Australian Government
Great Barrier Reef
Marine Park Authority

Workshop Summary: Management and Science of Fish Spawning Aggregations in the Great Barrier Reef Marine Park 12-13 July 2007

Martin Russell and Rachel Pears
(editors)

2007

Published by the Great Barrier Reef Marine Park Authority

ISBN 978 1 876945 66 5 (pdf)

National Library of Australia Cataloguing-in-Publication entry:

Workshop summary [electronic resource] : management and science of fish spawning aggregations in the Great Barrier Reef Marine Park, 12-13 July, 2007 / editors, Martin Russell and Rachel Pears.

Townsville, Qld. : Great Barrier Reef Marine Park Authority, 2008.

ISBN 978 1 876945 69 5 (pdf)

Marine fishes--Spawning--Queensland--Great Barrier Reef Marine Park--Congress.
Marine fishes--Eggs--Queensland--Great Barrier Reef Marine Park--Congress.
Fishery management--Queensland--Great Barrier Reef Marine Park--Congress.
Great Barrier Reef Marine Park (Qld.)--Management--Congress.
Russell, Martin, 1969-
Pears, Rachel, 1969-
Great Barrier Reef Marine Park Authority.

577.789

Citation: Russell, M and Pears, RJ (editors), 2007. *Workshop Summary: Management and Science of Fish Spawning Aggregations in the Great Barrier Reef Marine Park*, 12-13 July 2007. Held at the Museum of Tropical Queensland, Townsville, Australia. Published by the Great Barrier Reef Marine Park Authority, Townsville.

Australian Government

Great Barrier Reef
Marine Park Authority

Director, Communication and Education Group
2-68 Flinders Street
PO Box 1379
TOWNSVILLE QLD 4810
Australia
Phone: (07) 4750 0700
Fax: (07) 4772 6093
info@gbrmpa.gov.au

Comments and inquiries on this document are welcome and should be addressed to:

Director, Fisheries Group

info@gbrmpa.gov.au

www.gbrmpa.gov.au

Contents

Executive summary

Fish spawning aggregations (FSAs) are a key issue for management of the Great Barrier Reef Marine Park.

A workshop was held by the Great Barrier Reef Marine Park Authority in July 2007 to bring together an expert group including reef fish scientists, managers and fishers to discuss the current status of fish spawning aggregations in the Marine Park and prioritise a strategic approach to management and science needs.

Knowing that fish species that form spawning aggregations are, or potentially are vulnerable to overexploitation, the 28 workshop participants developed a list of research priorities and management considerations.

The following research priorities were identified for the next five years (2007-2012):

1. The Queensland Government's long-term monitoring programme for the Coral Reef Fin Fish Fishery should include collection of reproductive samples for key target species.
2. Continue and expand the long-term dataset from Scott Reef and Elford Reef coral trout spawning site monitoring project offshore from Cairns, with replication in the north and south of the Marine Park.
3. Priority species for research are large mouth nannygai, black jewfish and grunter.
4. Implement a Marine Park wide interview survey to compile historic and current information on spawning aggregations for all key species.
5. Survey Old Reef to determine actual aggregation sites and timing for key species.
6. Investigate the impacts of fishing disturbances on aggregations, specifically for Spanish mackerel, grey mackerel, flowery cod, camouflage cod and coral trout species.

Workshop participants considered the current management arrangements under the *Queensland Coral Reef Fin Fish Fishery Management Plan 2003* and the *Great Barrier Reef Marine Park Zoning Plan 2003* to provide suitable protection of FSAs for most coral reef fin fish in the Marine Park. However, there were concerns about the adequacy of protection of FSAs for some inshore and pelagic species. The workshop participants provided six specific management considerations:

1. The spawning closure management arrangement should be adaptively managed.
2. More information is needed on species-specific spawning behaviours to better determine how well Marine Park zoning protects FSAs.
3. A risk assessment should be done to determine if the current spawning closures on the Great Barrier Reef are needed.
4. To reduce socio-economic impacts of the spawning closures, a modification could be considered. Suggested modifications are provided in the "*Management priorities"* section of the report.
5. Species-specific spawning closures, rather than the broad species protection currently in place, could be considered.
6. Management should consider accounting for latitudinal and temporal variability in aggregation timing.

