

# Diving in the pursuit of science

## ADVANTAGES AND LIMITATIONS OF SCUBA DIVING FOR STUDYING SUBTIDAL POPULATIONS

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In recent years SCUBA diving has been widely employed for assessing commercial stocks, for conservation studies, and for detailed ecological research in both temperate and tropical environments. SCUBA allows *in situ* observation of organisms and provides information unobtainable by other survey methods. However, much scientific work employing SCUBA simply utilises standard or convenient procedures, despite evidence of unacceptable levels of imprecision and consequent low reliability and repeatability.

As SCUBA dive time is limited due to financial and logistical considerations, it is particularly important that surveys are conducted with highly efficient techniques. It is, however, impossible to provide strict rules for the design of underwater surveys using SCUBA. Optimal sample unit sizes for a given survey may vary by orders of magnitude, depending on the characteristics of the target organism, environmental variation, habitat variability, and available resources. Despite that it is appropriate to suggest guidelines for certain types of surveys and how different factors may affect estimates obtained. It is likely that most surveys will require pilot studies to optimise sampling technique, which will save time and expense in the long term.



Spatial characteristics of the target organism and survey scale are factors that can seriously affect the results. More effort is for example required to survey rare species at a given level of precision than common species. The size of sampling unit employed must thus encompass the scale of distribution of the organism under consideration. Failure to follow this recommendation leads to results that exhibit a skewed distribution that misrepresent the population, and data that hinder statistical analysis.

Also the mobility of the organism under scrutiny varies, and operates in conjunction with spatial distribution. Mobility in rare organisms may increase the precision of estimates because they are more likely to be noticed by a scientific diver. However, mobility can have a negative effect on precision of estimates for common species as the scientific diver has to identify individuals. This usually results in overestimates when individuals are counted more than once.

Cryptic species pose particular problems. They are usually underestimated because observers easily miss many individuals. The precision for estimates of cryptic species can often be improved when relatively small sampling units are surveyed, as this can help to focus the observer's attention. Divers are more likely to miss cryptic species if too large a sampling unit is surveyed.

The complications of camouflage are exasperated in complex and heterogeneous habitats such as the rocky subtidal, where small sampling units may be less representative. Larger sampling units encompass the variability, and thus create more reliable estimates. Artificial reefs constructed from standardised materials, such as the Loch Linnhe Artificial Reef, are excellent locations for precise ecological investigations because of their structural homogeneity. In such environments, small sampling units provide dependable pseudo-replicates, where even low levels of sampling effort achieve high precision.

### PHOTOGRAPHIC SURVEYS

Underwater photography as a population estimation technique can produce data comparable to that from visual diving



surveys. Digital technology also requires similar survey and analysis times. But photography has serious limitations in sub-optimal turbidity and light conditions, particularly when one considers the relatively poor definition of photographs currently obtainable from digital cameras. These effects reduce the size of the possible sampling unit, decrease the minimum subject plane-camera distance, and may significantly lower detection incidents of small and cryptic species. Large species on the other hand may not fit in the photo frame, while mobile species may be disturbed by divers and camera apparatus.

The benefits of SCUBA as a means for the study of subtidal organisms clearly need to be weighed against the inherent biases in these techniques to devise reliable methods for a given study. Each study should thus be considered individually to determine the most appropriate sampling unit or method, and indeed whether SCUBA is the most appropriate technique. ●

*This study was carried out as part of an MSc in Aquatic Resource Management at King's College, London, and was supervised by Dr Martin Sayer, SAMS. Diving and underwater photography were arranged by Dr Simon Thurston and Hugh Brown from the National Facility for Scientific Diving at SAMS. All fieldwork was funded by a SAMS bursary.*