ECOLOGICAL BASIS FOR PARALLEL DECLINES IN SEAGRASS HABITAT AND CATCHES OF COMMERCIAL FISH IN WESTERN PORT BAY, VICTORIA

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A decline of over 70 % of the seagrass cover in Western Port Bay occurred between 1973 and 1984 (Bulthius *et al.* 1984; Shepherd *et al.* 1989). The losses occurred predominantly from intertidal areas of *Heterozostera tasmanica* (Bulthius *et al.* 1984; Shepherd *et al.* 1989). Although the exact causes of this decline are not known, the major proximate cause was thought to be desiccation and/or high temperatures coupled with a fine coating of adherent mud on the leaves reducing light levels (Bulthius *et al.* 1984; Shepherd *et al.* 1989). The underlying causes of losses may have included increased turbidity and sediment deposition resulting from catchment erosion and dredging operations, increased emersion at low tide due to changes in topography and tidal hydrology, and unusually high temperatures over summer (Bulthius 1983; Bulthius *et al.* 1984). Losses may have been self-perpetuating; initial seagrass death may have led to mudbank erosion, increasing suspended solids and sediment deposition in adjacent areas.

The decline in seagrass cover was paralleled by a decline of about 40 % in total commercial fish catches from Western Port Bay (Figure 1; MacDonald in press). Catches in Port Phillip Bay, excluding pilchards for which catches increased rapidly, remained relatively constant over the same period. Catch declines in Western Port Bay were particularly apparent for some species, such as leatherjackets (Figure 2) and grass whiting (Figure 3) where catches in the 1980's were at historically low levels (MacDonald in press). Although alternative explanations for the declines, such as overfishing, and changes in fishing effort or larval input, cannot be rejected, the results are suggestive of a link with seagrass decline for some species. In contrast, catches of other species such as yellow-eye mullet either showed no signs of decline, or actually increased (Figure 4). King George whiting showed a more complex pattern, with a major peak in catches in the early 1970's declining to approximately pre-peak levels in the 1980's (Figure 5). A similar early 1970's peak was apparent for King George whiting catches in Port Phillip Bay, suggesting that factors such as changes in effort, or larval input, were responsible for the peak (C.M. MacDonald, unpublished). Post-peak catches of King George whiting in Port Phillip Bay were approximately double those of pre-peak levels, while in Western Port Bay, pre- and post-peak levels were similar, suggesting a relatively greater decline in Western Port Bay.

This presentation describes a small part of a major research program on juvenile and adult fishes associated with seagrass beds in Port Phillip Bay, Western Port Bay and Corner Inlet aimed at identifying possible linkages between fish populations and seagrass habitats. For the purposes of this presentation we will concentrate on the distribution, abundance and diets of the four species described above to investigate possible reasons for the patterns of decline or otherwise of commercial catches in parallel with seagrass loss.

Results are described for sampling conducted in 1989/1990 at three sites in Swan Bay and one site on the adjacent coast of Port Phillip Bay (Figure 6). Seagrass and unvegetated habitats were sampled at each site. Sites at Queenscliff and St Leonards were adjacent to the shoreline whilst sites at Tin can and North Jetty were in deeper water (1 m MLWS). Dietary studies were conducted on fish collected at three subtidal sites in Western Port Bay; Rhyll, French Island and Tooradin.

Field sampling was conducted with fine-mesh seine nets of 10 and 15 m length and 1 mm mesh. The nets were small enough to selectively-sample specific habitats. When nets were deployed from a small boat, ropes were hauled using detachable weights to stop the net from rising from the bottom until completely retrieved.

Small juveniles of six-spined leatherjacket (Figure 7) and grass whiting (Figure 8) were almost exclusively collected from subtidal *Heterozostera* beds. Both species recruited directly to seagrass in the spring/summer (Figures 7 and 8). King George whiting recruited to unvegetated patches amongst subtidal *Heterozostera* in Swan Bay in spring, and older juveniles were collected in reasonable numbers from the near-shore Queenscliff site in February/March (Figure 9). Yellow-eye mullet were collected at the near-shore St Leonards and Queenscliff sites and were never collected at the deeper subtidal sites (Figure 10). This species tended to occur over unvegetated sand at St Leonards, but there was no obvious habitat preference at Queenscliff.

The diets of six-spined leatherjackets were dominated by seagrass associated biota, including both plant and animal material (Figure 11A). The diets of grass whiting were dominated by seagrass-associated epifauna, mainly molluscs and crustaceans (Figure 11B). The smallest King George whiting juveniles consumed crustacean plankton which was quickly replaced by crustacean epifauna (Figure 12A), consisting mainly of groups such as epibenthic harpacticoid copepods, mysids and tethygeneid amphipods, which would tend to be concentrated in unvegetated patches amongst seagrass beds. Larger individuals consumed soft-sediment crustacean and polychaete infauna (Figure 12A). The diets of small juveniles of yellow-eye mullet were dominated by planktonic crustacea; however, the diets of larger individuals were composed mainly of algae and seagrass-associated epifauna (Figure 12B).

Six-spined leatherjackets and grass whiting are obviously highly dependent on seagrass in terms of habitat and diet. These species were not found to settle in areas where seagrass has been lost and replaced by unvegetated habitats. Food available in unvegetated habitats is probably also unsuitable for these species although this hypothesis would be difficult to test. In general, the parallel decline between seagrass and populations of these species is not surprising.

