihood of ecosystem recovery (see Figure 1).

Cross-jurisdictional management of the broader issue of climate change in relation to large scale (mass) coral bleaching is being coordinated by the Great Barrier Reef Marine Park Authority (GBRMPA) on an annual basis through the Coral Bleaching Response Plan (CBRP).³ The CBRP is a key strategy under the Great Barrier Reef Climate Change Action Plan 2007–2012. It has four components:

- an early warning system
- assessment and monitoring protocols
- a range of management actions to improve resilience outcomes
- an integrated communication strategy.

The CBRP has been developed in conjunction with *A global protocol for assessment and monitoring of coral bleaching* (developed by World Wide Fund for Nature, WorldFish Center and GBRMPA) and *A reef manager's guide to coral bleaching* (a collaborative initiative led by the National Oceanic and Atmospheric Association, GBRMPA and the International Union for Conservation of Nature) with the intention of maximising comparability and consistency in regard to bleaching responses across coral ecosystems around the world.

Additional resource material summarising the current state of knowledge about the likely impacts of climate change on the GBR ecosystem and the communities and industries that depend on it can be found in *Climate change and the Great Barrier Reef: a vulnerability assessment*.⁴

Scientists and reef managers are working to develop robust decision support tools for use on the GBR to address ecosystem impacts like coral bleaching. While not all ecosystem stress events can be predicted (e.g. flood events), mass coral bleaching generally occurs over the summer months and is primarily determined by prolonged increases in sea surface temperatures (SSTs). Tools such as ReefTemp⁵ and modelling done by CSIRO and the Bureau of Meteorology using the predictive ocean atmospheric model for Australia (POAMA) will become core elements of the early warning system that allows regional predictions of the risk of bleaching events to be made as part of the annual CBRP for the GBR.

3 http://www.gbrmpa.gov.au/corp_site/key_issues/climate_change/management_responses/coral_bleaching_response_plan

4 http://www.gbrmpa.gov.au/corp_site/info_services/publications/misc_pub/climate_change_vulnerability_assessment/climate_change_vulnerability_assessment