The outputs of the workshop form a strategic direction for managing and researching FSAs in the Marine Park. Also, the spawning protection management arrangements for the Queensland Coral Reef Fin Fish Fishery are currently being reviewed by the Queensland Government, and it is a requirement under the *Environment Protection and Biodiversity Conservation Act 1999* sustainability assessment for this fishery that adequate protection is being given to spawning stocks of the main target species. This workshop summary provides expert advice to this review.

Introduction

In 1998, the Great Barrier Reef Marine Park Authority (GBRMPA) held a workshop entitled '*Spawning Aggregations of Tropical Fishes on the Great Barrier Reef, and Implications for Management*'. Participants included representatives from management, research and fishing industry. The outcomes from the workshop contributed to policy development, the rezoning of the Great Barrier Reef Marine Park (Marine Park), the development of the Queensland Coral Reef Fin Fish Fishery Management Plan, spawning aggregation site identification and assessment training, and monitoring of aggregation sites.

Fish spawning aggregations (FSAs) have remained a key issue for management in the Marine Park and globally over the past 10 years, making it timely to reassemble a group of experts to discuss the way forward for FSA management and science in the Marine Park.

The objective of the 2007 workshop was to bring together an expert group including reef fish scientists, managers and fishers to discuss the current status of FSAs in the Marine Park and prioritise management and science needs. The workshop was opened by the Chair of GBRMPA, the Hon Virginia Chadwick, and independently facilitated by Pat Appleton. A photo and list of participants is provided in Appendix 1.

The outputs of the workshop form a strategic direction for managing and researching FSAs in the Marine Park. Also, the spawning protection management arrangements for the Queensland Coral Reef Fin Fish Fishery are currently being reviewed by the Queensland Government, and it is a requirement under the *Environment Protection and Biodiversity Conservation Act 1999* sustainability assessment for this fishery that adequate protection is being given to spawning stocks of the main target species. This workshop summary provides expert advice to this review.

Workshop discussions

The information provided in this document refers to the Great Barrier Reef unless otherwise noted. The discussion points below were raised by the workshop participants to help determine the management and research priorities for 2007 and beyond. The discussion points are not in priority order, however similar issues have been grouped together for ease of reference.

Management

The following discussion points were raised to assist in developing a strategic approach to management of FSAs in the Marine Park.

1. Worldwide, some 119 species from 18 families are known to form spawning aggregations. Many of these species occur in the Marine Park.

2. FSAs are in decline globally, with many cases of aggregations decreasing or extirpated due to overfishing through lack of, or poor management. However, such declines have not yet been demonstrated for any populations on the Great Barrier Reef (although there is currently concern about population declines of some mackerel species). The Australian Government and Queensland Government have a legislative responsibility to ensure that this does not occur on the Great Barrier Reef.

3. FSAs are classed by the IUCN as '*wildlife spectacles*', and a new Marine Conservation Subcommittee of the IUCN Species Survival Commission will be focusing on marine species under threat, including *wildlife spectacles*.

4. There are several high level international statements and recommendations on the need to protect spawning aggregations, including:
    - 2003 ITMEMS2 Call for Action – 'Reef Fish Spawning Aggregations Need Protection'
    - ITMEMS3 recommendation to protect important and vulnerable life history phases and habitats
    - 3rd IUCN World Conservation Congress recommendation to take action to protect reef fish spawning aggregations
    - 2006 ICRI statement on coral reef fish spawning aggregations
    - 2006 Philippines Cordova Accord (Mayors MPA Summit).

5. FSAs can be considered like 'canaries' in a mine, and the status of aggregations is a possible indicator of environmental and/or fish stock health. It is valuable to learn from experiences overseas about human impacts on aggregations. It is better to prevent overfishing of an aggregation, since there is no guarantee of recovery. Loss of FSAs will have negative ecological and socio-economic consequences.

6. There currently exists a suite of management arrangements for reef and inshore fish species in the Great Barrier Reef. These include size limits for many species, recreational possession limits, commercial total allowable catches, gear restrictions and seasonal spawning closures.