The link between seagrass and King George whiting is more subtle. Although post-larvae of this species mainly recruit to and feed in unvegetated patches, it is likely that seagrass detritus would lead to elevated abundances of prey species, possibly leading to elevated growth and survival of juvenile whiting. Swan Bay, with its greater amounts of macrophyte detritus, has already been shown to support higher meiofaunal abundances, and feeding rates of juvenile flounder, on unvegetated habitats compared with Port Phillip Bay (Shaw and Jenkins 1992). The infauna consumed by older individuals may also be more abundant in unvegetated sediments enriched by macrophyte detritus. Although decreased prey abundances due to loss of seagrass may be linked to the greater post-peak decline in catches of King

George whiting in Western Port Bay relative to Port Phillip Bay, in general, catches of this species may also be strongly influenced by other factors. In particular, recruitment of King George whiting is dependent on larval input from Bass Strait, and could be greatly influenced by interannual variability in Bass Strait current patterns (Jenkins and May, unpublished).

Juvenile yellow-eye mullet were not dependent on seagrass for habitat or diet, apparently foraging in shallow, near-shore areas for crustacean zooplankton, irrespective of benthic habitat. Although older individuals consumed some seagrass-associated epifauna, this linkage was apparently not critical to feeding success of this group.

To summarise, the strong parallel decline in fish catches and seagrass loss occurred in species which were specifically adapted to life in a seagrass habitat. Species with a reduced ecological link with seagrass habitat did not show a clear parallel decline with seagrass. The post-peak decline in King George whiting catches was greater in Western Port Bay than Port Phillip Bay, suggesting that the link between seagrass habitat and juvenile feeding may be of importance, although the pattern was dominated by other factors.

Work such as that described above identifies key factors which may vary with species, areas and times. However, there may also be useful broad patterns which may help determine which habitats should be protected for fisheries production purposes. For example, on a bay-wide scale, seagrass beds in Port Phillip Bay of similar structure vary in levels of recruitment depending on hydrodynamics (Jenkins, unpublished). This situation is similar to that described in New South Wales estuaries (Bell and Westoby 1986; Bell *et al.* 1987). It may be possible to predict which areas will receive high recruitment using hydrodynamic modelling (Jenkins and Black, unpublished).

Determining priority in preservation of habitats such as seagrass beds will depend on the particular values of interest. For example, in Port Phillip Bay, the seagrass habitats which would be preserved to maximise recruitment of economically-important fish species would be different to those preserved to maximise the overall diversity of fish species.

An important question is how to convey information such as that presented here to coastal managers and others who may influence possible impact on important habitats. Scientists are often reticent to become involved with the media; their views are often presented less than faithfully. However, other user or interest groups which are perceived by the public to conduct 'research' have a strong voice in the media. Although the sentiments expressed by such groups may be laudable in terms of habitat protection, unfortunately the information presented is often highly erroneous. A case in point was recent comments on the proposed relocation of a chemical storage facility from Coode Island, near Melbourne, to Point Wilson, near Geelong, on Port Phillip Bay. Claims were made by a lobby group on prime-time television news that most of the seagrass beds in Port Phillip Bay were located at Point Wilson and that these beds formed the basis of the food chain for dolphins in the bay. These claims were patently false and endangered the reputation and standing of scientists in general. Scientists could certainly do no worse than these groups. Perhaps professional scientific organisations should employ scientists trained specifically in media relations to convey correct information to the public.

Acknowledgements

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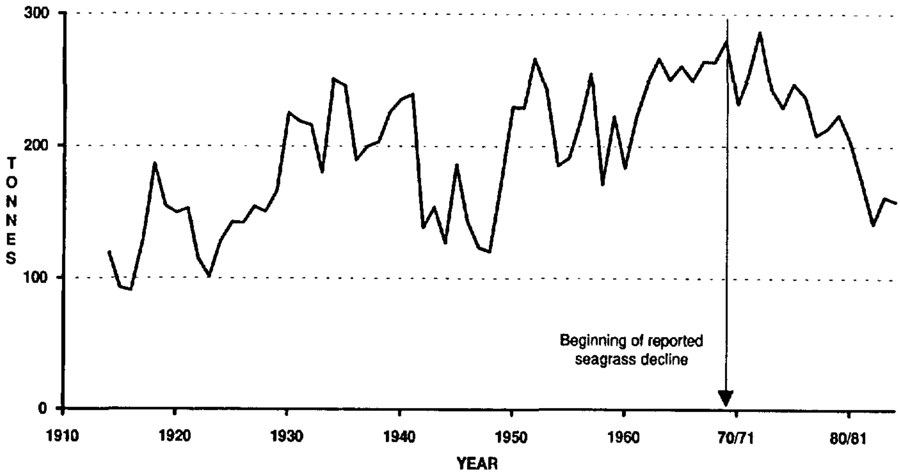


Figure 1. Annual catches of commercial finfish in Western Port Bay.

