Population dynamics of the scallop *Pecten novaezelandiae* in the Hauraki Gulf

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Abstract

The population biology and ecology of scallops in Greater Omaha Bay (a semi-oceanic bay) and Kawau Bay (a estuarine bay) was quantified by observation and experiment. Information was collected to extend the knowledge base on northern New Zealand scallop population dynamics, and for application to potential scallop enhancement in the region. Contagious scallop population organisation was found at all spatial scales examined, ranging from bay wide through to individual bed patchiness, down to the scale of inter-animal distances. Such clumping has strong implications for a range of population processes, including fishing susceptibility and fertilisation success.

Monitoring of adults found two main spawning events to occur; in late October and in mid January. Changes in the gonado-somatic index (GSI) were well synchronised between individuals within populations. Subsequent monitoring of spat-fall in artificial collectors documented two main recruitment events, probably the outcomes of the two local spawning events. These spat-fall events occurred on collectors separated by 10s of km. However, substantial density variations occurred between sites, indicating that local hydrodynamics may have played a significant role in modifying local spat-fall intensities. Smaller spat-fall events were also present between the two major events. The number of spat collected at a number of combinations of site and time were sufficient to support commercial spat catching operations, although problems were encountered with spat detaching at sizes too small to be retained by the collectors. In the 1993/94 summer a large algal bloom event completely eliminated scallop recruitment to collectors for the first three months of that season.

Mass mortality events were a major contributor to overall benthic scallop population mortality. Probable causes included intensive scallop harvesting (commercial and recreational), a major storm episode, and a large algal bloom. These effectively eliminated scallop populations from Greater Omaha Bay. The adjacent Kawau Bay was not affected by any of these particular events, but populations there did not

survive long after reaching adult sizes. Estimates of M (natural mortality) were higher for all scallop populations than have been previously documented in New Zealand studies.

Growth trajectories were reasonably consistent in waters shallower than 19 m, but a progressive decline occurred in both maximal size reached and average growth rates with increasing depth after this point. Food limitation may have been the mechanism involved, which is likely to vary significantly for other locations depending on local environmental conditions. Average time to recruitment to the fishery (100 mm shell width) was three years for the shallower populations. A slight reduction in average size of adults at higher densities was found for some populations, indicating a possible density-dependent effect.

Examination of a high density scallop bed found animals to display distinctive substratum preferences over small spatial scales, with higher abundances occurring on coarser materials such as shell gravel, marl and grit. Mud was not favoured as a habitat type. Movements of tagged animals at this location were spatially limited to within the particular habitat patch in which an individual was tagged and released, *i.e.* at a scale of 1s to 10s of metres. No animals moved between adjacent patches of similar habitat (100 m scale).

A B.A.C.I. type experiment was undertaken to assess incidental mortality effects of commercial scallop dredging on undersize scallops, at the spatial scale of beds. Significant negative effects were quantified, with the number of undersize animals killed per legal animal harvested estimated at 1.7 and 2.8 : 1, depending on the size frequency structure of the fished bed. Modelling of likely improvements in the number of animals surviving at the end of fishing, given a reduction in the minimum legal size from 100 to 90 mm, indicated improvements of 20 to 41% of the original population remaining after fishing, depending on animal size and assumed dredge efficiencies. A 90 mm MLS has subsequently been adopted by the Coromandel Scallop Fishery.

The results from this work provide detailed population based estimates of parameters required for successful management and optimal harvesting strategies of Hauraki

Gulf scallop populations. The large variability in parameters such as mortality, and strong abundance correlations with habitat type, has strong implications for such activities. This work also provides essential information for the undertaking of locally based enhancement operations, such as the spatial and temporal magnitude and variability of spat-fall events, and growth rates with respect to habitat features (*i.e.* depth).

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