

Reducing the Impacts of Fishing and Tourism on Fish Spawning Aggregations in the Great Barrier Reef Marine Park

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ABSTRACT

The Great Barrier Reef Marine Park Authority (GBRMPA) is taking steps to ensure that fish spawning aggregation sites (FSAS) in the Great Barrier Reef Marine Park (GBRMP) are not being overexploited by fishing and disturbed by tourism. There is concern that commercial and recreational fishers are targeting FSAS in the GBRMP; and the presence of divers and fish feeding may affect the normal spawning behaviour of fishes at these sites. The GBRMPA is attempting to mitigate the impacts of these activities to ensure the maintenance of FSAS and the aggregating fish that depend on them. In this paper I discuss the introduction of seasonal closures and prohibition of fishing for species caught in the Queensland tropical coral reef finfish fishery; the rezoning of the GBRMP, which will help protect FSAS via a network of no-take areas; and the locations of mooring, pontoon, and anchoring sites in relation to FSAS.

KEY WORDS: Aggregation, reef-fish, spawn

INTRODUCTION

The Great Barrier Reef Marine Park (GBRMP) is the world's largest coral reef ecosystem and marine protected area, extending over 2,000 km along Australia's east coast, with some 3,000 reefs and 900 islands. In recognition of its importance to both the Australian and the international community, the GBRMP is managed by the Government of Australia and is a World Heritage Area. The Great Barrier Reef Marine Park Authority (GBRMPA) is responsible for managing this important area and works closely with government fisheries management agencies to ensure fisheries in the GBRMP are ecologically sustainable.

The GBRMPA is taking steps to protect fish spawning aggregations in the GBRMP from impacts of fishing and water-based activities associated with tourism. There are two areas of concern. Firstly, there is concern that reef finfish stocks may be overfished, partly as a result of targeted and incidental fishing on spawning aggregations throughout the GBRMP. Secondly, there is concern that water-based activities associated with tourism structures such as moorings, pontoons and reef anchorages in or close to fish spawning aggregation sites (FSAS) could disrupt the normal spawning behaviour of aggregating fishes.

DISCUSSION

Fish Spawning Aggregation Sites in the GBRMP

To date, 133 species of fish in 21 families have been reported to form spawning aggregations, either in the GBRMP or elsewhere in their geographical range. Forty-nine species from 12 families have been observed to form spawning aggregations in the GBRMP, and 84 other species that also inhabit the Great Barrier Reef (GBR) have been reported to form spawning aggregations in other locations (Russell 2001).

Information held by the GBRMPA on the locations of FSAS in the GBRMP suggests that two different types of FSAS are used by fish species such as common coral trout *Plectropomus leopardus*. These are given the term primary FSAS and secondary FSAS (Samoilys 1997, Zeller 1997). Primary FSAS are key sites visited consistently each year by fish such as *Plectropomus spp.*, maori wrasse *Cheilinus undulatus*, barramundi cod *Cromileptes altivelis* and potato cod *Epinephelus tukula* for spawning. These sites may be characterised by geomorphological and topographical features, depth profile and flow dynamics that offer highly specific characteristics that facilitate territory establishment, courting and spawning rushes. Secondary FSAS, visited sporadically each spawning season by *P. leopardus* and other species for spawning purposes, share some of the characteristics of primary FSAS. It is thought that each reef in the GBRMP has one or more primary FSAS and several secondary FSAS. The main spawning season for species that use primary FSAS is October through December. Fish species such as *Plectropomus spp.* move to FSAS each spawning season on the reef they inhabit, but do not move between reefs (Davies 2000).

The Need for Protection from Fishing

In the GBRMP, the tropical coral reef finfish fishery is made up of commercial and recreational fishers, including fishing tours (charter), using hook and line and spear (recreational only) to target demersal reef fishes. The major fishes targeted include species in the families Lethrinidae, Lutjanidae and Serranidae (Brown et al. 1994, QFMA 1996). There are about 300 commercial fishing operations actively targeting coral reef finfish. A further 1300 commercial fishers are licensed to take coral reef finfish, but presently operate primarily in other fisheries. The commercial catch is about 3000 tonnes per year; most of this catch is now exported live into Asia. *P. leopardus* dominates the catches, comprising about 45% of the catch (Mapstone et al. 1996). Some 120 fishing charter vessels take about 265 tonnes. Some 800,000 Queensland-based recreational fishers (QFMA 1999a) catch about 1500 tonnes of reef finfish per year.