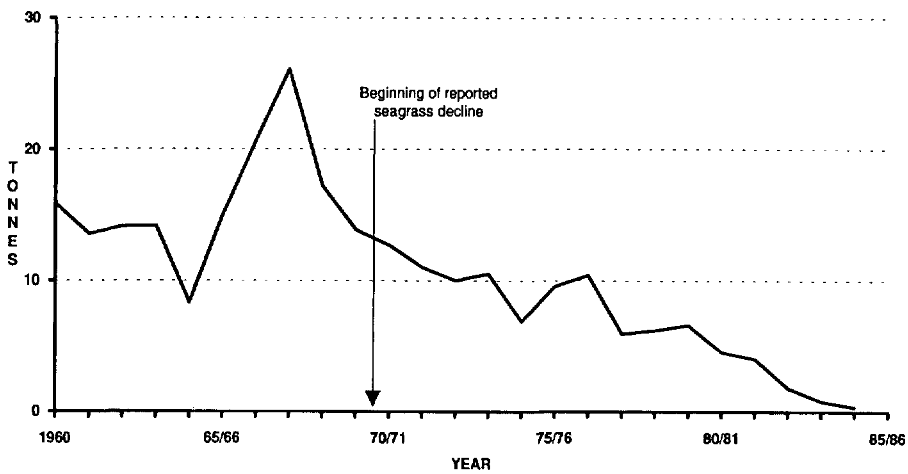


Figure 2. Annual catches of leatherjackets in Western Port Bay.

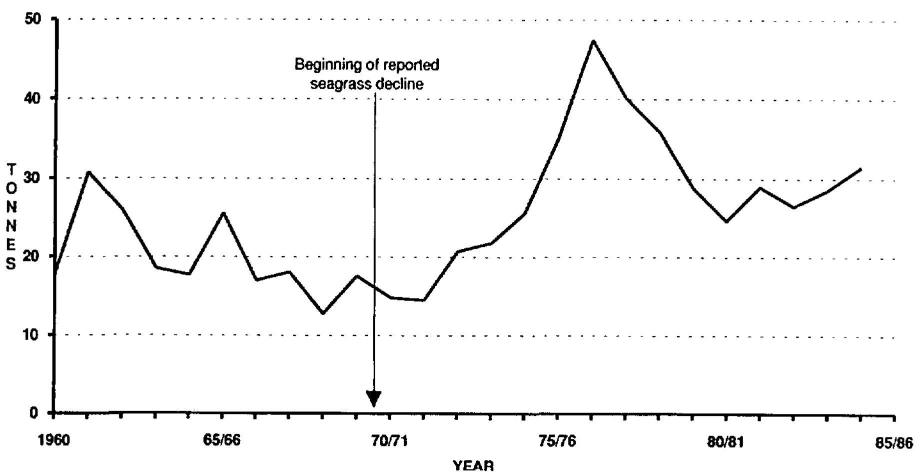


Figure 3. Annual catches of grass whiting in Western Port Bay.

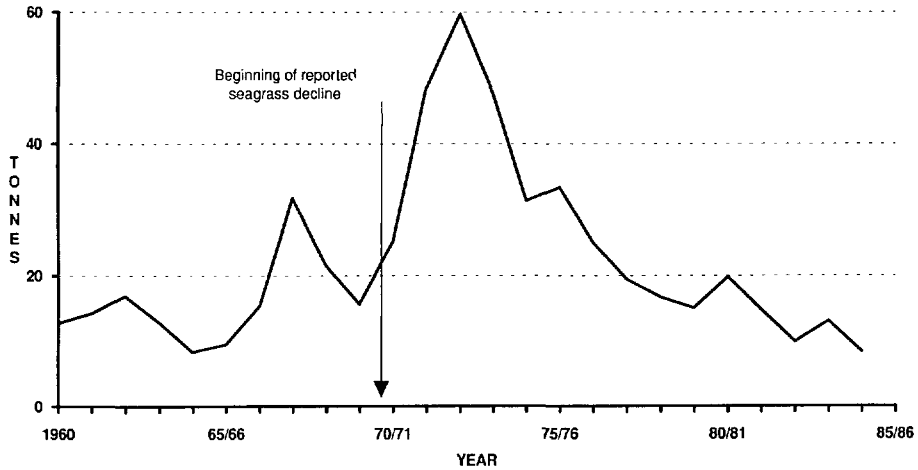


Figure 4. Annual catches of yellow-eye mullet in Western Port Bay.

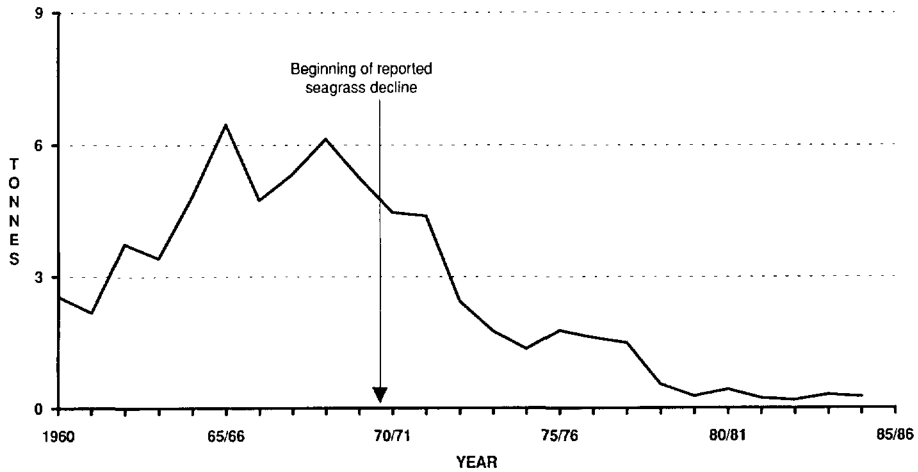


Figure 5. Annual catches of King George whiting in Western Port Bay.

