

Scallop Dredging of Cardigan Bay – review of scientific study

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Overall, I consider the combined reports (Bangor University, Fisheries and Conservation Report Nos. 59-61) to document a robust scientific study into the effects of scallop dredging within Cardigan Bay, which is of high scientific merit, and of sufficient quality to be utilised to inform the Welsh Government Policy. The authors have examined the data in a wide range of ways, conducting a very thorough investigation.

The study is of high relevance to the Welsh Government Policy, as set out in the Marine and Fisheries Strategic Action Plan. The M&FSAP identifies the aim of introducing an ecosystems approach to management, maximising the sustainable use of resources while protecting the environment. This study contributes to this, through examination of the effects of fishing on benthic communities and the physical substrate.

The objectives of the study are clearly stated in the introduction section of Part 1 of the report. The objectives are very broad ("*to determine the effect of scallop dredging on the benthic communities and habitat characteristics in the SAC and identify sustainable levels of scallop dredging to inform management options*"), presumably as defined in the contract for the work, but the authors have done a comprehensive job of splitting this high level objective into a number of specific hypotheses, which are tested for both infaunal and epifaunal communities.

Given the localised nature of the question (specific to Cardigan Bay) and the lack of high resolution fishing effort data, the scientific approach (BACI experiment) appears the most appropriate. The authors identify that the size of treatment plots can be an issue in this type of study, with the potential for rapid immigration into small plots underestimating true recovery times, but the substantial size of plots in this study avoids this issue. The study was not quite able to reach the planned levels of experimental fishing disturbance, but still provided a broad gradient of treatment effort levels, consistent with areas open to fishing in the region. While the study area has been closed to fishing since 2009, this may not have been long enough for the recovery of particularly slow growing species or habitats (were they to occur in this area). This would mean that the study would probably underestimate the overall effects of fishing if such species had been present prior to any fishing in the area. Given the locality (exposed coast) and the fact that the cobble reefs in the area were specifically excluded, this is probably not an issue. It may have been unavoidable, but the use of different size vessels in the 3-6nm and 6-12nm zones may have introduced some confounding with depth (if the sites offshore were deeper) if there is any difference in the impact of a standard dredge pass between vessels (perhaps because of speed, or tow bar weight). Vessel type (big/small?) could potentially have been included as an explanatory variable in the analyses. This may have improved the overall model fits, and it perhaps would have been interesting to see if vessel size has an impact on benthic effects, but probably wouldn't have had much effect on the overall levels of effect detected.

The sampling approaches employed to collect biological data were appropriate. The statistical approaches used are appropriate for the data and the hypotheses being tested. Examining the physical seabed environment was probably the most difficult aspect of the study, and the authors acknowledge that not all physical changes will be detected using side-scan. It seems very difficult to draw many quantitative results from the side-scan data. More intensive particle size analysis and *in-situ* investigation into parameters like penetration and sediment shear stress might have been more

powerful approaches, but would also have been considerably more expensive to collect. Any physical effects of biological significance would be detectable through the biological sampling anyway, and so physical aspects appear to have (correctly in my view) been given a lower priority.

The results are presented in a clear and standardised way. Each hypothesis is addressed separately, with clear justification, a description of the analytical approach, the results and conclusions. The range of hypotheses examined follow a logical order (spatial autocorrelation first, then community composition etc), and where effects of fishing were identified, they were explored further to tease out additional understanding (e.g. sensitive traits). The individual conclusions sections summaries the separate hypotheses tests, and the Discussion section of Part 3 of the report pulls these together with useful interpretation of the implications of the results. The potential limitations of BACI studies, and issues of multiple significance testing are discussed appropriately, and the interpretation of the results observed are valid.

The overall quality of the evidence provided is high, and the conclusions drawn are appropriate. The results are also consistent with studies elsewhere in similar habitats, giving further confidence that they can be used to inform policy.