There is concern about the sustainability of fishing spawning aggregations of *Plectropomus spp.*, *Epinephelus spp.*, *C. undulates* and *C. altivelis* in the GBRMP. Reports of targeted fishing on FSAS have been made to the GBRMPA and the managers of the coral reef finfish fishery, the Queensland Fisheries Service (QFS). Increased fishing pressure occurs from September to November (Mapstone et al. 1996, Turnbull and Samoilys 1997), which corresponds with the spawning season for *P.*

leopardus as well as other important fishery species. Davies (2000) suggests that an increase in catchability of *P. leopardus* on mid-shelf reefs in the Cairns Section of the GBRMP during September is attributable to fish aggregating to spawn. Catchability of *P. leopardus* is likely to increase as a result of the aggregated distribution of fish in locations that can be efficiently exploited by fishers and the heightened feeding activity of the fish associated with spawning (Johannes and Squire 1988, Samoilyls and Squire 1994, Davies 2000, Russell 2001).

Within the past 10 years, spawning aggregations of *P. leopardus* (Samoilyls, M., pers. comm. 1999), blue spot trout *Plectropomus laevis*, and *C. undulatus* (Squire, L., pers. comm. 1999.), have diminished in size and number at various locations in the northern part of the GBRMP. Aggregations of *C. undulatus* and *P. laevis* documented by Johannes and Squire (1988) no longer form at Ribbon and Jewell Reefs (Squire, L., pers. comm. 2000). Recently, it has been found that one of two main spawning aggregations of *P. leopardus* on reefs near Cairns has diminished over the past few years, most likely due to overfishing (Samoilyls, M., pers. comm. 1999).

GBRMPA's Strategy to Protect FSAS from Fishing

Currently, the GBRMPA reef zoning plans indirectly provide for protection of some FSAS from fishing, through the protective zoning of reefs throughout the GBRMP, although protection of FSAS was not part of the original intent of the zoning plans. About 20% of the reefal area is closed to reef fish fishing. In the near future, the GBRMP will undergo a rezoning as part of the GBRMPA Representative Areas Program (Day et al. in press), and the locations of primary FSAS will be considered in the identification of areas in need of protection. This strategy involves high-level protection of whole reefs and groups of reefs that represent specific bioregions in the GBRMP.

Site-specific spawning closures to exclude fishers from known FSAS seasonally or permanently have been considered by the GBRMPA. However, it is considered that such closures would be ineffective in practice. This strategy may be beneficial if there were a few key FSAS in the GBRMP. Potentially every reef in the GBRMP has one or more primary FSAS, and it is not known which FSAS are more important for supplying new recruits to surrounding areas. Considering the size of the GBRMP, small site closures would be extremely difficult to enforce without some form of satellite tracking device on all fishing vessels and/or a labour-intensive enforcement program. Closures may also highlight the location of FSAS and increase the risk of targeted poaching.

The GBRMPA and the QFS are considering broader reef-wide strategies that protect fish spawning aggregations from overexploitation in the GBRMP.

In July 1999, the Queensland government released a draft Management Plan for Queensland Tropical Coral Reef Fish Species (QFMA 1999b). The draft plan included provisions for the protection of fish spawning aggregations by prohibiting the possession of reef finfish for nine-day periods in October and November in the northern regions of the GBR, and November and December in the southern regions of the GBR. This north/south, staggered closure strategy was proposed because it was thought that

Plectropomus spp. spawn later in the southern regions of the GBR. The proposed nine-day closure in each month would commence four days before the new moon; *P. leopardus* spawns during the new moon. It was anticipated that other fishes that aggregate to spawn at the same time would also benefit from the closures. In response to this proposal, the GBRMPA proposes that the nine-day closures extend reef wide during October–December. It is unclear if there is a north/south variation in spawning times on the GBR for *Plectropomus* spp., and there are inherent enforcement difficulties considering the closures prohibit the possession of reef finfish in different areas at different times.