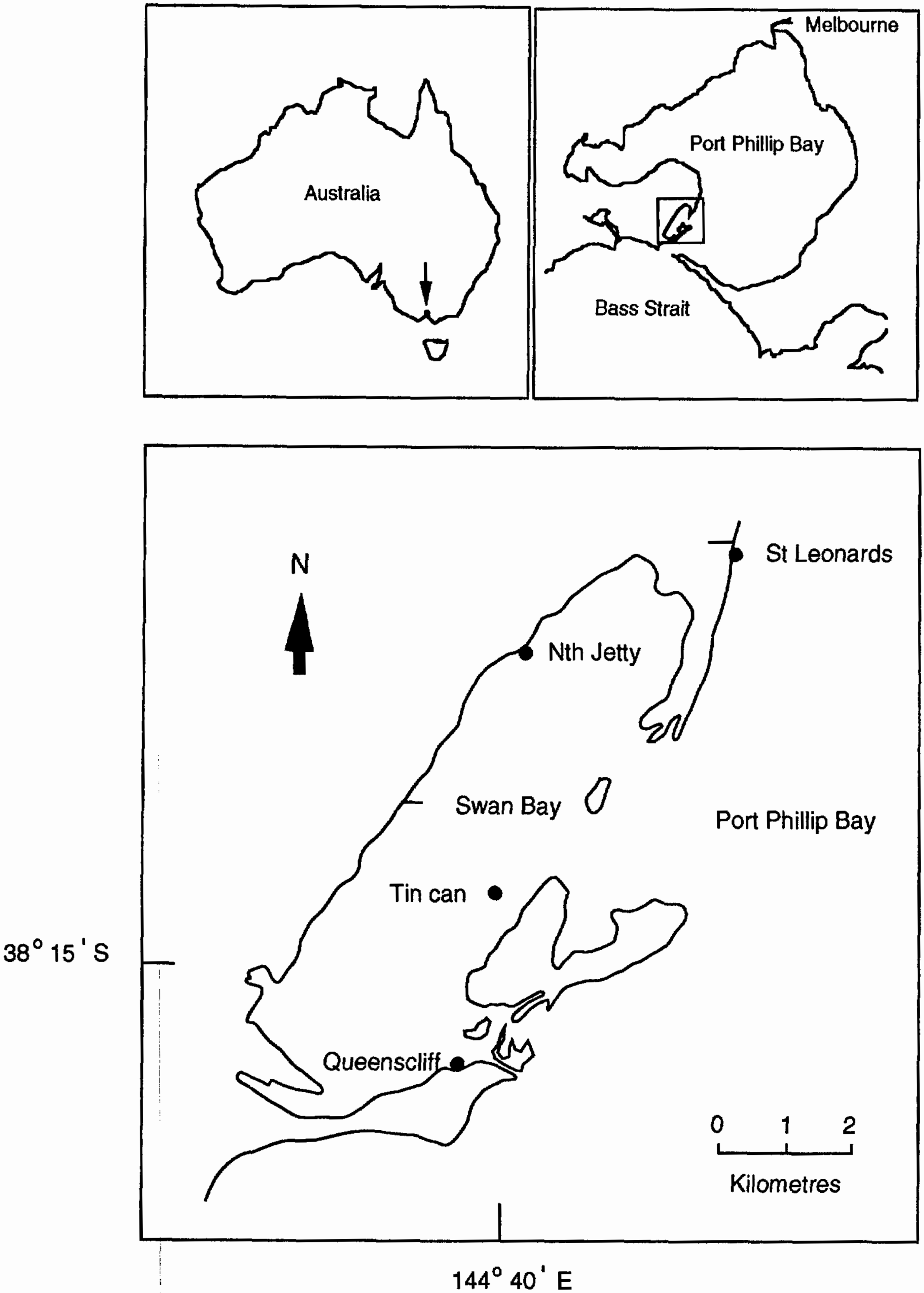


Figure 6. Location of sampling sites in Swan Bay and Port Phillip Bay, Victoria, from which juvenile fish were collected. Insets: Location of Port Phillip Bay on the Australian coast, and location of Swan Bay in Port Phillip Bay.