7. Under current Marine Park zoning, 33 per cent of the Great Barrier Reef is zoned no-take (Green Zones). Commercial and charter fishing is spread throughout the Great Barrier Reef, and recreational fishing generally occurs closer inshore and adjacent to population centres. With effective compliance of Green Zones, the direct fishing impacts on FSAs are confined to about 67 per cent of the Marine Park, and commercial and recreational fishing has general delineation between offshore and inshore.

8. The current 33 per cent protection of the Marine Park in Green Zones does provide some protection to FSAs. However, more information is needed on species-specific spawning behaviours. It is unknown how many key FSAs for different species are included in the Green Zones. Only six reefs and areas with validated FSAs for coral trout, Spanish mackerel and grunter were specifically included in Green Zones during the rezoning of the Marine Park in 2004. There are over 2900 reefs in the Marine Park, where little is known about FSAs.

9. Under Queensland fisheries legislation, reef fish are provided some protection during spawning times through seasonal closures over the new moons in October, November and December each year. Barramundi is protected during its main spawning season between November and February each year.

10. The introduction of these spawning closures into the Coral Reef Fin Fish Fishery by the Queensland Government was a precautionary management approach triggered when a strong downward trend in population densities of common coral trout (*Plectropomus leopardus*) was recorded in the late 1990s in the southern and Townsville regions of the Great Barrier Reef.

11. These spawning closures are part of an agreed package of management arrangements for the fishery at the time of implementing a fishery management plan for the Coral Reef Fin Fish Fishery. However, the closures were designed specifically to benefit common coral trout. There are some benefits to other species, for example, 28 species have been observed spawning at the same time during long-term monitoring at Scott

Reef and Elford Reef offshore from Cairns. It is noted that not all these species are targeted, and that the spawning closures do not protect some other fished aggregation-spawning species that aggregate at other times. Management needs to consider if it is appropriate and beneficial to have a blanket closure over a range of species, with an effect of only protecting the spawning success of a few species.

12. The spawning closures are a part of a broader package of management measures for the fishery agreed to by the fishing industries and the Queensland and Australian Governments. If the spawning closures were modified or removed, the whole package should be re-considered (for example, should quotas and bag limits be adjusted?).

13. The commercial fishing representatives suggested that the current spawning closure management arrangements are now outdated. This has particularly been brought about by the rezoning of the Marine Park, the introduction of a management plan for the fishery, including a quota system, and the fact that the fishery currently targets a small percentage of the reef in waters shallower than 25 metres. The quota system has moved the fishery into an almost exclusively live fish fishery for coral trout. These issues were not as apparent when negotiations were being held in developing the suite of management arrangements under the fisheries management plan.

14. The current closures do not match the exact length of time that coral trout may be on an aggregation site; the timing will vary. However, five days is more likely to be the average time. The nine-day closure times were decided as part of the management plan for ease of compliance and as a method of effort reduction in the fishery.

15. Species differ in their spawning behaviour. For example some snapper species may form large aggregations (not yet documented in the Great Barrier Reef), whilst some coral trout species may form small aggregations (10's to 100's of fish, documented on the Great Barrier Reef). The current spawning closures cover the entire Great Barrier Reef for all coral reef fin fish species. Having one management tool across all species may not ensure appropriate protection. More information is needed on a species-by-species basis to determine the most appropriate closure times per species as an alternative to a blanket closure. There is merit for species-specific closures if enforcement issues can be addressed. (*Post workshop note: The commercial live fish fishery targets coral trout, whereas the charter fishery targets a wider range of species. Therefore, a species-specific closure for coral trout is more likely to alleviate concerns raised by charter fishing operators, but less likely to alleviate concerns raised by commercial fishers about the economic impacts of the closures*).

16. The enforceability of the current closures is currently relatively high, and there is good compliance. This is because the closures prohibit the possession of coral reef fin fish, and any fishing boat with these fish on board must be in port during the closures.