5 <http://www.cmar.csiro.au/remotesensing/gbrmpa/ReefTemp.htm>

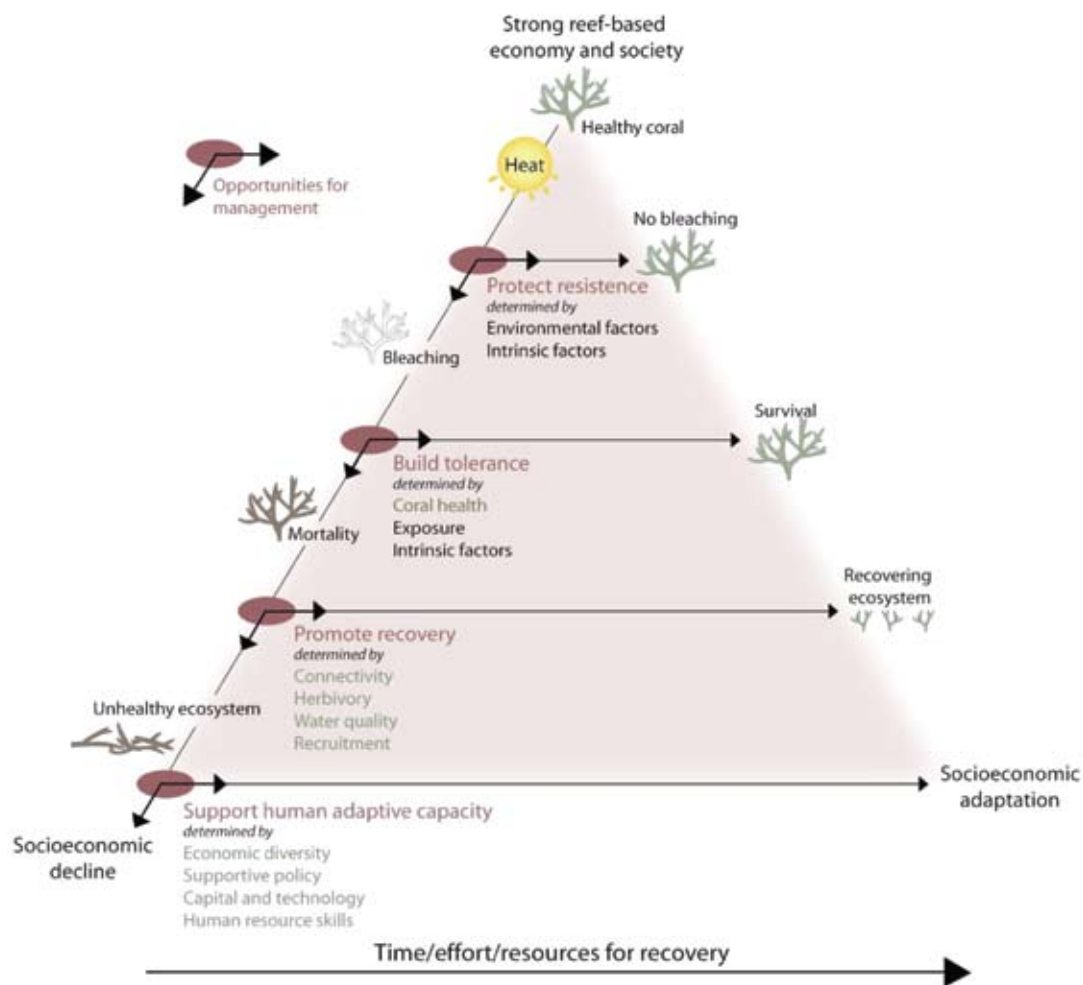


Figure 1. Four conditions determine the outcome of stressful temperatures for coral reefs—bleaching resistance, coral tolerance, reef recovery and human adaptive capacity. Each of these is influenced by a suite of factors that, in combination, determine the resilience or vulnerability of the system. Factors that can be influenced by local management actions are highlighted in green. Factors shown in black cannot be changed through local management interventions, but can be incorporated in the design and placement of management initiatives to enhance ecosystem resilience (Marshall & Shuttenberg 2006).

3. Objectives

The following are key objectives of this fishery-specific Coral Stress Response Plan:

- Provide for an adaptive, responsive approach to coral stress that is consistent with the whole-of-government approach being coordinated by GBRMPA.
- Ensure that fishing activities do not compromise the resilience of coral reefs that are subject to a range of stress events (including coral bleaching).
- Recognise fishers’ stewardship and long-term knowledge of ecosystem resilience and natural processes occurring in the areas they routinely collect within.
- Proactively involve fishers and other community members in the early warning and monitoring phases of coral stress.⁶

⁶ Fishers and community members are involved in early warning and monitoring in areas identified as being at greater than moderate risk of bleaching over summer in the Coral Bleaching Response Plan. By monitoring catch sites using standard monitoring techniques (RHIS—see Appendix 2) prior to bleaching occurring, fishers contribute to a baseline assessment of individual reef health, which is a critical aspect of customising decision-making if bleaching then occurs.

- Maintain open communication with all stakeholders to achieve balanced and appropriate fishery-based responses (within a range of other community-wide responses) when coral reefs exhibit signs of stress (e.g. mass bleaching).
- Improve stakeholders' understanding of the links between coral bleaching events (most visible indicator of stress) and the QCF and MAFF.
- Recognise and contribute to Australia's international obligations to maintain ecosystem functions for species of conservation interest (e.g. corals, under the Convention for International Trade in Endangered Species (CITES) and the Convention on Biological Diversity (CBD)—particularly the Addis Abbaba principles).

4. Fishery profile

The MAFF and the QCF operate on the east coast of Queensland, primarily on the GBR.

4.1. MAFF

Marine aquarium fish are commercially harvested with the use of hand-held apparatus, fishing lines, cast nets, scoop nets, seine/barrier nets and herding devices (e.g. small rods). Divers in the commercial fishery use scuba or surface-supplied air from hookah apparatus, which gives divers extended time underwater and increased mobility. These technologies allow MAFF fishers to harvest at a range of depths and in a range of environments, which in turn reduces the level of interaction between MAFF harvesting and other uses of the reef (e.g. tourism activities).

The popularity of 'mini-reef' displays has driven collectors to provide an increasingly diverse range of live animals to their markets. In addition to an extensive range of fish species, coral shrimp, colourful sea cucumbers, nudibranchs, gastropods and other molluscs, sponges and ascidians are all targeted by MAFF harvesters for trade.

Damaged or unhealthy specimens are of little commercial value—the market demands perfect specimens with low susceptibility to disease or infection. As a result, fish and invertebrates are carefully selected and handled by divers. For certain species, the market often also demands specific sizes of fish. This further contributes to the selective harvesting of MAFF operators.