Seasonal fishing closures are considered an effective way of ensuring aggregating fishes are protected from fishing during the main spawning season in the GBRMP. The proposed nine-day, new-moon closures during October–December would help ensure reproductive success of fishes that aggregate to spawn at this time. It could be argued that a closure over the entire three-month main spawning period for *Plectropomus* spp. is a more effective option. However, the nine-day new moon closures are only one part of a broader strategy for this fishery. Other management measures include conservative size limits, recreational bag limits and reduction in commercial licences.

Seasonal closures for particular species have been considered, but this option is not being progressed. This will not reduce the disturbance of spawning fish if the protected species is caught and returned to the water. This strategy also has inherent enforcement difficulties, considering that some fish are filleted on board the boats.

Several species of fish in the GBRMPA have iconic status. These are large fish with “character” and value for visitors to the reef, and are an integral part of the Great Barrier Reef World Heritage Area. A more stringent management strategy is being proposed for iconic species that may be vulnerable to fishing pressure because of their low natural abundance, large size, inquisitive nature, reproductive biology, or particular spawning site requirements. The GBRMPA is advocating the total protection of *C. undulatus*, *C. altivelis* and *E. tukula*. It has also been suggested that several other smaller *Epinephelus* spp. and *Cephalopholis* spp. should be afforded similar complete protection because of their reproductive biology and potential vulnerability. Information suggests that the high-value, commercial species such as *C. undulatus* have very specific spawning sites and utilise fewer spawning sites than *Plectropomus* spp.. Consequently, their populations would be affected to a greater degree if fishers targeted or incidentally fished their spawning sites. It has been proposed by some commercial fishers that a catch limit of one fish per boat for *C. undulatus* and *C. altivelis* would, if enforced effectively, prevent these fish being taken in large numbers from spawning sites. However, the GBRMPA considers if these species are to be protected, a more precautionary and enforceable approach to their conservation would be to prohibit this take. This management strategy has already been introduced for *C. undulatus* in Western Australia because of concerns about unsustainable fishing.

The management plan for the Queensland coral reef finfish fishery is expected to be in place in the second half of 2002. It is likely that the new moon closures will be introduced and the vulnerable species will be protected. If the management plan does not address the above concerns adequately, the GBRMPA will consider using its

legislative mandate.

The Need for Protection from Tourism Water-based Activities

Commercial tourism is a major industry in the GBRMP. Tourists visited the GBRMP for some 1.3 million visitor days in 1998–1999 (GBRMPA Environmental Management Charge data), with an estimate of over 500,000 tourists diving or snorkeling in the GBRMP each year (Aiello 1996). More than 90% of these tourists visited the Cairns-Port Douglas and Whitsunday regions, which cover 4% of the GBRMP.

It is possible that large numbers of snorkelers and divers could inhibit the formation of fish spawning aggregations or disturb normal spawning behaviour, subsequently affecting the reproductive success of aggregating fishes (Sadovy, Y., pers. comm. 2000). The presence of individual research divers at FSAS has been reported to disrupt the spawning behaviour of several fish species, including *Acanthurus* spp. (Randall 1961a, b), red hind *Epinephelus guttatus* (Shapiro et al. 1993b), *Plectropomus* spp. (Samoilys, M., pers. comm. 1999, Carlos and Samoilys 1993, Squire, L. and Hartney, T., pers. comm. 2001) and *Scarus* spp. (Randall and Randall 1963), possibly a predator evasion response. Aggregating fish commonly seek shelter if they are approached or disturbed by a diver, and the colour patterns exhibited by courting males, e.g. *P. laevis* (Carlos and Samoilys 1993) and *Acanthurus* spp. (Randall 1961a, 1961b), have been observed to change back to non-reproductive colour when disturbed by a diver. During October 2001, spawning aggregations of *P. leopardus*, globehead parrotfish *Scarus globiceps*, and red bass *Lutjanus bohar* were observed to move away from divers and modify their aggregating behaviour when approached by several divers participating in a GBRMPA FSAS identification and assessment training course.

Damage to coral, primarily by boat anchors, but also by some divers and snorkellers has been reported in the GBRMP (Tourism Review Steering Committee 1997, Hawkins and Roberts 1992, Roupheal and Inglis 1995). Reef sites used heavily by divers may have more damaged coral colonies than reefs with low diver activity (Hawkins and Roberts 1992). However, coral damage by divers may not be a significant impact on FSAS. It is possible that major alteration of coral substrate may change the topographical characteristics of an area and possibly cause fish to choose another less favourable area to spawn, or not spawn at all, although this has not been verified.

