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DETERMINATION OF MOST ACCURATE SURVEY SIZE AND METHOD FOR VISUAL COUNTING OF CORAL TROUT (PLECTROPOMUS SPP.)

A report to the Great Barrier Reef Marine Park Authority

prepared by:

A.M. Ayling and A.L. Ayling

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Introduction

Between January and May 1983 coral trout surveys were carried out on 56 reefs in the Cairns and Central Sections of the Great Barrier Reef Marine Park. On 32 of these reefs density estimates were made using two different survey methods. One of these methods was the standard hectare count (150 x 67m) previously developed by GBRMPA in a series of workshops held in the Capricorn Group of reefs. The second method used a much smaller survey area; a transect 50m long and 20m wide (0.1 ha).

As has been previously reported (A.M. Ayling, reports to GBRMPA April 1983 and June 1983) the estimate of coral trout density obtained from ten of the 50 x 20m transect counts was consistently twice that derived from five of the one hectare counts. It was thought that these differences resulted from a degree of bias inherent in each method. The one hectare counts probably underestimated actual density for two reasons: 1. The area being searched was so large that fish were overlooked during counting; 2. The actual area counted was probably normally less than a hectare because of the difficulty of accurately estimating the area searched. On the other hand, observation suggested that some coral trout were attracted toward the observers during the counts resulting in an overestimation of actual density when using the small 50 x 20m transects.

In an attempt to determine the degree of bias in the two count methods it was proposed that a variety of different sizes of count be made on a single reef using several different count techniques. It was hoped that some indication of true density could be obtained, from which bias could be estimated.

In order to minimise the confounding influence of the natur variability in trout numbers within a section of reef this work was carried out on a reef where the variance measured during the previous counts was relatively low. The back reef region of John Brewer Reef off Townsville filled these criteria and was used for these count comparisons. This area is a relatively straight and homogeneous stretch of reef approximately 1.5km in length (figures 1 and 2). On this section of reef replicate counts of seven different sizes were made. In addition, two different techniques were used to survey the designated area for one of the count sizes.

Methods

1. The GBRMPA hectare count

As originally proposed, this count method covers a 150 x 67m area. To delineate this area a 150m line is laid along the outer edge of the reef flat, with a 65m line run out at right angles from one end of the first line. Two observers then start from the opposite end of the 150m line and swim a zig-zag course 65m down and up the reef slope until the 65m line at the other end of the search area is reached. Each observer covers the entire search area, recording the species and estimated total length of each coral trout seen.

2. Modified hectare count

During the Cairns Section coral trout survey a modified hectare count method was used to facilitate keeping track of the actual area surveyed. In this technique the 150m line was laid out through the centre of the count area, approximately 33m from the edge of the reef and parallel to it. Two observers searched for trout approximately 34m each side of the line, swimming zig-zag paths along parallel 17m wide strips, first on one side of the line and then back along the other. Each observer covered half the hectare area and the two counts were combined to give the total number per ha. Five random counts using this method were made in the study area on John Brewer Reef during this investigation.

3. Transect counts

Transect counts of six different sizes were also censused in the John Brewer study site. Areas of 50 x 10m, 60 x 10m, 75 x 10m, 50 x 20m, 60 x 20m, and 75 x 20m were simultaneously counted along a 75m tape run out down the reef slope at right angles to the reef edge. While one observer ran out the tape, the second began a zig-zag search along one side of the tape, noting coral trout seen within 5m of the line, and those between 5 and 10m from the line. Fish were recorded separately for the sections 0-50m, 50-60m, and 60-75m along the tape. The first observer, returning from the end of the tape, counted trout in the same six divisions on the opposite side of the line.

4. Instantaneous transect counts

To get a relatively unbiased estimate of coral trout numbers, ten replicate 50 x 20m were surveyed using an instantaneous technique to minimise the possible influence of the observers on the coral trout in the area. Using two observers, counts were made 10m each side of a 50m tape as it was run out by a third diver; the tape layer taking care not to get in advance of the two observers.

