11 YIELD ESTIMATES AND SPAWNING POTENTIAL

11.1 Surplus Production Models

The review of catch and effort information (Section 6) indicated that no long-term time series of reliable catch and effort data exists for the commercial and recreational line fisheries that would be suitable for use in a surplus production model. The infrastructure is now in place for collecting such catch-effort data over a long period of time for the commercial fishery (CFISH database). No infrastructure is in place to collect such long-term data from the entire recreational fishery. In particular, no plans currently exist to collect regular (at least yearly) and reliable data from the small-boat recreational fleet by use of boat-ramp surveys.

Even when catch and effort data are available, experience from two reef fisheries (Gulf of Mexico/U.S. Southern Atlantic and Hawaii) suggests that their value in the development of management plans may have substantial limitations. Huntsman and Waters (1987) provide an enlightening history of the development of management plans for reef fisheries in the Gulf of Mexico and the U.S. Southern Atlantic since the mid-1970s. Although commercial catch records were available, they were found to be of limited value. Catches were recorded by location of landing rather than location of fishing. Separation of species in the catch records were either lacking, improper, or not applied consistently. For example, `grouper' referred to over twelve species in two genera. Also, information on recreational catches was either totally lacking or `so fragmented that it was useless'. Of even greater importance, little information on fishing effort was available and no information was available on the economic and social aspects of the reef fisheries in the two areas (Huntsman and Waters 1987). These limitations on the usefulness of catch and effort data for the fisheries remained as the management plans were implemented, with the managers eventually opting for a management strategy based on yield-per-recruit rather than surplus-production models (Huntsman and Waters 1987).

Ralston and Polovina (1982) examined catch and effort statistics for the deep-water line fishery in the Hawaiian Islands for the period 1959-1978. They examined statistics for 13 species from 4 banks and attempted to fit Schaefer surplus-production models to the data. No fits were statistically significant (Ralston and Polovina 1982; Polovina 1987). Fits were improved by combining species into three groups based on cluster analysis and a significant fit was obtained for all species combined for one of the banks. Overall, catches were maintained at high levels but catch per unit effort declined with increasing effort (Ralston and Polovina 1982).

These two examples stress that even if a long-term time series of catch and effort data existed for the entire GBR demersal line fishery (both commercial and recreational), good statistical fits of models such as the Schaefer or Fox surplus-production models are not necessarily assured. Yield estimates based upon catch-effort data alone are not recommended for the GBR demersal hand-line fishery. Such estimates should be combined with yield-per-recruit estimates.

11.2 Yield-Per-Recruit Models

The review of age, growth, mortality and longevity information (Section 5) indicated that reliable estimates of some of the necessary biological parameters for yield-per-recruit modelling are, or soon will be, available (ie. growth characteristics) whereas others are known only poorly (ie. mortality estimates - total (Z), natural (M) and fishing mortality (F) and thus exploitation rates). Reliable age determination should provide the key to good estimates of Z. Estimates of Z from length frequency distributions of relatively long-lived fishes such as coral trout (10 to 12 years) and sweetlip emperor (>14 years) should be treated with care. If sufficiently large samples of fish can be aged from populations that have not been fished for perhaps 10 to 15 years (e.g. preservation zones) a good estimate of M is possible for species such as coral trout

and sweetlip emperor. Most estimates of M for reef fish have been derived from Pauly's (1980) empirical formula. Ralston (1987) provides another empirical formula to estimate M for lutjanids and serranids. Such estimates of M can be used to estimate the ratio M/K (natural rate of mortality/von Bertalanffy growth co-efficient) and to estimate F if Z is known. The ratios M/K and F/Z (exploitation rate) can be used to estimate relative yield per recruit values. The empirical formulae will provide only approximations of M and thus M/K and F/Z. Far more direct estimates of M (by determining age structure on unfished reefs) and F (by obtaining good estimates of catchability (q) and fishing effort (f) to get a direct estimate of F via F = qf e.g. Beinssen (1989a)) are recommended. Mark-release-recapture techniques also provide some promise for estimating mortality rates.

No yield-per-recruit assessments have been published for any species on the GBR. G. McPherson (QDPI --Northern Fisheries Laboratory) has made preliminary estimates for species such as coral trout and these are being refined as more information becomes available. Some of these preliminary estimates are likely to be useful in the current deliberations on legal minimum sizes of many fishes in Queensland (QFMA-QDPI Working Group on Legal Minimum lengths, 1991). Other research groups also are working towards collecting the necessary biological data for yield-per-recruit assessments (e.g. QDPI --Southern Fisheries Laboratory, JCU --Marine Biology, AIMS). Given the reasonably successful use of yield-per-recruit models in the line fisheries of the Gulf of Mexico and the US Southern Atlantic (e.g. Huntsman et al. 1982, 1983; Mahmoudi et al. 1984; Huntsman and Waters 1987), this form of yield assessment holds a great deal of promise for a wide variety of species taken by the demersal line fishery on the Great Barrier Reef.

11.3 Spawning Potential

Two measures related to equilibrium yield from a stock are the spawning stock biomass per recruit and egg per recruit (Goodyear 1989; Goodyear and Phares 1990). The spawning stock biomass per recruit (SSBR) is a measure of the expected lifetime reproductive potential of an average recruit and is obviously an important correlate of the potential for growth of a population. The ratio of the fished to unfished spawning stock biomass per recruit (SSBR fished/SSBR unfished = Spawning Potential Ratio (SPR)) provides a basis for evaluating the condition of the spawning stock and the establishment of criteria for managing the spawning potential of the stock (Goodyear 1989). Egg per recruit estimates require not only information on the spawning stock biomass per recruit but also the lifetime fecundity.

These measures have been proposed recently as a fisheries management objective for the reef fisheries in the U.S. Southern Atlantic (Goodyear 1989; Goodyear and Phares 1990). Given our relatively limited knowledge of spawning stock biomass and fecundity for the stocks of reef fish of commercial and recreational fishing interest on the GBR, such management objectives to produce an equilibrium yield of specified magnitude remains an objective for the future on the GBR.