Management arrangements for the MAFF include:

- a limit on the number of licences (currently 49)
- limits of two boats and three collectors operating under a licence at a time
- gear restrictions (including no use of scuba or hookah by recreational fishers)
- limited catch for some operators (A2 fishery symbol holders)
- size limits for certain species
- limited access to special management areas.

The five special management areas (SMAs) were introduced to divert effort away from centres with the potential for heavy, localised fishing effort. Access to these areas is limited to certain licences (determined by a history-based process conducted in 2003). The SMAs are:

- Cairns area (16 licences)
- Whitsundays area (3 licences)*
- Keppel area (8 licences)
- Sunshine Coast area (8 licences)
- Moreton Bay area (11 licences).

* Note, under GBRMP regulations (provisions in the Whitsundays Plan of Management), MAFF (and coral) collection no longer occurs in the Whitsundays SMA.

The exact boundaries of these areas are specified in the Fisheries Regulation 2008.

In addition, there are a range of spatial closures imposed through Commonwealth and state marine park zoning.

4.2. QCF

The commercial QCF is based on the collection of a broad range of coral species from the classes Anthozoa and Hydrozoa. The key components of the fishery are:

- living rock—the dominant catch component (about 70%), consisting of dead coral skeletons/fragments colonised with algae and other organisms, representing a suitable substrate for live corals in aquaria
- live corals for aquaria
- ornamental corals—taken live or dead, dried and processed on land and sold as a non-living product to the home decorator market.

The emphasis of the QCF is on quality rather than quantity, with pieces chosen selectively for their size, shape and colour. Due to the strong market demand for live corals used in private aquaria, key target species are generally the small and vibrant varieties.

The majority of live corals collected in Queensland for the aquarium trade are species that are not considered 'reef-building' corals. Targeted live coral types include hard corals that are solitary, large-polyped or free-living; soft corals; zooanthids; corallimorphs and anemones. A small sector of the fishery supplies the ornamental coral trade, which is based on mainly abundant, fast-growing, reef-building species.

To obtain the desirable specimens, coral fishers have explored a range of depths and environments. A large amount of aquarium coral taken in the fishery is sourced from depths of more than 10 m, often in areas between reefs. The conditions (particularly light levels) found in these habitats can be more easily replicated in domestic aquaria and, consequently, the species found in these habitats are more suited to collection.

Management arrangements for the QCF include:

- a limit on the number of licences (currently 59)
- a limit of one boat and a limited number of collectors (currently under review) operating under a licence at a time
- collection by hand or with non-mechanical, hand-held instruments only (scuba and hookah are also allowed in the commercial fishery)
- no recreational collection from within Commonwealth or state marine parks.

5. Links between reef health and fishery operations

Reef ecosystem stress (such as coral bleaching events) may reduce the capacity of reefs to support human use, including commercial harvest fisheries.

Current research suggests that species directly dependent on coral are likely to suffer more immediate consequences if large amounts of coral die. However, there are time lags for the trophic cascades that affect a much wider range of species as the ecosystem function (e.g. shelter) of coral declines further (Pratchett et al. 2006; Wilson et al. 2006).

What is not well understood is the knock-on effect of trophic cascades to the broader ecosystem. For example, visibly healthy ecosystems have been shown to shift quickly to undesirable states—

often when coral cover is reduced (Hughes et al. 2003). Sometimes this can occur when critical functional groups are lost at a local scale (Bellwood et al. 2004). Given that the MAFF targets a wide range of species (including some herbivores), and collects predominantly juveniles in small numbers, it is unlikely to disrupt ecosystem processes by removing critical functional groups.

The linkages between coral bleaching and QCF and MAFF fishing activities will depend on the following factors.

(i) *Extent of spatial overlap*

Coral collection occurs predominantly in the Cairns and Keppel areas. MAFF collecting occurs in the GBR and waters south of the GBR. The Keppel area has demonstrated a particularly high frequency of bleaching events in recent years and this trend is predicted to continue. Consequently, there is likely to be some spatial overlap between bleached areas and MAFF and QCF fishing activities. Spatial overlap will be assessed for each detected bleaching event on the east coast of Queensland.

(ii) *Depth overlap*

The MAFF and QCF collect live organisms from a range of depths (but generally greater than 5 m deep) and often in inter-reefal areas. Loose live rock is collected from generally high-energy environments where depth can range from 0–16 m, depending on location. Coral bleaching occurs more commonly in shallow reef environments. While the extent of depth overlap between the two is predicted to be minimal, it will be important to assess in order to determine appropriate fishery responses.