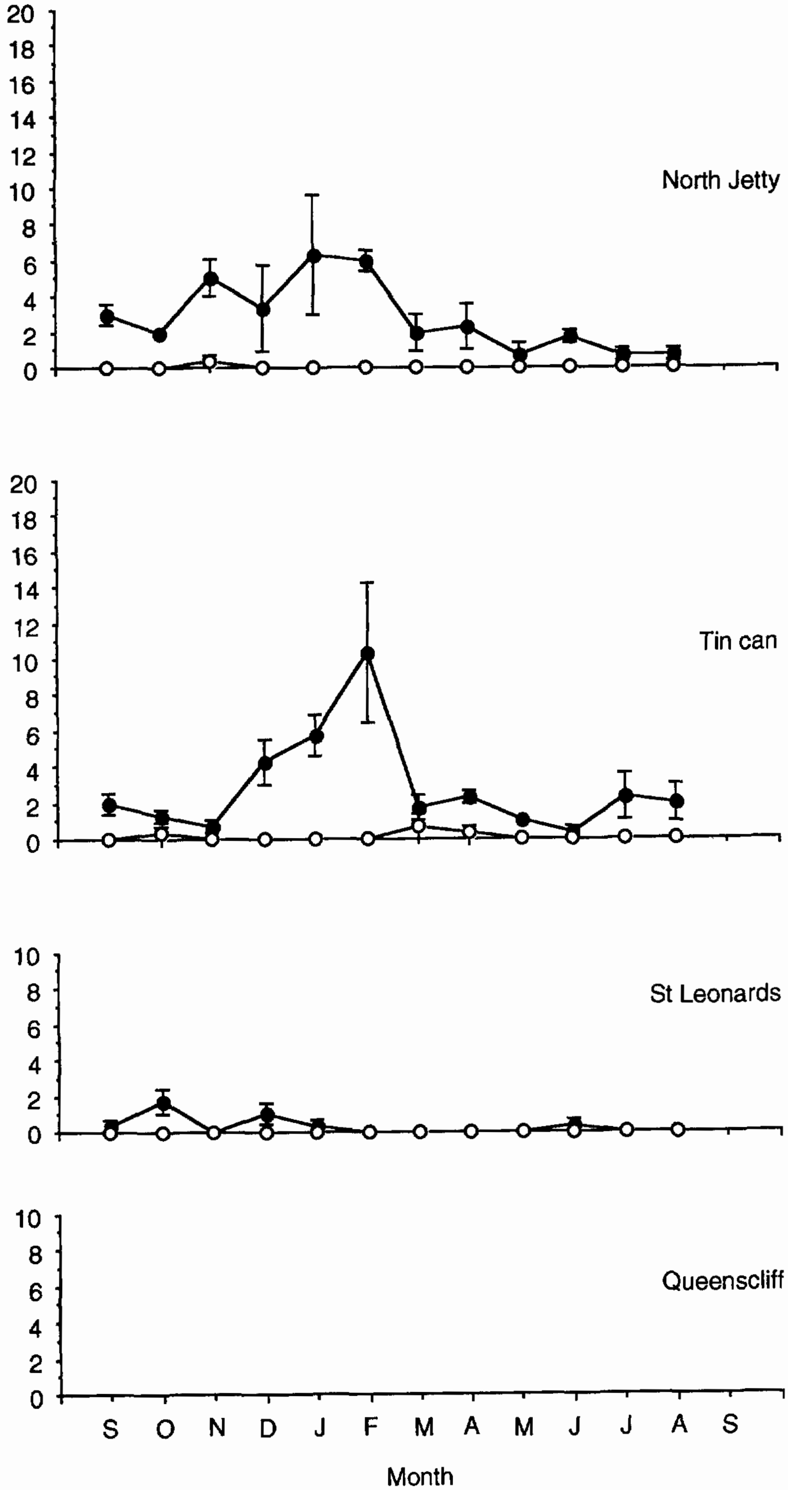


Figure 7. Abundance of juvenile six-spined leatherjackets in seine-net samples. Open circles, unvegetated habitat; closed circles, seagrass habitat.