Another potential threat to FSAS is fish feeding. Daily fish feeding, a popular activity at tourist sites, can attract groups of predatory fishes, which may normally feed at other locations. The presence of these predators could prevent the formation of spawning aggregations of smaller fishes at these sites. For example, it has been suggested that regular feeding of *E. tukula* and *L. bohar* at the Cod Hole, northern GBRMP, has resulted in the cessation of large spawning aggregations of *Acanthurus* spp. and other fishes from frequenting the site because of the presence of predators (Squire, L., pers. comm. 2000).

GBRMPA's Strategy to Protect FSAS from Tourism Water-based Activities

During the 1990s, more than 500 moorings and 20 pontoons were installed throughout the GBRMP. These structures have been situated to take advantage of water currents, clear water and protection from prevailing winds. Several moorings and pontoons are believed to be positioned in or adjacent to primary FSAS. In 1997, the GBRMPA developed a working policy to only permit new moorings and pontoons to be installed at least 100 metres away from primary FSAS. Subsequently, the *Cairns Area Plan of Management* (GBRMPA 1999) required consideration of the locations of FSAS when locating moorings, pontoons and Reef Anchorages, and site planning of reefal areas for tourism activities included an FSAS assessment by qualified Authority FSAS assessors.

The GBRMPA is collating information and maintaining a database on the locations and physical and temporal characteristics of FSAS in the GBRMP. This information is for a limited number of fish species of commercial, recreational and conservation importance, for example, *Plectropomus spp.* and *C. undulatus*, and to date is for a limited number of reefs in the GBRMP. The information has been obtained from scientists, commercial fishers, tourism operators and from site assessments conducted by FSAS identification and assessment officers.

Currently, the GBRMPA has six officers trained in the identification and assessment of FSAS. These officers were trained during two courses in October 2000 and October 2001, during which attempts were made to determine the physical characteristics of a primary FSAS in the GBRMP, using several known primary FSAS as an indicator of these characteristics. There seem to be variations between FSAS longitudinally and latitudinally in the GBRMP, and variations between the spawning site preferences for different species, thereby complicating the development of a standard assessment process. Subsequently, until more information is obtained on what reef characteristics are necessary for particular reef fish to spawn, assessments required for identifying the most appropriate locations for moorings etc., will be done only during the peak spawning time, and involve identifying spawning fish behaviour.

CONCLUSION

The protection of spawning fish in the GBRMP is a key focus for the GBRMPA. Precautionary management arrangements to protect FSAS and the fish when they aggregate at these sites to spawn are being developed using the best available information, although this information is limited.

The GBRMPA is concerned that FSAS may be unsustainably fished in the GBRMP. There are some examples in the GBRMP and many examples outside Australia of overexploitation of reef fish as a result of fishing FSAS. Protecting FSAS in the GBRMP through the use of marine protected areas is one management tool that will help ensure reproductive success of reef fish. However, considering the size of the GBRMP, the numbers of reefs, the numbers of FSAS, and the unknown variations in spawning times for different species, seasonal closures during the peak spawning months are also being considered. Nine-day closures to reef fish fishing are proposed

over the new moon in October, November and December. For iconic and vulnerable species, such as *C. undulatus*, *E. tukula* and *C. altivelis*, complete protection is necessary. The GBRMPA is working closely with fisheries managers to progress these strategies. However, closures and protection measures under the *Great Barrier Reef Marine Park Act 1975* will be considered if Queensland fisheries management planning for coral reef finfish is delayed or management strategies are not adequate.

With respect to managing the impacts of water-based, tourism activities on primary FSAS, the GBRMPA is taking a precautionary approach when determining the most appropriate locations for moorings, pontoons and anchorage areas. The GBRMPA's FSAS identification and assessment officers are gathering more information on the characteristics of FSAS, and potential impacts, to further develop these management arrangements.

It is clear that FSAS and the fish when they aggregate to spawn at these sites need protection from human impacts. The GBRMPA has a legislative obligation and is working proactively to reduce the potential impacts on spawning fish and help ensure reproductive success of reef fishes in the GBRMP in the long term.

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