(iii) *Species effects (coral)*

Coral species in a similar habitat often show different susceptibilities to bleaching. Marshall and Baird (2002) suggest that fast-growing *Acropora* species are the most susceptible corals to thermal stress. The majority of the coral fishery generally targets smaller corals occurring at depths below 5 m, and mostly species that are not prone to bleaching (Atkinson et al. 2008). Assessment of the coral fishery target species and their proneness and resilience to bleaching will be important in determining fishery responses to bleaching events.

(iv) *MAFF target species and their roles in ecosystem resilience*

Studies conducted on the GBR have linked the resilience of bleached corals with the presence of herbivorous/grazing fish that help control algal growth in coral habitats (Hughes et al. 2007). These include species such as parrot fish, rabbit fish, surgeon fish and sea urchins. Similarly, the presence of anemone fish in bleached anemones may enhance the host's resilience by protecting them against predation (Porat & Chadwick-Furman 2004) and by removing debris, dead tissue and possibly parasites (Mariscal 1970). Depending on the severity of a bleaching event, it may be appropriate to limit the removal of some or all of these important species from bleached areas.

(v) *The role of live rock in coral recovery*

It is suggested that the availability of live rock (particularly fixed substrate) is important during the coral spawning and recruitment months (October and November) following a bleaching event (Johanna Johnson, pers. comm., 2007).

5.1. Resilience mechanisms

Public awareness regarding climate change and its consequences on human activity is growing. On the GBR, management of the ecosystem for resilience—in the face of increasing uncertainty—cuts across jurisdictions and sectoral interests. It will take the collaborative efforts of all stakeholders to develop a toolbox of resilience mechanisms.

This document is intended to coordinate the efforts of managers and fishers in the MAFF and QCF to contribute effectively to this process. Flexibility and responsiveness will be a key component of any resilience strategies. An important delivery mechanism will be stewardship initiatives (over and above existing management) to minimise the impact of a range of activities and promote ecosystem resilience.

5.1.1. Stewardship action plans and voluntary moratoriums

A stewardship action plan (ie. code of conduct) has been developed by Pro-vision Reef Inc., the recognised peak representative body for the MAFF and QCF industry. This stewardship action plan details current best practice techniques, including those for species identified in the ecological risk assessment processes for these two fisheries.

The stewardship action plan is intended to be a living document that is reviewed regularly and as new information comes to hand. Some examples of harvesting standards for at-risk or high-profile species include:

- providing for a minimum percentage of anemones to be left untouched in colonies
- the practice of removing only one pair of clownfish from single anemones to ensure protection for the anemone
- leaving a certain number (or proportion) of existing anemone fish in an anemone to avoid re-colonisation by different species of anemone fish.

The stewardship action plan applies generally to all members of Pro-Vision Reef Inc. (around 60% of the current licences in both fisheries and about 80% of the catch in both fisheries); however, industry acknowledges the need to adapt best practice during or following environmental stress events, and to responsive management arrangements administered under other instruments. The stewardship action plan establishes a response gradient of voluntary restrictions for species and habitats that have been subjected to local scale environmental impacts such as coral bleaching, for example:

- providing guidelines as to when collecting should be reduced or ceased for at-risk species
- providing a mechanism to achieve voluntary spatial and temporal separation between collecting activities and impacted sites.

Specific best practice protocols that have already been developed by industry to apply to the Keppel area⁷ include:

- the aim to minimise the impact of collection on stressed environments by
 - not taking bleached anemones (or coral)
 - not taking clownfish from bleached anemones
 - a reviewable moratorium on collection of some species at some locations (either because they have been significantly impacted by bleaching or because they are important sites to the local dive-based tourism sector).

⁷ The Keppel area is recognised as an area that often is affected by bleaching and (sometimes) mortality from high SST events or flooding from the Fitzroy River.

Industry has also given agreement to advise local communities in each SMA (for the MAFF) of the boats (and their boat marks) authorised for use in the SMAs. It is hoped that this will improve the community's ability to monitor industry's compliance with the existing management arrangements and any industry stewardship initiatives.

Additionally, industry has identified the need to underpin their assumptions of best practice with science in various aspects of these two fisheries. They are currently seeking reputable research partnerships to address these questions.

Other reef industry sectors are also developing stewardship initiatives to reduce impact on stressed environments.