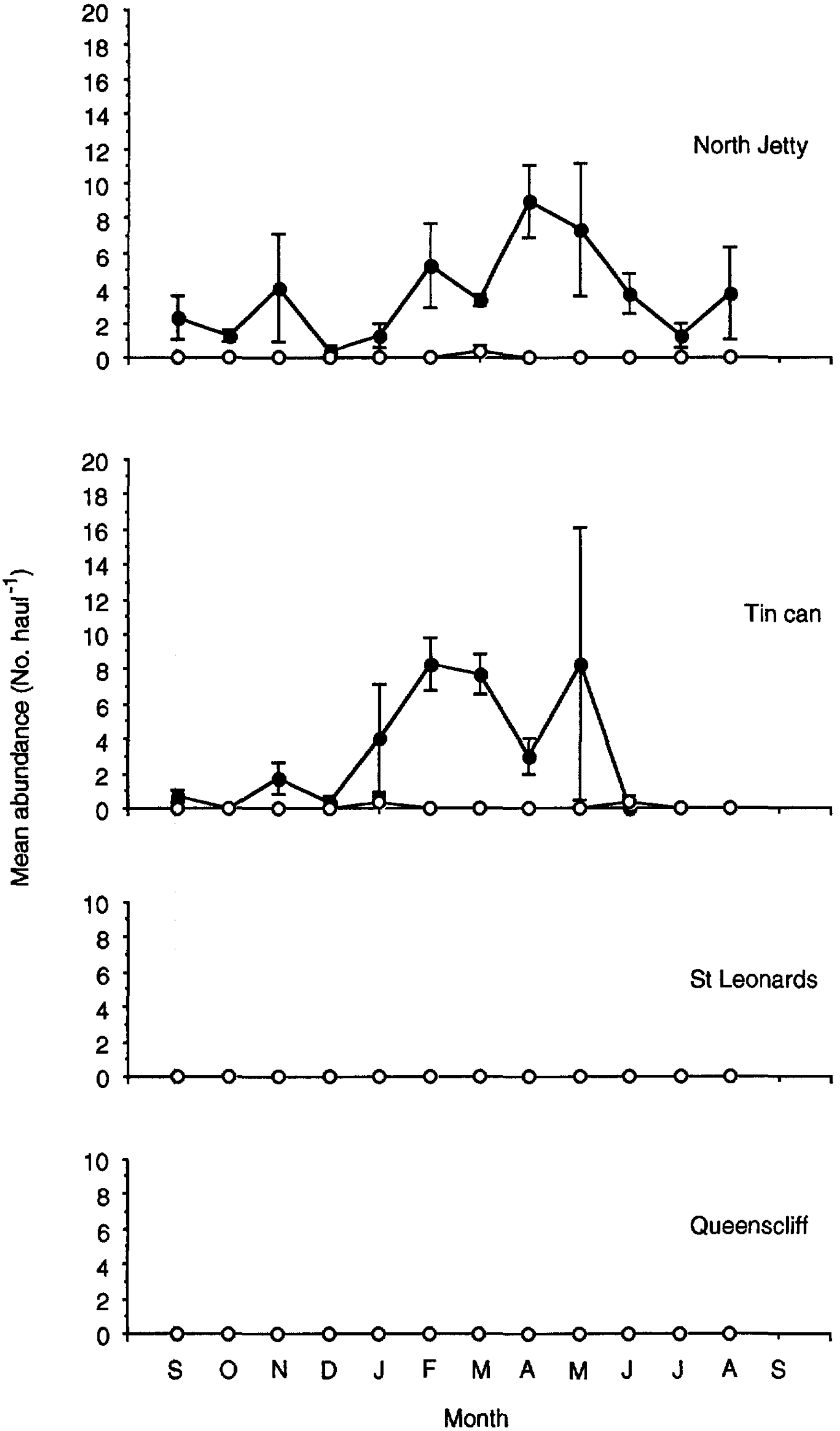


Figure 8. Abundance of juvenile grass-whiting in seine-net samples. Open circles, unvegetated habitat; closed circles, seagrass habitat.

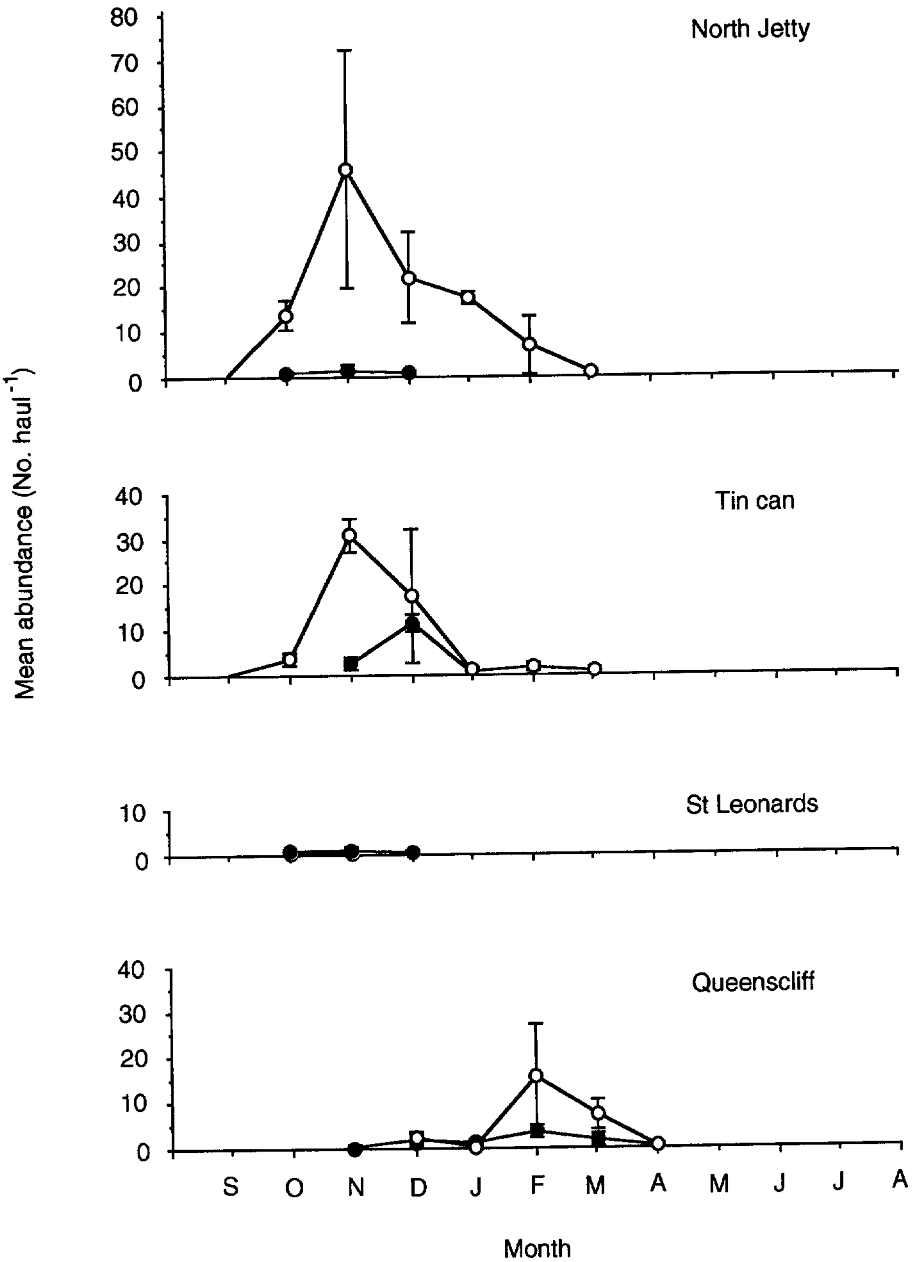


Figure 9. Abundance of juvenile King George whiting in seine-net samples. Open circles, unvegetated habitat; closed circles, seagrass habitat.

