CSIRO PUBLISHING

Marine & Freshwater Research

Volume 51, 2000

A journal for the publication of original contributions
in physical oceanography, marine chemistry,
marine and estuarine biology and limnology

www.publish.csiro.au/journals/mfr

All enquiries and manuscripts should be directed to
Marine and Freshwater Research
CSIRO PUBLISHING
PO Box 1139 (150 Oxford St)
Collingwood Telephone: 61 3 9662 7618
Vic. 3066 Facsimile: 61 3 9662 7611
Australia Email: ann.grant@publish.csiro.au

Published by **CSIRO** PUBLISHING
for CSIRO and
the Australian Academy of Science

Mar. Freshwater Res., 2000, **51**, 755–63

A baited underwater video system for the determination of relative density of carnivorous reef fish

Trevor J. Willis and Russell C. Babcock

Leigh Marine Laboratory, University of Auckland, PO Box 349, Warkworth, New Zealand
email: t.willis@auckland.ac.nz

Abstract. Estimates of the relative density of fishes form the basis of many marine ecological studies as well as the assessment of effects of fishing or pollution. Plasticity in the behavioural response of large reef fishes to SCUBA divers means that commonly used underwater visual census (UVC) techniques do not always provide reliable estimates of relative density. The paper describes the system configuration, deployment methods, testing and use of a remotely deployed baited underwater video (BUV) system for the survey of carnivorous reef fishes (snapper, *Pagrus auratus* and blue cod, *Parapercis colias*) in marine reserves of northern New Zealand. Concurrent UVC and BUV surveys inside and outside a marine reserve showed that, whereas UVC detected few snapper in either area (resulting in little confidence in statistically significant results), BUV demonstrated significant differences in relative density. Conversely, blue cod were found to occur at significantly higher densities within the reserve by UVC, but not by BUV. The provision of accurate estimates of fish size (<20 mm error) from video footage also illustrated differences in size structure between protected and fished populations. The data suggest that a combination of survey techniques is likely to be necessary where multispecies assemblages are being assessed.

Extra keywords: abundance estimates, sampling methods, temperate reefs, underwater visual census

Introduction

The ability to make accurate estimates of animal abundance is fundamental to the study of the ecology of those animals (Andrew and Mapstone 1987), as well as providing the basis for the assessment of environmental effects. Such estimates need not be absolute – for many studies it is sufficient to determine relative abundance among sites or times (Connell *et al*. 1998). Regardless of the aims of any given study, data quality and the capacity to detect changes in abundance are dependent on several factors. First, the survey method must be appropriate to the species of interest, taking cognisance of both the spatial scale sampled and the behavioural traits of the target species. Second, the sampling programme must be properly designed, with adequate controls in both time and space (e.g. Hurlbert 1984; Jones *et al*. 1993; Underwood 1993; Edgar and Barrett 1997; Kingsford and Battershill 1998). Finally, any changes in community structure or density of particular species must be of sufficient magnitude to be detected, that is, consistently greater than the scope of background variation.

In studies of reef fish ecology (particularly in shallow tropical environments), abundance estimates are usually obtained by SCUBA divers using variations of underwater visual census (UVC) methods because of their non-destructive nature. The limitations of UVC are well known (e.g. Thresher and Gunn 1986; Lincoln Smith 1988, 1989; St John *et al*. 1990; Thompson and Mapstone 1997), but the method is still often used, albeit with repeated calls for the use of methodological pilot studies to reduce observer error and enhance the accuracy and precision of data obtained (McCormick and Choat 1987; Cheal and Thompson 1997).

Several recent studies have demonstrated that the accuracy of a single survey method can be variable for sampling multispecies fish assemblages (Hickford and Schiel 1995; Jennings and Polunin 1995; Connell *et al.* 1998; Kulbicki 1998; Willis *et al*. 2000). These problems are distinct from UVC observer error. It has been suggested that multiple methods be used concurrently to obtain overall estimates of abundance (Connell *et al.* 1998; Willis *et al*. 2000). Most of the methods previously compared fall into one of two general categories: direct observation (UVC) and remote capture (e.g. angling, long-lining or gill-netting) techniques. The need for multiple methods relates to interspecific differences in body size, habitat association, aggregative behaviour, mobility, or responses of fish to the presence of divers. At times, these interspecific differences can be systematically biased by the very factor that is under investigation. This is particularly the case for studies of marine reserve effects, where fish behaviour can vary markedly among sites (Cole 1994).

10.1071/MF00010 1323-1650/00/080755