17. Different reef fish species spawn at the locations they live on a reef (resident), or move to specific locations during narrow time windows for spawning within or between reefs (transient). Management for these two types of aggregating behaviour may need to be different. For example, protection of actual spawning sites for transient aggregating species could be achieved through spatial closures, whereas resident aggregating species, which may have multiple aggregation sites, could be better managed by seasonal closures and/or other non-aggregation focussed measures such as total allowable catches and species bans.

18. Knowing that fish aggregate to spawn (making them vulnerable to overexploitation if aggregations are targeted) and there are many information gaps, there is a need to take the precautionary approach for management. The management arrangements implemented must achieve most gain for least pain to users to protect aggregating fish. As a high priority, the socio-economic impact of any closure options must be assessed.

19. It is noted that the current seasonal spawning closures have a significant effect on the charter and recreational fishing industry. Issues include loss of business opportunities and customer confusion over shifting dates from year to year. An additional consideration is the effect of weather on fishing. Recently there has been bad weather either side of the new moon closures, resulting in a longer period without fishing for commercial, charter and recreational fishers.

20. December is the least preferred month by the commercial fishing sector for spawning closures in the Coral Reef Fin Fish Fishery, because it effects the supply of fish for the Christmas seafood season.

21. There is a socio-economic cost relating to the timing and duration of spawning closures. Particularly, there is concern by commercial and recreational fishers about the inclusion of December in the closure times. This has the greatest impact on commercial and charter fishing businesses compared to September, October and November. The cumulative length of the closures has a considerable impact on businesses such as charter fishing.

22. It is important to identify both the species and the areas most at risk to overexploitation. A systematic approach is suggested using criteria to feed into a risk assessment for aggregating species. Possible criteria include: targeted/potentially tradeable species, transient/resident, number of aggregations relative to abundance of species, stock status, life history, state of knowledge including about aggregation sites and existing management arrangements.

23. FSAs and spawning migrations of fish that inhabit inshore areas could be at more risk to overfishing than species that inhabit mid-shelf and outer reef areas. This is because the inshore areas are more accessible to fishing, and there is an increasing coastal human population. Other factors transferring pressure from offshore to inshore stocks include high fuel prices causing some boats to fish closer to shore. The FSAs of inshore species may thus require more investigation and management priority.

24. Climate change may place additional pressures on fishes, including aggregating species, but details are uncertain. However, climate change may also provide advantages and opportunities for spawning (e.g. longer breeding seasons for some species).

25. Fishing practices are dynamic and pressures on reef fish are likely to change in the future. For example, future changes in domestic and international market forces could result in increased demand for secondary species. Similarly, spatial patterns of fishing effort may change, such as greater pressures in the northern Great Barrier Reef. This requires a management system in place that can rapidly respond through appropriate triggers to new developments or findings.

26. Some anecdotal information suggests that the current spawning closures cause a transfer of recreational fishing effort into other fisheries, such as pelagic and inshore. However, some recreational fishers don’t go fishing at all during the closures. Similarly,

some workshop participants suggested that the current spawning closures might be causing a pulse fishing effect before and after closures, i.e. effort displacement. However, provided that the closures reduce the fishing impact on fish that would not otherwise be available to the fishery, this may not be a concern.

27. Some workshop participants suggested that the spawning closures should remain as a management tool to help protect the reproductive success of exploited reef fish populations in the Great Barrier Reef. However, other participants suggested that this management tool is no longer necessary. Overall the participants suggested that this management arrangement needs to be adaptively managed to ensure adequate benefit to individual species, and to minimise socio-economic impacts. Provision of research information, benefits and reasons for closures to the public needs to be improved.

Research

The following discussion points were raised to assist in developing a strategic approach to research of FSAs in the Marine Park.

1. There are many information gaps on the patterns in spawning locations, spawning behaviour (before, during and after spawning) and timing.

2. Typically, there seems to be short spawning seasons for larger reef fish on the Great Barrier Reef.

3. The locations of FSAs (globally) are predominantly on outer reef drop offs, reef channel mouths and reef promontories; there are many examples of this geomorphology in the Marine Park. However, only some of these areas are closed to fishing under Marine Park zoning, and many inshore spawning species and non-promontory, drop-off and reef channel spawning species may not be protected at all.

