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Editors comment:

This contribution is based on a letter sent by Mr. H. Lassen to ICLARM's programmer, Mr. F. Gayanilo, in response to a query concerning the implementation of Bhattacharya's method as part of the "Compleat ELEFAN" package, to be described in a next issue of Fishbyte. Dr. Pauly suggested that this letter be turned into a Fishbyte article. However, he noted that "as was the case of Dr. J. Gulland's letter to the Editor in Fishbyte (5(1):4-6), the ELEFAN I program is criticized for features that it shares with common statistical methods. Thus, for example, no one expects when using a linear regression for the method itself to provide an indication as to which point is an outlier or not. This is, a decision that is left, for good reasons, to the user - just as in the case of peaks which lie far away from a growth curve identified by ELEFAN I. Moreover, growth parameter estimates obtained by ELEFAN I are *not* influenced by such outlying peaks, and hence this whole argument is specious anyway".

ON THE USE OF VISUAL SURVEY METHODS FOR ESTIMATING REEF FISH STANDING STOCKS

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In the past, visual surveys have been used extensively in reef fish ecology and recently have begun to be applied to reef fish stock assessment. In ecology, visual survey methods have been widely used for comparative surveys and for answering specific questions about reef fish abundances. The application of visual surveys to standing stock estimates is a relatively new approach, and is a promising technique for use in developing countries. The points outlined below are offered as cautionary notes so that, once addressed, we may make the most of the available visual survey techniques.

Visual surveys are a class of methodologies. There are several forms which use either timed swims (e.g., Williams 1982), measured transects (e.g., Choat and Bellwood 1985), estimated areas (e.g., Russ 1985), or point counts (e.g., Thresher and Gunn 1986). Numbers are either estimated individually (e.g., Choat and Bellwood 1985) or on a log scale (Russ 1984).A range of species are usually counted simultaneously, occasionally including fish sizes (e.g., Russ 1985). The range of methods are not all equally suitable for surveying a given range of species and care is needed to select an appropriate technique for the species or family considered. For example, instantaneous area counts appear to be the most effective way of estimating densities of visually apparent species (Thresher and Gunn 1986).

One must also accept that a technique found suitable for a family in one geographical region, such as the Great Barrier Reef, is not necessarily suitable in other regions. For example, in parts of the Philippines conditions differ markedly, with only small diver-wary fish remaining, as a result of intense fishing activity.

Only recently have the inherent errors associated with the use of visual survey methods begun to be addressed. These include transect width (Fowler 1987), fish size (Bellwood, in press, a) and the choice of method (Thresher and Gunn 1986). However, many potential sources of error remain, perhaps most importantly diver-mediated effects (especially in heavily fished areas) and accuracy vs. the number of species (groups) being censused simultaneously. The errors associated with each technique must be understood and the efficiency or applicability of the various techniques must be assessed.

It is not solely the number of samples that is of importance, but also the nature of these samples. In many cases, a large amount of data are collected but are of little or no use. Large scale projects in developing countries are particularly vunerable as field assistance is often available, but strict control over sampling methods may be difficult. If, for, example, one censuses 5 reefs, at 3 sites on each reef, once per month, but makes no specific allowance for depth or location on the reef, then a large amount of data may be collected but questions about reef differences or seasonal changes will be compounded by the effects of depth and location which may mask all other sources of variation. Care should therefore be taken that sufficient thought be given to the type of survey and not merely to the number of samples (cf. Coates 1987).

Visual surveys typically estimate fish numbers whereas yields and fishery standing stocks are invariably expressed in mt or kg. The use of numerical estimates (as an estimate of the standing stock) vs. actual or potential yields in kg (Savina et al. 1986) must be questioned. An estimated stock of 300 fish is meaningless in terms of its potential yield, unless individual fish sizes are also known. Numerical estimates can be used profitably for comparisons between areas but extreme care is needed in the interpretation of these data in a fisheries context (Bellwood, in press, a). Biomass estimates are preferable. Visual estimates of fish biomass have been used (Russ 1985) but attention must be paid to the increased sources of error associated with such techniques (Bellwood, in press, a).

One of the most important questions that must be addressed is the relationship between the species which are visually censused and their contribution to the actual or potential yield of an area. Visual censuses are restricted to diurnally active, non-cryptic, reef species. In one area studied in detail only 40.2% of the total 'reef' fish yield comprised species that may be censused on the reef (Bellwood, in press, b). Of these species, 57% were schooling planktivores *(Naso, Axinurus, Caesio)* which are particularly difficult to count accurately, especially when using transect or area surveys (pers. obs.). Visual surveys probably greatly underestimate these stocks (c.f. Thresher and Gunn 1986). It must be noted that visual surveys only census the species observed (familial divisions are not equivalent). Visual surveys may indicate the quality of a reef for divers but not necessarily its fishery potential.

It is imperative that a note is made of the time of day and area of reef surveyed, in relation to fish yields. For example, on Apo Island, Central Philippines, most carangids are caught in the twilight hours of dawn and dusk. This stock is not available for visual censusing and other methods, such as catch per unit effort must be applied if one wishes to try and elucidate relative stock sizes. Acanthurids, the second largest component of the catch at the island, are caught from specific localities, where schools of over 1000 kg (400+ individuals) are common. Stock estimates are only of relevance to actual yields if the areas surveyed are the same as those fished.

This article does not aim to discourage the use of visual surveys but merely attempts to point out some difficulties associated with the technique, so that visual methods may be applied more productively in the future. Visual survey methods are relatively cheap, non-destructive, unselective and easily replicated. As such, they are ideally suited to the needs of many developing countries where reef fisheries represent an important resource, and are often in urgent need of protective management.

Overall we can increase our ability to estimate reef fish stocks by knowing our limitations. In some cases no answer may be better than a quick one. However, in all cases, a balanced answer is preferable, where one considers the strength of the data and weighs this against the known limitations of the techniques being used. It is to this end that I present the above observations.

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