

13 RECOMMENDATIONS ON RESEARCH PRIORITIES

Below we describe areas we have identified as priority areas of research for species of fish of commercial and recreational importance on the GBR. They have been selected on the basis of research relevant to management of the GBR. The knowledge required is not necessarily sophisticated relative to that identified as priority requirements in better studied fisheries. This reflects our present understanding of the ecology and population dynamics of the relevant species on the GBR. Numbers and headings below refer to chapters of this review.

13.1 Distributions and Habitats

Basic knowledge of the distributions of fish species of recreational and commercial importance is remarkably lacking within the Great Barrier Reef Marine Park. For no species do we have a good understanding of its distribution throughout its complete life-cycle. We highlight two general areas requiring particular attention:

(i) **Distributions of Juvenile Fish.** Little is known of the distributions of juveniles of any species of commercial or recreational importance. Yet such information is critical to understanding, for example, the significance of nearshore habitats to reef fishes and interactions between the trawl fishery and the line fishery. Data is particularly required on the significance of nearshore habitats, especially sea-grass areas, but also estuaries, fringing reefs and shallow bay habitats as nursery areas for lethrinids and the snappers *Lutjanus malabaricus*, *L. erythropterus* and *L. johnii*. The habitat of juvenile *Lethrinus miniatus*, in particular, needs to be defined. This is the second most important species commercially and yet juveniles (<20cm) have rarely been found.

(ii) **Distribution and Abundance of Fish Below SCUBA Depths.** We have a good understanding of the distribution and abundance of the coral trouts through extensive visual surveys using SCUBA. We have little idea, however, of the proportion of the population or its distribution, below these depths. Most of the spawning population, for example, may occur in depths and habitats that cannot be surveyed using SCUBA. There is a general lack of understanding of species distributions and size distributions of species below about 20m. Is there a clear distinction between the 'reef' fauna and species found on the surrounding trawl grounds (as there appears to be in trawl by-catch)? Answers to these problems will require the development and refinement of sampling techniques other than visual surveys. Traps, droplines, surveys from submersibles and fish trawls appear to be good candidates.

13.2 Early Life Histories

(i) **Taxonomy.** Although lethrinids and lutjanids (*Lutjanus* spp.) are not uncommon in larval net tows, the value of net tow studies for examining significant problems of early life histories are very limited because of the inability to identify these taxa to species level. Significant advances in our knowledge of the early and middle stages of pre-settlement of these taxa (critical for understanding patterns of dispersal) is dependent on taxonomic studies that will allow species-specific identification, similar to studies carried out for coral trout by Leis.

(ii) **Recruitment and Light-traps.** An understanding of spatial and temporal variability in patterns of recruitment of species of recreational and commercial importance is critical for a number of reasons outlined in the text. Although underwater studies of newly-settled individuals of these species have to date been largely unsuccessful, light-traps are proving very useful in assessing recruitment variability of at least coral trout. Their use in this role should be extended.

13.3 Reproduction

(i) **Spawning Aggregations.** A number of species of commercial and recreational importance are known to form spawning aggregations. Such aggregations create unique opportunities to study many problems. Further work is required to better define spawning behaviour, specifically the timing and location of aggregations, for as many species as possible.

(ii) **Age and Size at Maturity.** Age and size at maturity are very important parameters in stock assessment but are poorly known for most species. More effort is required to determine these parameters for species on the GBR.

(iii) **Mechanisms of Sex-Change.** Most, if not all, coral trouts and emperors undergo sex-change during their lives. This greatly complicates the question of size and age at maturity and requires detailed study. An important problem for stock assessment and questions of the effects of fishing is the mechanism of sex change. Is it size-dependent, age-dependent, socially controlled, a mixture of these or perhaps controlled in other ways? The answers to these questions will have different management implications.

13.4 Age, Growth, Mortality and Longevity

(i) **Determination of Age and Longevity.** A more concentrated effort is required to identify annual and seasonal banding patterns in the hard parts of reef fish of commercial and recreational fishing significance. Section 5 established clearly that biologists working on reef fish on the GBR have been slow to address questions of basic demography, and age determination is the key to sound demography. We need to be able to age all species of commercial and recreational interest, including the smaller lethrinids and lutjanids and species in a range of genera which are likely to become more important in the reef fishery in the future e.g. *Epinephelus*, *Cephalopholis*, *Gymnocranius*, *Diagramma*, *Plectorhynchus*, *Aprion*, *Etelis*, *Cheilinus*.

(ii) **Validation.** An important aspect of age determination is validation of the temporal significance of checks in hard parts of fishes. The use of traps, tetracycline injection and mark-release-recapture techniques probably offers the best opportunity for such validation.

(iii) **Rates of Growth and Mortality.** Determination of age is the key to good estimates of both growth and mortality. Growth and mortality estimates are the key elements in yield-per-recruit estimates. We need estimates of both growth and mortality for a wide range of species. [More effort is required to sample the components of the stocks in deeper waters for inclusion in growth and mortality estimates.] Comparisons of rates of growth, mortality and longevity in different regions of the GBR are essential for management.

(iv) **Age-Structured Population Dynamics.** Our knowledge of the population dynamics of large reef fish must be age-based. Age-structure information from a number of reefs of known recruitment history exists for only one species of reef fish on the GBR - the pomacentrid *Pomacentrus moluccensis* in the Capricorn-Bunkers. The insights into population dynamics of this species gained through age-structured information (longevity, growth, mortality, factors affecting population size) are exemplary. It is this level of detail of population dynamics that is required for species of commercial and recreational fishing significance on the GBR.