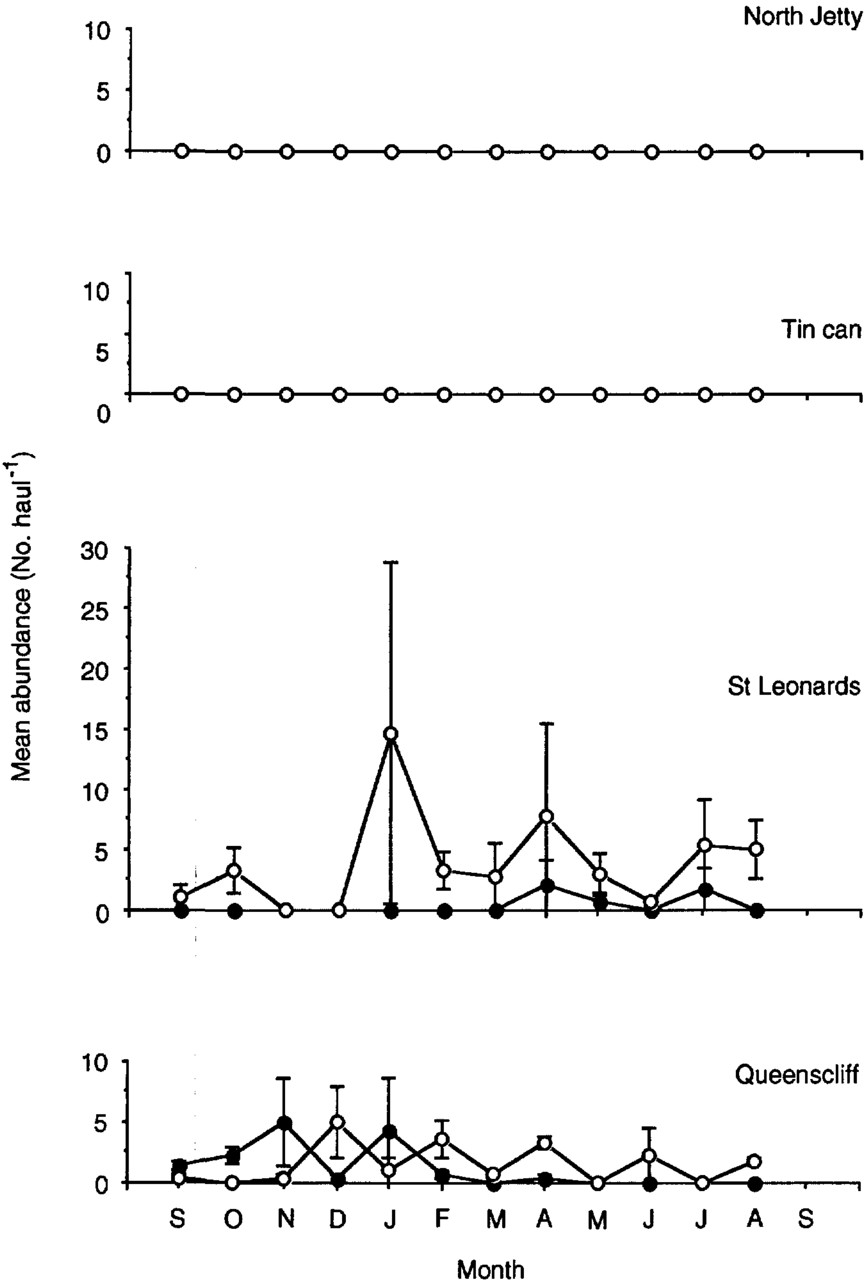
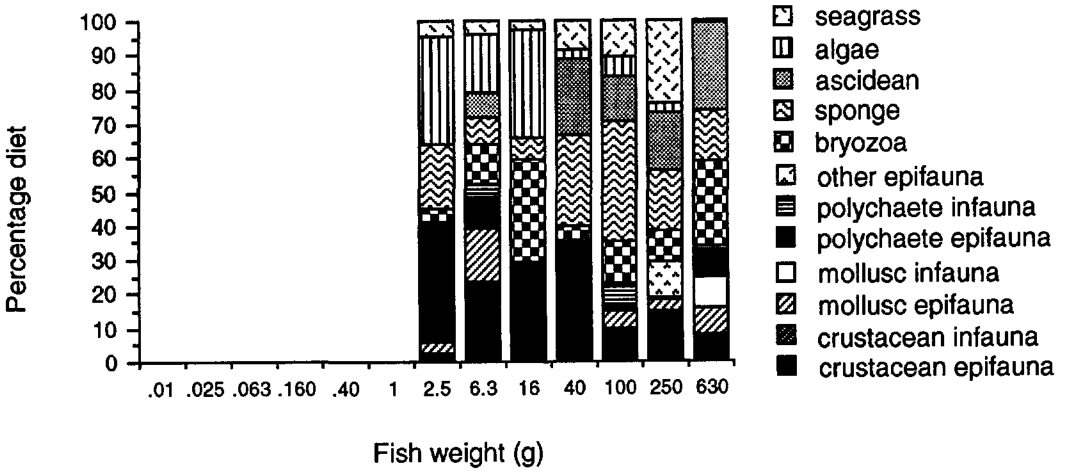


Figure 10. Abundance of juvenile yellow-eye mullet. Open circles, unvegetated habitat; closed circles, seagrass habitat.

A.



B.

