SPAWNING AGGREGATIONS OF CORAL TROUT AND MAORI WRASSE ON THE GREAT BARRIER REEF MARINE PARK.

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Explanatory Note .

Over a period of several days in late October, 1987, I interviewed a number of ex-commercial fishermen who had each fished the waters of the Great Barrier Reef for many years and who had reputations for being unusually keen observers of marine natural history. I was interested in what I could learn from them concerning the timing and location of spawning aggregations of reef fishes, especially coral trout. Over the previous decade I had interviewed reef fishermen in numerous tropical Pacific Islands and found among them many who were valuable sources of information on this subject.

The information volunteered by all but one of the GBR fishermen I interviewed was limited, uncertain and contradictory. These fishermen were, in addition, much less able to differentiate between different species than are typical Pacific Island fishermen. For example, coral trout, with the exception of ocean trout, *Plectropomus laevis*, were lumped, as were red emperors and red snappers. Not only were these fishermen poor taxonomists, they were also unsure of most aspects of the behaviour of the fish they sought; their information was often based (as they generally admitted) on surmise rather than direct observation.

This comparative lack of knowledge is probably the result of more than one factor. But the fact that most older GBR fishermen have never dived, and have thus never observed fish directly underwater seems very likely to be an important part of the explanation.

The last ex-fishermen I interviewed proved to be a fortunate exception. Twenty years younger that the other men I interviewed, Lyle Squire had dived extensively on the GBR. He is the holder of numerous Queensland and national amateur spearfishing records. After fishing commercially for a number of years he became, and remains a research assistant at the Northern Fisheries Research Centre in Cairns.

Squire's observations on spawning aggregations of ocean trout and of several other reef fishes were detailed and persuasive. In view of the lack of research on this phenonmen in the GBR region, and of the potential value of such information for fisheries management (Johannes, 1982, and see below) these observations seemed to me to be well worth recording as a source of information for future researchers and fisheries managers.

Accordingly, I asked him to coauthor the report that follows. Unless otherwise identified, the observations on GBR spawning aggregations in this report are based on Squire's observations. One measure of his observational ability underwater is the fact that, as Randall and Hoese note in their 1986 Monograph on Indo-Pacific coral trout taxonomy, Squire asserted that footballer trout, *Plectropomus laevis* (the main subject of our report) and the ocean or blue-spot trout, "*Plectropomus sp.*", are simply two color forms of the same species - a judgement accepted by coral trout taxonomists only recently.

If the information in this report were made generally available, it could lead to heavy pressure being put on spawning aggregations of *P. laevis*. Therefore my coauthor and I request that the report should not be circulated, and that it should be available only to qualified researchers who may examine it only on GBRMPA premises and who may not reproduce it until and unless the time comes when *P. laevis* spawning aggregation sites become widely known.

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CORAL TROUT SPAWNING AGGREGATIONS

Off the Cairns and Northern Sections of the Great Barrier Reef, ocean trout, *Plectropomus laevis*, form aggregations during the months of September/October through December/January in passes through the outer reefs. These fish are aggregating to spawn. We base this conclusion on the behavior of fish in the aggregations (discussed below) and the fact these fish invariably have well-developed gonads (and are in peak condition with high fillet yields) except sometimes near the end of the aggregation period.

The fish gather at very specific locations near outer barrier reef channels. Aggregations are seen as least as far south as Slasher Reefs and as far north as Cat and Log Reef These are the northern and southern limits of the observations recorded here, and these fish may well also aggregate in similar habitats beyond these limits.

Typically aggregations are found off the northwest corners of the outer reefs. Such reefs include Opal, Ribbion, Day, Hicks, Carter, Jewell and the Ribbon Reefs. Where bombies are found off the corner of the reef, the aggregations will typically be found along the edge of the bombies. If there is more than one line of bombies lying off the edge of the main reef, the aggregations will invariably be found orienting to one of the bombies in the outer line.

Invariably the aggregations are found in areas of strong currents. As currents shift around a bombie with tide or wind, the aggregation will shift around the bombie to stay in the area of strongest current.