13.5 Catch and Effort

(i) **Commercial Line Fishery.** Detailed information is now available (since January 1 1988) for catch-effort characteristics of the commercial line fishery (QFMA/QDPI CFISH database).

The value of this information will increase as the duration of the data collection increases. There is a strong need to contact as many commercial line fishermen as possible for historical records of catch/effort. Many fishermen keep such records as a means of paying employees.

(ii) **Recreational Small-boat Fishery.** A strong need exists for more extensive and regular boat-ramp surveys to improve our knowledge of the small-boat recreational fleet. Such studies seem to be far preferable to telephone or mail recall surveys.

(iii) **Charter Boat Fishery.** The best time-series of catch-effort data for the GBR Reef Line Fishery come from the competition records of fishing clubs using charter boats or their own boats. A strong need exists to document and analyse these data and to ensure that such information continues to be collected.

(iv) **Aerial Surveillance.** Within the constraints of limited budgets, it would be advantageous to make more use of aerial surveillance to estimate numbers of boats (from all fishery sectors) fishing on particular reefs. With good ground-truth information on numbers of fishermen per boat, hours fished per day etc., such data might potentially provide good estimates of effort.

13.6 Stock Structure

Basic studies of stock structures are required. These are important in determining the potential interdependence of different reef areas and to highlight populations that may have different population parameters (and hence different responses to disturbance). Coral trout and sweetlip emperor (*L. miniatius*) are the obvious species to emphasise, not only because they are the major taxa of commercial interest but also because of particular aspects of their distribution and ecology. Circumstantial evidence suggests that sweetlip may be particularly restricted in their movements, and hence may be more likely than other species to differentiate into different stocks. As discussed in the text, there is evidence that population parameters of *P. leopardus* in the Capricorn-Bunkers are different to those elsewhere on the GBR. Together with the relative geographic isolation of the Capricorn-Bunker Group from the rest of the reef, these observations suggest that *P. leopardus* in this Group may be a different stock to those elsewhere.

13.7 Movements and Migration

Little is known of the movements or migrations of species of recreational and commercial importance. A number of mark-release-and-recapture studies in progress will greatly increase our understanding of movements within reefs. The most important problem from a whole-reef management view and for the design of effects of fishing experiments is the extent and nature of movements of fish between reefs. Large, carefully thought out, tagging studies will be required to solve this problem.

13.8 Yield Estimates and Spawning Potential

(i) **Surplus Production Models.** Given the need for collection of catch-effort data from all sectors of the fishery over a long time period, and the need for a range of effort values over many years, it is unlikely that estimates of yield from a surplus-production model for the GBR reef line fishery will be available for some time, if at all. Nevertheless, collection of reliable catch-effort data from all sectors of the fishery over as long a period as possible is essential to detect major trends in the fishery.

(ii) **Yield-Per-Recruit Models.** The basic information on growth, and to a lesser extent mortality, will soon be available to make preliminary yield-per-recruit estimates for a few of the

major species. We still need better estimates of rates of natural and fishing mortalities, however. The data required for yield-per-recruit estimates (growth, mortality estimates) for a wide range of species of fish of commercial and recreational fishing interest are simply not available (Section 5). Such information should become available over the next 5 years or so. Yield-per-recruit estimates will provide us with some of the most reliable yield estimates available for the GBR reef line fishery.

13.9 Management Measures

(i) **Legal Minimum Sizes of Fish.** Research to determine age and size at first reproduction and sex change for a wide range of reef fish of commercial and recreational fishing interest should be a high priority. Such information is essential for making decisions on appropriate legal minimum sizes at first capture. For example, the current minimum size of sweetlip emperor (30cm TL) would appear to be below the size at first reproduction. (Minimum legal sizes of reef species are under review by QDPI at the time of writing this report).

(ii) **Cost-effectiveness of Bag Limits.** Some research should be directed to determining if bag limits do provide a cost-effective method of reducing catch in the recreational fishery.

(iii) **Assessment of the Effects of Zoning on the Reef Line Fishery.** An assessment of whether zoning of reefs is having a beneficial, detrimental or neutral effect on the reef line fishery will require detailed studies of the nature and rates of movement of fish between fished and unfished areas. This includes detailed studies of movement and mortality rates of both adult and larval fish as they move between reefs. Studies of interreefal movements of adult and larval fish should be a priority.

(iv) **Closures of Parts of Reefs.** Zoning has generally been applied on a whole-reef scale. Some pilot studies should be made to determine the impact of closing parts of individual reefs on the fishing at that reef. Such studies will require detailed knowledge of within-reef movements of adult fish.

(v) **Recruitment Rates of Coral Trout to Closed and Open Reefs.** Detailed monitoring of this kind would provide insight into an important aspect affecting population size on an individual reef.

(iv) **Nature and Extent of Fishing Violations on Closed Reefs.** Information of this type is critical in interpreting the effects, if any, of zoning on the reef line fishery. If 'unfished' reefs are in fact receiving unmeasured but substantial amounts of fishing mortality, the real impact of zoning may be underestimated.

(vii) **Surveys of Distribution and Abundance of Target Species.** Surveys of the type carried out to date (e.g. visual surveys of coral trout) should be continued and, if possible, monitoring should be both regular and long-term, in both fished and unfished areas. The methods of monitoring could be expanded to include visual census, trap studies, monitoring of experimental catch rates, monitoring of age structures etc.. Such monitoring would provide some of the best estimates of stock abundance available.

(viii) **Experimental Studies.** Use of zoning provisions to set up well-designed, long-term experiments to investigate effects of fishing and protection from fishing should be a high priority. Studies comparing fished and unfished areas, depletion experiments (such as the Boulton Reef experiment) and studies of the long-term dynamics of the recovery of stocks are recommended.