4. Species that form large FSAs and have a short spawning season and few aggregation sites are at the highest risk from overfishing. This is because a large proportion of the mature fish population that may otherwise not be available to a fishery can be taken in a relatively short time period. In this situation there is a real risk of local depletion.

5. Need to delineate between spawning aggregations, feeding aggregations and spawning migrations for management purposes. A spawning aggregation may be more vulnerable to fishing impact than a feeding aggregation, because it may be drawing a higher proportion of mature breeding individuals from a population that would not otherwise be available to fishing. Fish moving to an aggregation site may be highly vulnerable to overfishing.

6. In identifying potential spawning aggregation sites, it's not appropriate to just look at a reef photo and locate potential spawning sites. There are a variety of influences that determine the location of an aggregation site. However, this method might be used as a first estimate, but it must be substantiated by other information such as fisher interviews, catch records, and in-water validation.

7. Need to look at models of water movement and larval movement to help determine the best management response. On the scale of the Great Barrier Reef, knowledge of which reefs are source and sink reefs is needed so that aggregations on source reefs are adequately protected.

8. Drifters can be used to study the potential larval distribution from a site to help define sites as sink or source reefs. Fish may choose aggregation sites to promote retention of eggs and larvae or provide an initial boost for the eggs and larvae away from the site, for example reef channels flushing the eggs and larvae out, away from the reef.

9. Spawning sites can be mapped in detail using towed GPS to describe the spatial and temporal patterns of aggregations. Such intensive study of a site can lead to better understanding of aggregating behaviour.

10. Acoustic and conventional tagging of spawning fish can indicate the draw area of an aggregation site to assess the spatial scale of aggregating behaviour.

11. Information on possible locations and timing of aggregations needs to be gathered. This information should be validated through in-water surveys to close the information gaps and better define any potential north-south latitudinal and inshore-offshore differences.

12. There seems to be little information globally on the impact of non-extractive human use on spawning aggregations. A useful study would be to assess the impact of divers, boats and noise on aggregations to determine if reproductive output is affected.

13. Old Reef, a mid-shelf reef offshore from Bowen, is a known spawning aggregation area for several reef fish species that has been fished for several years. This reef is currently open to limited fishing as a Conservation Park Zone (Yellow Zone). A research project needs to be established for this reef, because it may be a unique area for large aggregations of humphead Maori wrasse, flowery cod, camouflage cod and possibly other species of groupers, and could be a representative example of a source reef or primary aggregation reef. There are likely to be other reefs in the Marine Park with similar attributes.

14. There is no reliable stock assessment of key target species in the Queensland Coral Reef Fin Fish Fishery except for red throat emperor. This is recommended as a priority for research. However, a Management Strategy Evaluation is being done for coral trout and an Ecological Risk Assessment has been done for the ‘other species’ quota category.

15. There is a need to investigate ways to reduce socio-economic impacts of spawning closures. For example, better public education about timing of closures may reduce the impact on the charter fishing industry, because fishers will attempt to organise trips around the closures.

16. It is important not to make generalised assumptions in relation to FSAs or fish biology. The aggregating behaviour and timing of spawning differs between species, and it is a common mistake to extrapolate across similar species.

17. Anecdotal reports of decline in FSAs from historic levels and/or disappearance of some aggregations should be investigated. It is important to consider a historic perspective in understanding current patterns. Oral histories are a possible source of information, and should be documented as a priority.

18. There is little information currently available to demonstrate the value of the spawning closures to the reef fish populations and to the community. There is a need to fill the information gap on benefits from these closures. It is recognised that the only research

currently being done is on monitoring two spawning aggregations of coral trout on reefs offshore from Cairns. Expansion of this monitoring to other reefs (both open and closed to fishing) should be a priority.

19. The protection of spawning aggregations as an element of building resilience to climate change in coral reef management needs to be better understood. More information is needed to demonstrate the importance of healthy fish populations with relatively unimpacted spawning aggregations in ensuring resilience to environmental changes such as climate change.

Species case studies

The information below is a summary of case study discussions on spawning behaviours of key target species in the Marine Park, presented by workshop participants.