5.1.2. Reef protection markers

One mechanism to reduce human impacts on already stressed reefs is to reduce the impact of anchor damage and minimise all use of such areas by installing no-anchoring markers. This approach is currently undergoing experimental trials in the Keppel area.⁸

5.1.3. Temporary emergency closures

Short-term closures (up to six months) of small areas may help protect severely stressed reefs by excluding all users. This will allow important biological processes to occur that may facilitate recovery (e.g. settlement of new coral recruits and maintaining critical functions such as grazing and predation).

6. Coordination of actions

This Coral Stress Response Plan forms an important response framework for those fisheries closely linked to coral stress events on the GBR. It is integrated with the CBRP (coordinated by the GBRMPA), and a cross-jurisdictional approach to its development has been taken to ensure its consistent application.

This Coral Stress Response Plan has direct links with each of the four key areas of the CBRP—early warning system, assessment and monitoring, management actions and communication. For a schematic diagram of this Coral Stress Response Plan and how it integrates with the CBRP and current industry initiatives please see Appendix 3. Further details of the GBRMPA CBRP are provided at Appendix 1.

6.1. Proactive assessment of reef health

As the summer period approaches, analysis of climate forecasts and remote sensing data are used by the Predictive Ocean Atmosphere Model Australia (POAMA) group to provide a long range prediction (1–6 months) of the risk of mass bleaching. If there is a high risk of bleaching, general logistical preparations for assessment and monitoring will be triggered under the CBRP. Two other important features will also be actioned under the Coral Stress Response Plan:

- the establishment of a review taskforce (composed of industry, representatives of the three management agencies—Queensland Primary Industries and Fisheries (QPIF), GBRMPA and the Environmental Protection Agency—and, if needed, an independent scientist)

⁸ http://www.gbrmpa.gov.au/corp_site/management/site_management/keppel_bay_and_islands_site_management_arrangements/keppel_bay_resilience_project_-_no_anchoring_areas

- notification to industry in key collection areas to begin voluntary rapid assessment and monitoring protocol⁹ (Reef Health and Impact Summary (RHIS)—see Appendix 2) surveys to provide a baseline of the health in their collection areas.

The former provides notice to the relevant representatives that they may be called on at short notice to review significant amounts of information, prior to stakeholder consultation about response options.

The latter provides a good baseline of health and resilience prior to any impact at important collection locations. Pre-impact information allows response gradients to be customised for actual impacts at individual locations. This early warning process enables fishers to not only adapt to future risk by modifying collection practices, but also, if conditions do subsequently deteriorate, to manage their businesses around localised impacts as effectively as possible.

6.2. Monitoring coral bleaching

SST modelling has long been recognised as a valuable tool for predicting coral bleaching events. GBRMPA's ReefTemp program uses satellite data on SST, SST anomalies (i.e. above average temperature for a particular month/season), degree heating days and heating rate to monitor reef condition over the summer months and identify the potential for coral bleaching events (for details of the approaches used see CBRP 2008–2009).

BleachWatch is a program that collates observation data on coral condition that has been collected and reported by community members/reef users. If ReefTemp identifies that conditions are warming up, BleachWatch participants are notified and asked to be vigilant in reporting their observations. If reports of early signs of bleaching are received from BleachWatch participants in January, site inspections are conducted by GBRMPA in late January or early February. If substantial bleaching is observed, full ecological surveys are undertaken by GBRMPA in March. Recovery surveys are usually conducted 3–4 months after the full ecological surveys (i.e. June or July) (CBRP 2008–2009).

Regular updates on coral condition and summaries of BleachWatch reports are publicly available on the GBRMPA website¹⁰ over the summer months. More detailed information will be provided to fishery managers, on a regular basis, after bleaching is observed. For example, preliminary data on bleaching severity and extent can be provided to fishery managers within 1–2 weeks of surveys, including recovery surveys, although a full approved report will not be available until April/May (CBRP 2008–2009).

6.3. Notification

Once coral bleaching has been officially detected in an area, QPIF will notify stakeholder groups that the fishery response process has been triggered. All communications relating to bleaching events will be well integrated with broader communication strategies developed for the CBRP.

Notification methods may consist of the following:

- emails to the harvest fisheries Management Advisory Committee (MAC)
- letters to licence holders

⁹ The RHIS system was developed by the EPA and the GBRMP Day-to-Day Management group (DDM). It includes measures of coral bleaching extent and severity from the Bleachwatch program, in addition to an assessment of other key reef health parameters such as algal cover, physical damage and coral disease.