Ocean trout will also aggregate off reefs that do not have bombies, such as Moore Reef, but these aggregations are typically comparatively small. Here the aggregations will generally be found in the vicinity of the most prominent underwater promontory projecting from the reef near the northwest corner. (Underwater promontories are often the preferred spawning sites for a wide variety of coral reef fishes [e.g. Randall and Randall, 1963; Johannes, 1978]). Here aggregations form at precisely the same locations year after year.

Small spawning aggregations of *P. laevis* are also sometimes associated with plug reefs - the more or less oval, comparatively small reefs found a short distance inshore of the channels separating the barrier reefs. The locations of such aggregations are much less predictable from year to year than those previously described.

Fishermen may catch 20 - 50 fish from an aggregation of *P. laevis* in one day. This species is the largest of the genus (Randall and Hoese, 1986); females in aggregations average 5-7 kg, males average around 13 kg with a maximum weight of more than 20kg. These considerations, plus the fact that coral trout fetch the highest market prices of any reef fish have justified the long trips involved in catching them.

But these trips, averaging about one month in duration, involve fishing only for about two weeks. The rest of the time is spent in traveling and sitting out bad weather. Comparatively few fishermen know the timing and whereabouts of these aggregations well enough to make a profit from fishing them. There are seldom more than 50 - 60 fish in such aggregations. They are found over the reef slope at depths of between 6 and 20 m. The fish are found near, but not on the bottom. Members of the aggregation tend to move higher into the water column in the late afternoon.

Throughout the day the largest individuals typically hover one to several feet higher off the bottom than the rest. These large fish are further distinguished by several very prominent dark, saddle-like vertical bars. These fish are referred to by fishermen as "saddlebacks." They are, when speared, invariably found to be males. The behaviour and appearance of these particular males in the aggregations prompt suggest they are dominant males. They appear to "guard" small groups of females, nudging them periodically as if trying to keep them in a circumscribed area, and chasing other, non vertically barred males[3]. Dominant males sometimes present themselves sideways to an approaching spearfisherman, flex their bodies laterally and vibrate rapidly, seemingly in a threat display, before darting away. Such a fish will sometimes approach so close as to make it impossible for the diver to pull his speargun back far enough to spear it.

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[3]Johannes (submitted) similarly observed that only the dominant males in spawning aggregations of *P. areolatus* in the Solomon Islands displayed dark vertical bars and hovered above the rest in spawning aggregations.

Females tend to cluster below dominant males and are much harder to approach and spear than males. Under water and when freshly caught some females in aggregations exhibit a relatively faint yellow hue in their paler parts. These colors fade afer the fish are caught.

What appears to be typical serranid courtship has been observed, and involved single dominant males and single females, but spawning was never witnessed. Fish caught in such aggregations are not uncommonly found to be running ripe. If these fish tend to spawn around dawn or dusk, as many reef fishes do (e.g. Johannes, 1978) (including, apparently, *P. areolatus*[Johannes, submitted]) , this would explain why divers do not witness the event.

Fishermen who have exploited aggregations of *P. laevis* over the past decade have a policy of not fishing the same aggregations for more than one day running unless poor weather discourages them from moving on. These fishermen observe that when they return to an exploited aggregations after several days, the numbers of fish have typically increased noticeably. In other words new individuals appear to have joined the aggregation during the fishermen's absence.

At any given location, the timing of the formation of spawning aggregations of *P. laevis* (as well as some other coral trout, see below) varies from year to year by about a month. This is characteristic of many species of reef fishes (Johannes, 1981). Aggregations also seem to form and disperse progressively later as one moves north along the GBR. When aggregations form off Cairns in late September or October, they can be expected to form in the area from off Cooktown to Jewell Reef in November and December. In December and January aggregations will be abundant north of Jewell Reef.

This information dictates the following strategy for finding the aggregations. A fisherman will initially target a spawning site at the southern end of his intended intended fishing range. If he finds no aggregation upon reaching this site he will proceed to known aggregation sites further north. As the season progresses the fisherman will begin a fishing trip at locations further north than he does early in the season. The fish are caught mainly by trolling, using mackerel spoons, pink jigs or garfish.