Red throat emperor *(Lethrinus miniatus)*

- Spawns in July to October.
- Aggregating behaviour unknown.
- Spawns outside the current 9-day closure periods.
- Spawning does not seem to coincide with a particular lunar phase.
- There does not seem to be any timing variation from north to south in the Great Barrier Reef. However, in the northern Great Barrier Reef all mature female fish spawn and in the southern Great Barrier Reef only some mature females spawn.

Stripey (*Lutjanus carponotatus*)

- Spawns in October to December.
- Aggregates in relatively large aggregations (100s of fish).

Coral trout *(Plectropomus spp.)*

- Common coral trout (*P. leopardus*) spawns in September to November/December, with September and October being the main spawning time for at least the northern Great Barrier Reef. Similar timing in Torres Strait.
- Bar cheeked trout (*P. maculatus*) spawns in September to October in Torres Strait.
- Passionfruit trout (*P. areolatus*) spawns in at least July to August in Torres Strait. However, there is a spawning aggregation off Innisfail in November to December.
- All coral trout species use different spawning sites. For example, on Scott Reef and Moore Reef offshore from Cairns, common coral trout use a different location to passionfruit trout.
- Numerous other species (more than 28 reef fishes) have been observed using the common coral trout spawning site at Scott Reef, some of which are fishery species.
- In Melanesia, *P. areolatus* aggregate on the full and new moons throughout about 50 per cent of the year.
- Passionfruit trout are known to use ‘resting sites’ between spawning. These fish may be vulnerable to fishing because they may still be aggregating, but feeding to prepare for the next spawning event.
- Blue spot trout (*P. laevis*) spawns in January north of Lizard Island.
- Common coral trout spawning at primary aggregation sites is predictable, with spawning occurring at sunset over a five-day period over the new moon. However, spawning also occurs outside aggregations during the first quarter lunar phase.

Barramundi cod (*Cromileptes altivelis*)

- Limited information available, some spawning in October to November.

Flowery cod (*Epinephelus fuscoguttatus*) and camouflage cod (*E. polyphekadion*)

- Spawn in November to January. However, maybe October as well.
- Aggregate for one or two weeks per month, potentially throughout the lunar phases on the Great Barrier Reef. However, the aggregating behaviour elsewhere in their range is strongly lunar related.
- These species are secondary target and by-catch species. The current market demands small fish, so these fish are not being targeted. These species also fetch lower prices than coral trout, and there is an aquaculture supply of flowery cod.
- Relatively rare on the Great Barrier Reef mid-shelf reefs (about two fish per hectare of reef).
- There are records of high catches in the mid to late 1990s from targeted fishing.
- Old Reef offshore from Bowen has historically provided high catches, predominately during the full moon.
- The current size limits are to be changed and will likely help protect the reproductive component of the flowery cod population.

Wrasses (Labridae)

- Spawn in various months.
- Spawning occurs in pairs and in large aggregations.
- There are only about three to five mature humphead Maori wrasse per hectare of reef.
- Humphead Maori wrasse is known to spawn on reef fronts, but possibly at other sites.

Conclusions

The workshop participants were asked to answer the following questions to determine research and management priorities:

Knowing that fish species which form spawning aggregations are, or potentially are vulnerable to overexploitation:

Research

1. Which aggregating species potentially at risk are fished in the Great Barrier Reef?
2. What information gaps exist in our knowledge base of their spawning behaviour?
3. Which of these species are priorities for research and why?
4. What research needs to be done and how?

Management

5. Having identified the number of targeted and potentially targeted fish species that aggregate to spawn, what management measures should be employed to provide protection to the spawning aggregations?

Research priorities

In response to questions 1 and 2, the workshop participants concluded that the species listed in Table 1 are of special interest with respect to research needs and the need for appropriate management of spawning aggregations in the Marine Park.