¹⁰ http://www.gbrmpa.gov.au/corp_site/key_issues/climate_change/management_responses/coral_bleaching_status_2008-09

- written or electronic notification to known community groups (e.g. ‘Friends of [locality]’ groups), non-government organisations/conservation societies and tourism operators
- media release.

A second notification will ensue following outcomes of the data review and consultation process (see section 6.4).

6.4. Data review and consultation

Following the detection of bleaching through the GBRMPA ReefTemp and BleachWatch programs, the review taskforce will review, analyse and interpret available bleaching data (including results of any ecological surveys that have been conducted) and records of fishing activity in the bleached areas.

6.4.1. Review of bleaching data

All available information on the severity, spatial extent (including depth effects) and species-level effects of coral bleaching will be reviewed following identification of a bleaching event. This information will be considered when reviewing fishery data so that the fishery response is appropriate and relevant for the particular bleaching event.

6.4.2. Review of fishery data

QPIF holds catch and effort records for the MAFF and QCF. To maintain confidentiality, fishery managers will review these records. The entire review taskforce will consider relevant conclusions. This review will reveal the presence or absence (and volume) of fishing activity in areas of interest (i.e. bleached areas) and will enable QPIF to target consultation at the relevant operators in fisheries whose fishing activities are likely to interact with the stressed system.

6.4.3. Consultation and communication

If there has been no recent reported fishing activity in the affected area(s), QPIF will:

1. consult with fishery operators to (i) verify catch and effort data and (ii) assess the significance of the affected area(s) to fishers (e.g. future intentions, seasonal/cyclical harvesting)
2. consult with the non-fishing stakeholders (e.g. relevant community group) to (i) assess the significance of the affected area(s) and (ii) assess stakeholders’ expectations of fishing activity in the area.

If there has been recent reported fishing activity in the affected area, QPIF will:

1. conduct data analysis to assess the extent of activity (spatial, number of operators, species caught, proportion of operators’ total catch and effort) in the affected area(s)
2. consult with fishery operators to (i) verify catch and effort data (to a higher spatial and taxonomic resolution) and (ii) assess the significance of area(s)
3. communicate outcomes of steps 1–2 to stakeholders
4. undertake targeted consultation with community groups, other reef users and fishers to determine an appropriate fishery response (see section 6.5).

6.5. Determine and implement appropriate fishery response

Responses of varying intensity are identified in section 6.5.1 ('Response gradient') as potential mechanisms to limit the impacts of fishing operations on systems under stress from coral bleaching. The intensity of the response will ideally reflect the severity of bleaching and/or the overlap of fishing activities with the stressed system. Consultation activities outlined in section 6.4.3 will assist in determining appropriate responses from the gradient or identify appropriate alternatives.

Actions developed under the Coral Stress Response Plan will be integrated with any broad scale community actions developed under the CBRP to provide a holistic response to localised/regional stress events.

Response gradients will need to be determined on a case-by-case basis, using the best available information. Severity of the stress (e.g. bleaching) event will be a function of:

- (a) the relative level of bleaching at a location versus the original percent cover of hard corals prior to bleaching
- (b) the unique characteristics of each location—aspect, depth profile, location on the GBR (inshore/mid-shelf/outer shelf), local hydrography, relative health of the reef ecosystem (e.g. recent history of storms, disease, crown-of-thorns starfish outbreaks) and prior history of bleaching or flooding.

Responses will also be determined by how a given reef ecosystem responds to the stress event. Each event is unique and while some situations may result in mass bleaching, not all will result in mass mortality. Some locations may require intervention on various timescales to maximise recovery or improve resilience.

6.5.1. Response gradient

Responses* could include:

1. no changes to fishing practices (assumes already negligible impact of fishing on recovery/resilience)
2. no take of bleached corals or anemones (and associated anemone fish)
3. no take of bleached corals, reef building corals or climate-sensitive corals¹¹ and anemones
4. no take of bleached corals; reef building corals; climate-sensitive corals and anemones; and herbivorous/grazing species that control algal growth in coral habitats (e.g. parrot fish, rabbit fish, surgeon fish, urchins)
5. spatial separation of coral and aquarium fish fishing from bleached areas of reef by:
 - depth
 - site
 - reefs/areas.

*Note, intensity of response depends on bleaching severity and interaction with fishery. (1 = minimum intensity; 5 = maximum intensity).

¹¹ 'Climate-sensitive corals' are corals that are particularly prone to bleaching.

