7. STATUS OF THE STOCK AND PROJECTIONS

Using the estimated unfished and current spawning biomass, we calculated the estimated spawning potential ratio (female SPR) of the stock. However, the spawning biomass only represents female biomass and the selectivities of the fisheries estimated by Synthesis indicate that mainly males are targeted by the fishery (Figure 6.2). Although males do not produce eggs, sperm limitation can affect reproduction of a stock (Alonzo and Mangel 2004). Furthermore, large males have been observed to be territorial in this species, and may play an important role in reproduction (Adreani et al. In Press). Therefore, we also examined the "male spawning potential ratio" (male SPR) and the ratio of total biomass to recruits or the total spawning potential ratio (total SPR). Based on the results of the baseline model, we estimated an exploitation rate of 0.11 for Sheephead in 2003 and female SPR is estimated to be reduced to 80% of the unfished level. However, male and total SPR appear to be reduced by a much greater amount (Figure 7.1). However, the estimates of both current and unfished biomass (and thus exploitation as well) depend on natural mortality, various life history parameters and the coefficient of variation in growth. These variables in the model, especially natural mortality, represent important sources of uncertainty. We therefore examined the effect of natural mortality on the estimated status of the stock (Figure 7.2). We choose to examine two further estimates of natural mortality based on the oldest fish ever aged (53 years) and the oldest fish found in the samples (21 years) used to estimate the life history parameters (Warner 1975; Cowen 1990). Using the relationship published by Hoenig (1983), we estimated natural mortality rates of 0.07 and 0.2 depending on whether the maximum age of 53 years or 21 years was used. The predicted SPR is very much affected by the estimate of natural mortality (Figures 7.1 and 7.2) because of the effect of natural mortality on the estimated total biomass (Figures 6.12 and 6.13). The coefficient of variation in growth has a similar effect on estimated biomass (Figure 6.14) leading to a similar affect on the estimated SPR (Table 7.1). We also examined the 4 sets of life history parameters and estimated the current SPR (female, male and total) based on these different combinations of life history parameters (Figure 7.3). Clearly natural mortality and growth have important effects on estimated biomass and thus the interpretation of the data with respect to the status of the stock. Whether California Sheephead is believed to be below target levels currently depends on deciding what measure best represents the status of a sex-changing stock. Clearly natural mortality and variation in growth will also affect our interpretation of the current status of Sheephead. Although a clear relationship between male spawning biomass and recruitment may not exist, the relationship between female biomass and recruitment is no more obvious (Figure 6.3c).

We also used Synthesis to explore possible future projections for Sheephead. In these projections, recruitment was sampled from estimated recruitments from 1970-1995 and fishing mortality was fixed. In each single projection, the variability in recruitment led to variability in the predicted total and spawning biomass in the future (Figure 7.4). However, these predictions are consistent with the observed and estimated historical abundance of Sheephead. For every scenario, we ran 100 projections over 100 years. We used these projections to determine the range of possible values for expected total and spawning biomass (Figures 7.5 and 7.6). We examined the effect of no fishing (fishing mortality F=0) as well as fishing pressure similar to (F=0.2) and greater than current levels (F=0.5). As expected, increasing fishing mortality shifts the distribution of expected future biomass to the left (i.e. decreases expected biomass, Figure 7.7). These projections do not take into account the potential effect of male depletion on reproduction of the stock since our model assumes that recruitment is independent of spawning female or male biomass. We also explored the effect of natural mortality on projected biomass. Decreasing natural mortality leads to a decrease in expected future biomass (Figure 7.8) in the same way as natural mortality affected the historical estimates of biomass. Similar patterns exist when the coefficient of variation in size is varied (Figure 7.9).