Table 1 Species of special interest

Species	Reason
Camouflage grouper (*Epinephelus polyphekadion*)	Need to closely monitor the catch of this species, because it is vulnerable to overfishing and has the potential to become a target species in the live reef fish trade.
Flowery cod (*Epinephelus fuscoguttatus*)	Need to closely monitor the catch of this species, because it is vulnerable to overfishing and has the potential to become a target species in the live reef fish trade.
Grey mackerel (*Scomberomorus semifasciatus*)	Local community concern about netting of spawning aggregations in northern Great Barrier Reef, and anecdotal reports suggest declines. There is a lack of information to determine if there is a sustainability issue for the whole stock or localised depletions. Therefore, need to know the stock boundaries.
Pelagic species	For species such as Spanish mackerel, there is a need to examine the entire distribution in light of possible localised depletion issues. There is a concern about the disappearance of historic aggregation sites. Therefore, need to know stock boundaries and identify and characterise spawning aggregation sites.
Black jewfish (*Protonebia diacanthus*)	Lack of knowledge of aggregations on the Great Barrier Reef, except some information for northern Cape York Peninsula about targeting of aggregations.
Blue tuskfish (*Choerodon cyanodus*)	This species is being more targeted by recreational and commercial fishers, and there is a risk of overfishing.
Small spotted grunter (*Pomadasys argenteus*) Sooty grunter (*Hephaestus fuliginosus*) Spotted grunter (*Pomadasys kakaan*)	Aggregates in large numbers, and therefore populations can be reduced dramatically in a relatively short time. Need to know timing and location of aggregations.
Red emperor (*Lutjanus sebae*)	An important target species, but little is known about spawning behaviour, timing and locations.
Large mouth Nannygai (*Lutjanus malabaricus*)	Aggregations are being targeted, although little information is currently available if these are feeding or spawning aggregations. There is a high post-release mortality due to barotrauma, because this species is caught in relatively deep water.

Species	Reason
Coral trout (*Plectropomus spp.*)	Several species involved. The common coral trout is most important species in Coral Reef Fin Fish Fishery and thus needs management consideration. Keep doing research already underway. Additional information needs include spatial timing of spawning from north to south of the Great Barrier Reef, impact of fishing of spawning aggregations, and changes in catchability during spawning times. Need to consider each species separately.

In response to questions 3 and 4, the following research priorities were identified for the next five years (2007-2012):

1. The Queensland Government's long-term monitoring programme for the Coral Reef Fin Fish Fishery should include collection of reproductive samples for key target species.
2. Continue and expand the long-term dataset from Scott Reef and Elford Reef coral trout spawning site monitoring project offshore from Cairns, with replication in the north and south of the Marine Park. This should include identification of further aggregation sites, in both open and closed reefs, to monitor and compare with these sites.
3. Out of the nine key species of interest, three species are priorities for research
    a. Large mouth nannygai
        i. Identify aggregation sites, initially through local knowledge interviews and then by in water validation.
        ii. Use information from ANSA tagging programme to assist in fish movement assessment.
    b. Black jewfish
        i. Identify aggregation sites, initially through local knowledge interviews and then by in water validation.
        ii. Develop an acoustic tracking study to track the movements to determine the aggregation sites.
    c. Grunter
        i. Identify aggregation sites, initially through local knowledge interviews and then by in water validation.
        ii. Locate aggregation sites and identify the timing.
4. Implement a Marine Park wide interview survey to compile historic and current information on spawning aggregations for all key species.
5. Survey Old Reef to determine actual aggregation sites and timing for key species. This could be done as an intensive pilot study over a one-year period.
6. Investigate the impacts of fishing disturbances on aggregations, specifically for Spanish mackerel, grey mackerel, flowery cod, camouflage cod and coral trout species.

Management priorities

The current management arrangements under the *Queensland Coral Reef Fin Fish Fishery Management Plan 2003* and the *Great Barrier Reef Marine Park Zoning Plan 2003* were generally considered to provide suitable protection of FSAs for most coral reef fin fish in the Marine Park. However, there were concerns about the adequacy of protection of FSAs for some inshore and pelagic species.