6.5.2. Implement response

Once an appropriate response has been determined, its method of implementation will be established. Potential options, in order of decreasing desirability are:

- adaptation of the industry code of conduct
- another form of voluntary agreement from industry
- installation of reef protection markers (no anchoring areas)
- amendment of fishing licence conditions
- emergency declaration (temporary legislative action).

6.6. Review response

It is intended that fishery responses to bleaching events would remain in place until GBRMPA (or other accepted party) has conducted recovery surveys. GBRMPA usually conducts recovery surveys in June or July, approximately 3–4 months after the full ecological surveys following an observed bleaching event (Johanna Johnson, pers. comm., 2007).

Once the recovery survey results are finalised, the review taskforce will review the appropriateness of implemented responses and make a determination to:

- continue the initial response
- discontinue the initial response; or
- adjust the response.

7. Conclusions

The Coral Stress Response Plan will be reviewed regularly, based on the best available information. It is designed to promote partnerships and integrated solutions for fishers and other reef users faced with localised significant environmental impacts such as mass bleaching.

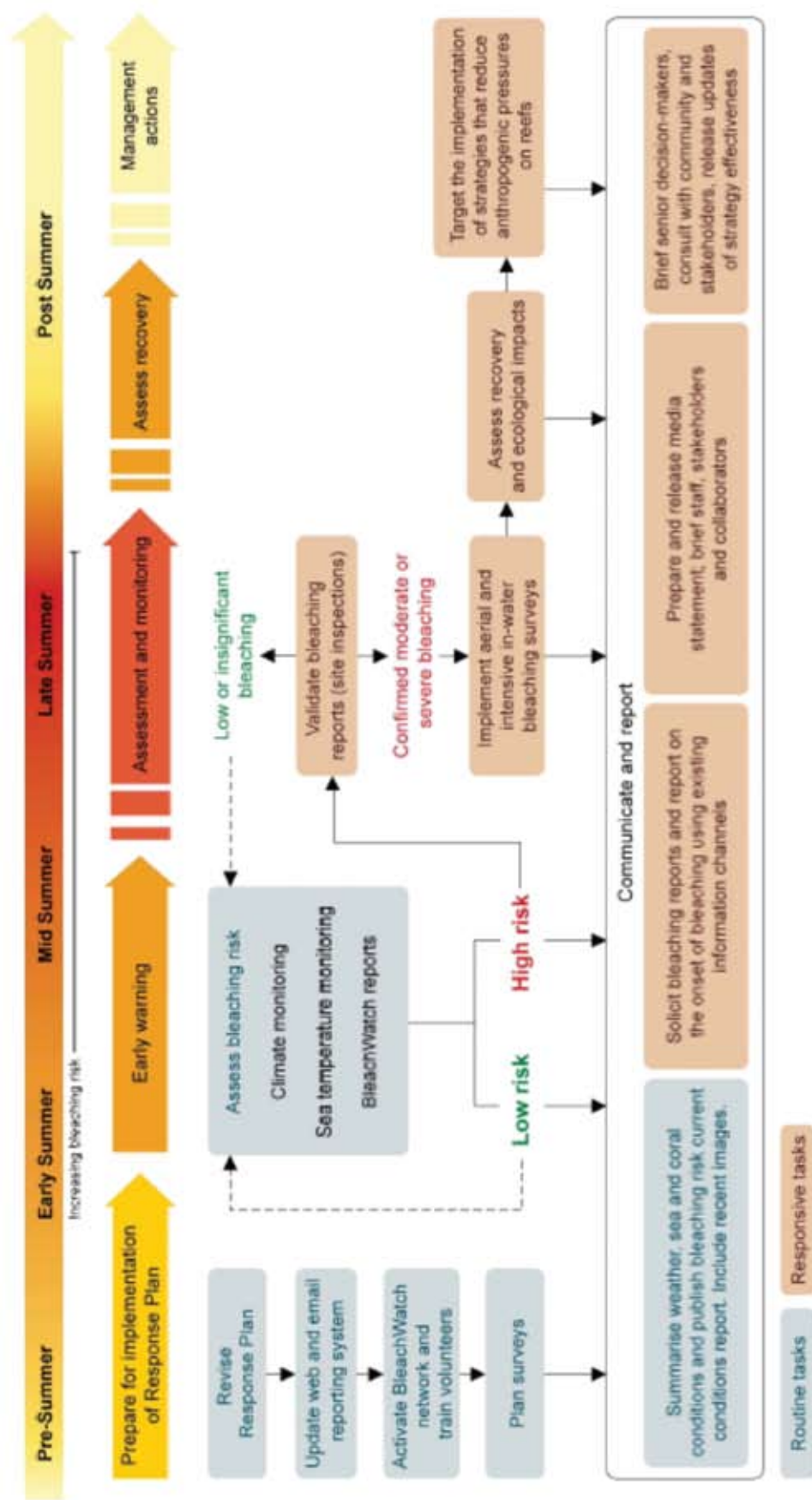
It is intended that sound research should be encouraged and supported to scientifically validate the current best practice assumptions underpinning this document. This will ensure that the best possible outcomes can be achieved for the GBR reef environment and the people and industries (such as the QCF and MAFF fishers) that rely on it.