Spawning aggregations of *P. laevis* are more numerous and tend to be larger as one progresses northward, with better fishing around the Ribbon Reefs than off Cairns and still better fishing north of the Ribbon

Reefs. It is not known if this is a natural trend or if it reflects decreasing fishing pressure as one moves progressively further from Cairns.

A number of other species of coral trout, including *P. leopardus*, and *P. areolatus*, also aggregate, often in multi-species groups, for several months around the end of the year. These aggregations are found at precisely the same locations from year to year in the middle reefs. Aggregation sites are almost never located on the weather side of reefs. The are usually found on the west or southwest sides, and always in locations where current eddies are strong. (Fishermen from Gladstone volunteered the same obseervations). Where aggregations are located on the weather side the area is ususally sheltered by a nearby reef.

Fish in these aggregations are more diffusely distributed than *P. laevis* in their aggregations. *P. laevis* are never seen in these aggregations. Since these aggregation occur in comparatively sheltered waters, fishermen who target *P. laevis* aggregations will switch to these middle reef aggregations of other, smaller coral trout during rough weather.

Spawning aggregations of many reef fishes exhibit lunar periodicity (Johannes, 1978) including *P. leopardus* in Palau (Johannes, 1981) and *P. areolatus* in the Solomon Islands (Johannes, submitted). Neither Squires nor the other GBR fishermen Johannes interviewed recalled any evidence suggesting that coral trout spawning aggregations on the GBR exhibit lunar periodcity.

Unlike some fish when in their spawning aggregations, *P. laevis, P. leopardus* and *P. areolatus?)* all take baited hooks while in their spawning aggregations.

MAORI WRASS SPAWNING AGGREGATIONS

Maori wrasse, *Cheilinus undulatus*, form aggregations starting a month or so later than those of *P. laevis*. In the Cairns section of the GBR Marine Park, they aggregate typically at the south end of the reefs making up the outer barrier reef.

Here they are often located along walls in 2 - 40m of water. Such aggregations are found in the Ribbon Reefs, but are larger and more numerous further north, i.e. north of Jewell Reef. They disperse by February.

Larger aggregations of this species consist of around 200-300 fish. It is assumed that these are spawning aggregations because the fish contain well-developed gonads; at other times of year they do not, and are then always seen travelling individually or in pairs. There are no obvious colour or behavioural differences among fish in these aggregations that enable divers to distinguish between males and females.

The average weight of fish in these aggregations is between 5 and 16 kg with some individuals weighing as much as 60 kg. These fish are never caught running ripe, nor have they been seen exhibiting courtship behavior or spawning, suggesting that they spawn at night.

Some fish are unsually easy to approach and spear when in spawning aggregations (Johannes, 1982). Maori wrasse, in contrast, are no easier to approach in their spawning aggregations that at other times. As with the coral trout mentioned above, Maori wrasse show no disinclination to take the hook while in their aggregations.

CONCLUSIONS

Coral trout are "the most commonly-landed, highly prized food fish in Queensland waters" (Saenger, 1978). Fishing pressure appears to have brought about a significant reduction in at least some species on the Great Barrier Reef (Craik, 1979; Goeden, 1979). Declines in population sizes are, of course, not necessarily indicative of overfishing, but fishing pressure on this and other species of coral trout is increasing and close watch should be kept on populations in the region.

There is a growing consensus among fisheries researchers that, when exploited, groupers (and snappers) tend to " decline drastically relative to other components of the reef community and [that] the species can even become virtually extinct" (Munro, 1987, p. 649; see also Bannerot et al, 1987). Statistics on coral reef serranide fisheries in the Pacific are scant. But there are several anecdotal reports of *P. leopardus* have been severely reduced by overfishing in some areas. Hooper (1985) reports concern among fishermen of Fakaofo Atoll, Tuamotu Islands, over the "almost complete disappearance" of *P. leopardus* from their waters. They were once caught in "sufficient quantities to sink a canoe" at this atoll while in their spawning aggregations (Hooper, pers. comm.). Fishermen in Palau, Micronesia, voluntarily banned themselves from fishing over the main spawning aggregation of this species in their archipelago because of their concern over its dwindling size (Johannes, 1981).