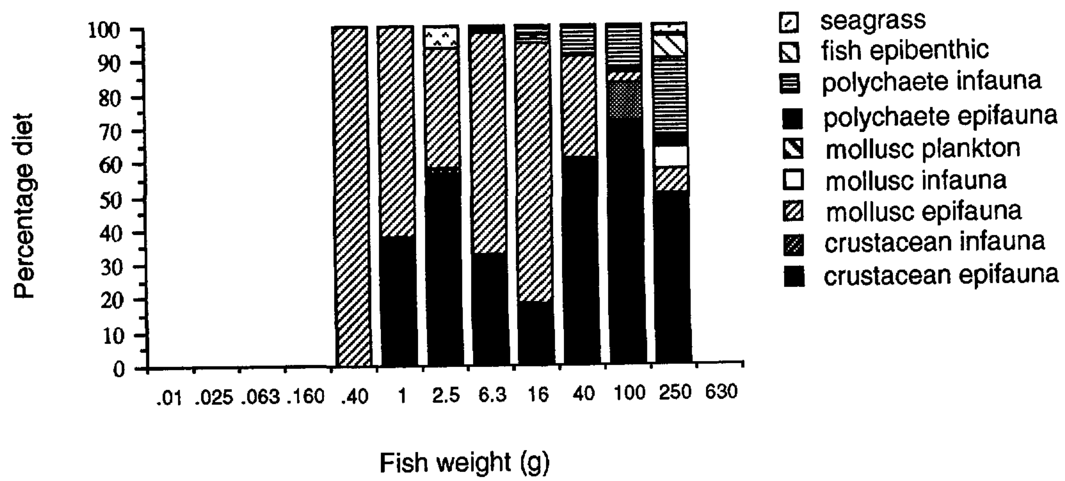


Figure 11. Dietary composition of fishes from Western Port Bay. A. Six-spined leatherjacket, B. Grass whiting.

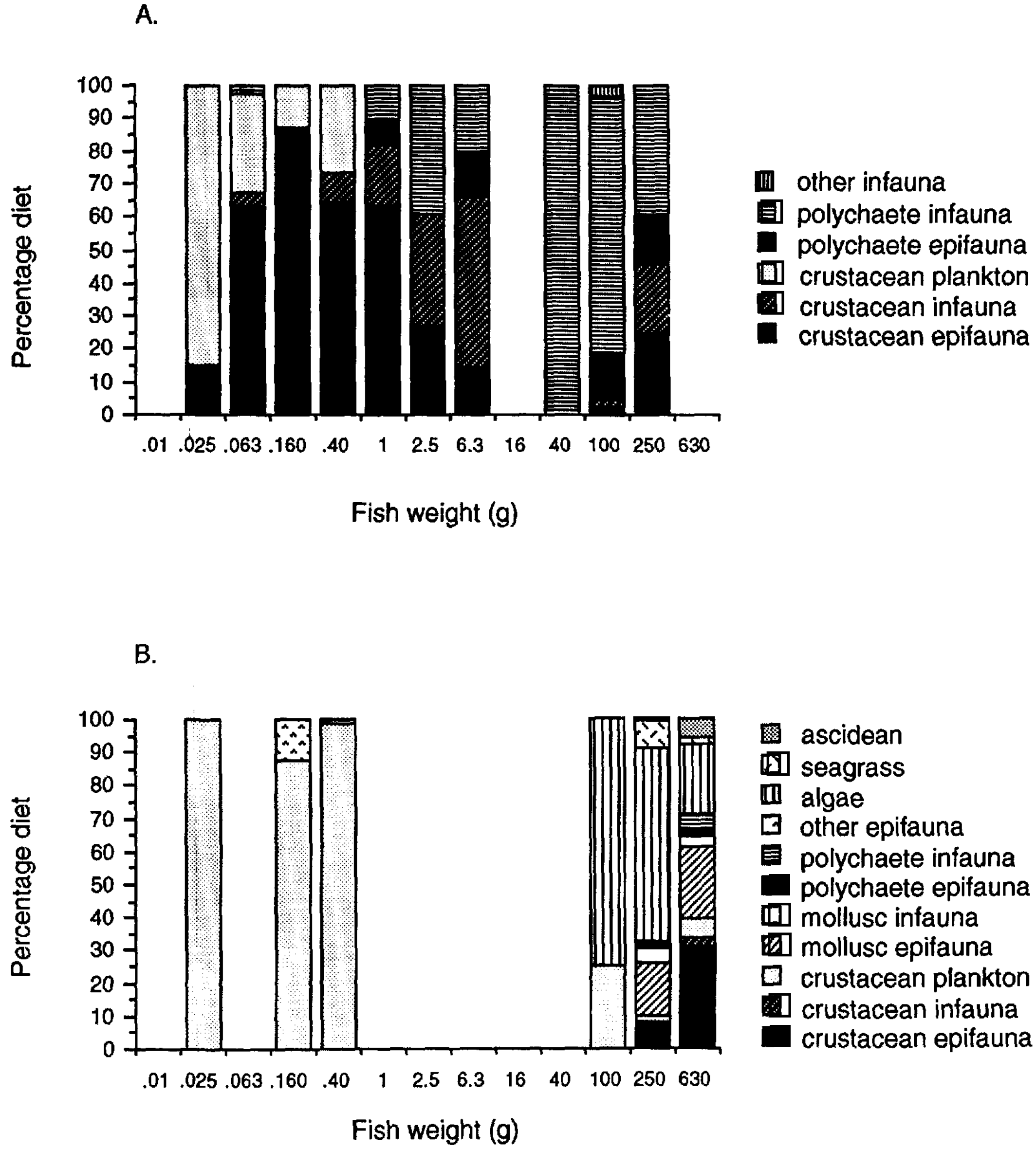


Figure 12. Dietary composition of fishes from Western Port Bay. A. King George whiting, B. Yellow-eye mullet.