While this plan has focussed mainly on bleaching as a manifestation of ecosystem stress, it is intended that it could provide a basic framework for managing responses to other forms of stress that affect coral reef ecosystems, should it be needed in future.

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Appendix 1. Coral Bleaching Response Plan schedule of routine and responsive tasks before, during and after the coral bleaching season (GBRMPA, 2008)



Appendix 2. Example of a RHIS form

Reef Health and Impact Summary 20 minute checklist

1. Observer and site details

Observer name: _____ Date: _____ Check one: SCUBA Snorkel

Reef ID / name: _____ Lat: _____ Long: _____

Habitat: Lagoon Bonnie field Wind speed: _____ Air temp: _____
 Crest Front reef (please circle) 0 _____ Water temp: 0-3m _____
 Slope Back reef Clear Partly cloudy 5-10m _____
 Reef flat Mainly cloudy 5-10m _____
 Other: _____ Aspect (e.g. NE): _____ Present Absent
 Flood plume: Yes No Suspended algal bloom: Present Absent

2. General habitat condition

Benthos Macroalgae (insert height and quantity code) _____

Live coral: _____ %
 Dead coral (not rubble): _____ %
 Sand/rubble/rock: _____ %
 Algae: _____ %
 TOTAL: 100% _____

Coral lifeforms (insert % of abundance see table 1)

Branching Slime Quantity None
 Plate Turfing B&C & pieces
 Massive Leafy/fleahy L Large patches
 Soft Coral Mat like E Everywhere
 Bushy Tree/bush-like
 Digitate
 Encrusting

3. Recent coral breakage

Amount affected None s-colonies 6-20 colonies >21 colonies

Branching None A Anchor Secondary cause None
 Plate Divers D Divers
 Massive Soft Coral S Snorkellers S Snorkellers
 Soft Coral W Weather/storm W Weather/storm
 Bushy V Vessel V Vessel
 Digitate An Animal An Animal
 Encrusting

4. Bleaching observations

Bleached coral at this site (table 2)

Category 0 (0%) Category 3 (31-50%)
 Category 1 (1-10%) Category 4 (51-75%)
 Category 2 (11-30%) Category 5 (76-100%) (only select one)

Most common level of bleaching severity
 Bleached only on upper surface
 Pale/fluoro (very light or yellowish)
 Totally bleached white
 Dead coral with algae

Types/lifeforms bleached

Branching Bushy
 Plate Digitate
 Massive Encrusting
 Soft coral

Indicate the depth range of the bleaching

Min: _____ m Max: _____ m

5. Coral disease

Amount affected none s-colonies 6-20 colonies >21 colonies

White syndrome (table 3) Branching Plate Massive Bushy Digitate Encrusting

Black band disease (table 3) Branching Plate Massive Bushy Digitate Encrusting

Brown band disease (table 3) Branching Plate Massive Bushy Digitate Encrusting

6. Crown-of-thorns starfish (COTS) scars

Amount affected none s-colonies 6-20 colonies >21 colonies

Drupella small scars Branching Plate Massive Bushy Digitate Encrusting

Number of Juvenile COTS (size of hand): _____
 Number of adult COTS (larger than size of hand): _____
 Number of Drupella snails: _____

7. Rubble

Abundance 1 2-5 >5

Fishing line Plastic Netting Rope Other

Other comments: _____

Table 1 Coral lifeforms

Branching Digitate Massive Encrusting Soft Coral Plate Bushy

Table 2 Amount of coral or bleaching

Category 0 (0%) Category 1 (1-10%) Category 2 (11-30%) Category 3 (31-50%) Category 4 (51-75%) Category 5 (76-100%)

Table 3 Coral disease

White syndrome Black band disease Brown band disease

Appendix 3. Coral stress monitoring and response flowchart