Bell (1980) was unable to locate a single specimen of *P. leopardus* on the reefs of two populated atolls in French Polynesia during 40 hours of underwater surveying, nor in the fish market at Papeete, nor in collections from fish poison stations., Yet the species was comon around nearby uninhabited islands. Bell (1980) stated, "in the case of coral trout populations vulnerable to fishing pressure, it appears that reserves (on the Great Barrier Reef) should be located where individuals spawn, so that recruitment to reserve, and presumably non-reserve areas alike, is enhanced."

Johannes (1980) has pointed out that reef fish spawning aggregations, like spawning runs of salmon, provide: 1. exceptional opportunities for fishermen to make large catches; 2. unique opportunities for researchers to monitor the populations they represent; and 3. convenient foci for management. So far only the first of these opportunities has been realized on the Great Barrier Reef. *P. laevis* is vulnerable to intense exploitation while in spawning aggregations in the Cairns section of the GBR Marine Park and seems, according to fishermen, to have decreased substantially in numbers in the past decade.

Research on spawning aggregations of commercially valuable coral reef fish has been carried out in other areas of the world but not on the Great Barrier Reef. This seems to arise at least in part from the assertion by a number reef biologists in Australia that "I haven't seen them therefore they cannot be there".

There are several responses to this. First, to witness spawning aggregations the biologist has to be at the right place (and spawning aggregations of larger reef fishes typically occupy a miniscule fraction of their total range). The researcher must also be there at the right time.

Secondly, the biologist must be able to recognize a spawning aggregation when he or she sees it. In the case of some coral trout this is more easily said than done. Aggregations of this species are diffuse; they do not take the form of spectacular "cones" like those of some Caribbean Epinephelids. The fish simply gather in unusually large aggregations. In addition they probably exhibit actual spawning behavior for only a short and (for the underwater observer) inconvenient period of the day.

Spawning activity has rarely been witnessed in serranid spawning aggregations and probably typically occurs mainly around or after dusk; courtship in *P. leopardus*, for example, has been reported only around dusk (see Thresher, 1984 for review).

Thirdly, marine biologists are spread very thinly over most reef areas (including the Great Barrier Reef) - much more thinly than fishermen. For this reason it is almost always fishermen that have first drawn the attention of marine biologists to spawning aggregations of large serranids, rather than biologists discovering them for themselves (e.g. Bardach, 1958; Craig, 1969; Smith, 1972; Burnette-Herkes, 1975; Johannes, 1978; Olsen and LaPlace, 1979; Colin et al, 1987; Shapiro, 1987; Johannes, submitted).

It is not our intention to determine whether or to what degree protection of spawning aggregations of coral trout is needed on the GBR. But if it is, or becomes so in future, then a measure of control over fishing pressure could be applied through spawning closures (Johannes, 1980).

Where a species has only a few spawning sites in a region, as do some Atlantic serranids such as *Epinephelus striatus* (Smith, 1972; Olsen and LaPlace, 1978; Colin et al, 1987), closures might be enforced directly on the spawning grounds. However, this is not practical where spawning aggregations are numerous and widespread, as is apparently the case with *P. laevis*, *P. leopardus* and *P. areolatus* on the Great Barrier Reef.

Control over exploitation of spawning aggregations might be accomplished through a total ban on fishing for the species during the spawning periods. But this would be extremely unpopular on the Great Barrier Reef because the spawning season coincides both with the Christmas holidays and the best fishing weather of the year. A less drastic measure would be as Bell (1980) suggested,to make some spawning sites into reserves where fishing is entirely forbidden.

A first step in facilitating any controls on exploitation of fish in spawning aggregations such as these would be to carry out research to confirm and extend the observations recorded in this report.

There other other practical implications of understanding coral trout spawning aggregations. For example, knowledge of the timing and location of spawning aggregations of reefs could also facilitate access to broodstock and eggs for sea cage farming, which is practiced with serranids (e.g. Chua and Teng, 1982), or for reef fish ranching, the feasibility of which is currently being examined in the Solomon Islands by the International Center for Aquatic Resources Management (John Munro, pers. comm.).

Also, if a significant portion of adult coral trout migrate to certain restricted locations to spawn in the summer, then censuses of their populations carried out at their interspawning locations during this period are liable to yield misleadingly low population estimates.

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