In response to question 5 regarding protection of spawning aggregations, the following management considerations were suggested:

1. The spawning closure management arrangement should be adaptively managed to ensure adequate benefit to individual species, and to minimise socio-economic impacts.
2. The current 33 per cent protection of the Marine Park in Green Zones does provide some protection to FSAs. However, more information is needed on species-specific spawning behaviours to better determine how well this management measure is protecting FSAs in the Marine Park.
3. A risk assessment should be done to determine if the current spawning closures on the Great Barrier Reef are needed considering that about 30 per cent of reef fish habitat is closed to fishing in the Marine Park. The risk assessment should consider that this might be true for coral trout, which have many aggregation sites throughout the Great Barrier Reef. However, those species with very specific and very few aggregation sites may not be adequately protected.
4. To reduce socio-economic impacts of the spawning closures, whilst ensuring adequate protection of FSAs, a modification could be considered to either change the closure times to four days over the new moon (2 days before and one day after the new moon) in September, October and November for the whole Great Barrier Reef. An alternative would be to keep the nine-day closures, but only for September and October, or October and November, the key spawning months for many reef fish. Importantly there is a need to have an appropriate precautionary time window prior to spawning to protect fish moving to aggregations, but have a short period after spawning because many reef fish quickly disperse from aggregations. Note that September has been identified as a key spawning month for several species including coral trout. To better match coral trout spawning season as well as reducing socio-economic impacts, it is suggested to include September rather than December in the closure times.
5. Species-specific spawning closures, rather than the broad species protection currently in place, could be considered after more information is obtained through research suggested above. However, it was recognised that ease of enforcement is essential.
6. Management should consider accounting for latitudinal and temporal variability in aggregation timing. To attempt to account for the latitudinal variation in spawning times for coral trouts, having a closure in the northern Great Barrier Reef for September and October and a closure in southern Great Barrier Reef for October and November, could achieve this. However, it is recognised that the high compliance concerns would have to be mitigated with this management approach.

Appendix 1: Workshop participants list

Name	Email	Organisation
Dave Williams	d.williams@iinet.net.au	Australian Institute of Marine Science
Peter Todd	aquacatcharters@iprimus.com.au	Charter Fisher
Greg Smith	lfsmith0@tpg.com.au	Commercial Fisher, QSIA
Lyle Squire (Snr)	lyle.squire@iig.com.au	Commercial Fisher
Terry Must	arabonseafoods@hotmail.com	Commercial Fisher, QSIA
Steve Howe	howeslc@bigpond.net.au	Commercial Fisher, QSIA
Pat Colin	crrf@palaunet.com	Coral Reef Research Foundation, Palau
John Kung	John.Kung@dpi.qld.gov.au	Department Primary Industries & Fisheries
Anthony Roelofs	roelofa@dpi.qld.gov.au	Department Primary Industries & Fisheries
Wayne Sumpton	wayne.sumpton@dpi.qld.gov.au	Department Primary Industries & Fisheries
Pat Appleton	applepj@bigpond.net.au	Facilitator
Mick Bishop	Mick.Bishop@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Dave Wachenfeld	David.Wachenfeld@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Rachel Pears	Rachel.Pears@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Fergus Molloy	Fergus.Molloy@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Martin Russell	Martin.Russell@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Bruce Wallner	Bruce.Wallner@gbrmpa.gov.au	Great Barrier Reef Marine Park Authority
Melita Samoilys (By Phone)	melita.samoilys@gmail.com	CORDIO, East Africa
Ashley Williams	ashley.williams@jcu.edu.au	James Cook University
Barry Goldman	barry.goldman@jcu.edu.au	James Cook University
Richard Evans	richard.evans@jcu.edu.au	James Cook University
Colin Simpfendorfer	colin.simpfendorfer@jcu.edu.au	James Cook University
Howard Choat	john.choat@jcu.edu.au	James Cook University
Matthew Fraser	matthew.fraser@jcu.edu.au	James Cook University
Bill Sawynok	infofish@zbcom.net	Recreational Fisher, CapReef
Dave Bateman	batemanw@bigpond.net.au	Recreational Fisher - Sunfish
Yvonne Sadovy	yjsadovy@hkucc.hku.hk	Society for the Conservation of Reef Fish Aggregations / University of Hong Kong
Rick Hamilton	rhamilton@TNC.ORG	The Nature Conservancy

Workshop Participants