5. Number of replicate counts necessary

In addition to the ten instantaneous 50 x 20m counts, twenty further random transects of this size were surveyed using the standard two-observer technique described in 3 above. Combined with the 50 x 20m counts from 3 and 4 above this gave a total of forty counts of this size from which random subsets could be drawn to determine the most effective sample size.

Results

The results from the different count areas and techniques are presented in table 1. Taking the mean of the instantaneous 50 x 20m transects as the most accurate baseline, and referring to this density as 1.0, the other count groups gave relative density estimates between 0.6 and 1.03, as listed in the table.

All the transect counts gave relatively accurate estimates of *Plectropomus leopardus* density, but the hectare count method underestimated numbers considerably, recording only 60% of the baseline density. The standard two observer transect technique, as used on all the reefs surveyed to date (method 3 above), appeared to give a good estimate of actual trout numbers, indicati that the activity of the observer running out the tape did not noticeably attract or repel trout in the area to be counted.

There was a large variance evident for all count groups, with the standard deviation ranging from 36-93% of the mean. Increasing the number of replicates did not reduce this variance; it appears to result from the clumped distribution of *Plectropomus* leopardus (Goeden, 1978; pers. obs.). Groups of 2-3 individuals were regularly seen together, and larger groups were often found associated with baitfish schools or some larger predator. As a result at least 10 replicates were needed to ensure that the mea is within ±20% of the grand mean of all 40 replicates, and 15 replicates to reduce the possible error to ±10%. In the field ten random replicates take approximately 2 hours underwater time for two observers (4 man-hours) and seems the most reasonable compromise between precision and increased field time (figure 3).

Discussion

Visual transects are frequently used to get quantitative estimates of reef fish density (Sale and Sharp, 1983; Brock, 1982). As Originally proposed by Brock (1954), and used by some workers since then (Russell, 1977), all fishes in the transect were counted, but most subsequent studies have restricted counting to a single species or a single family. The method has primarily been used to census populations of relatively small species, with a normal range of movement much smaller than the count area. It is logical that transect size should be varied depending on the size, abundance and range of movement of the species or group under consideration, but little mention has been made of this in the published discussions of this methodology (Sale, 1980; Sale and Sharp, 1983; Brock, 1982).

Although Plectropomus leopardus is a large piscivore that can move considerable distances within a reef, and has been shown to be capable of movement between reefs, it is normally rlatively sedentary, at least over the time scale required for running a count transect. Goeden (1978) followed individuals of different age classes and measured mean area searched, and the shape of this area, over a mean time period of 24 min. Converting these figures to mean search area per 10min - the time taken for two observers to complete a 50 x 20m transect count - indicates that at this time scale most sizes of P. leopardus moved within an area much smaller than the 50 x 20m of the transect (figure 4). This suggests that the 50 x 20m transect is a suitable size in relation to the short term movement patterns of P. leopardus, especially as a large percentage of most populations of this species are under three years of age (see length frequencies in reports to GBRMPA by A.M. Ayling, April 1983, June 1983, Feb.1984; also growth data in Goeden, 1978).

The normal abundance range of a fish species also needs to be considered in any discussion of ideal transect size; rare species should be counted over a larger area than common species to minimise the number of low or zero estimates. For the 50 x 20m transects surveyed on mid-shelf reefs mean P. leopardus numbers ranged from 1.5 to 15.4, a reasonable scale of abundance

The biggest problem to be faced in obtaining accurate density estimates of a large opportunistic reef-dwelling piscivore such as P. leopardus is the clumped distribution of the individual fishes. Goeden (1978) found that in some areas between 25-45% of individuals of this species were associated in groups of 2-3, and another 15-20% in groups of 4 or more. Much larger groups are often seen, usually associated with some high-level feeding opportunity. Clumping at this scale has the effect of increasing the variance inherent in replicate 50 X 20m counts.

However, increasing the count area does not appear to solve this problem; high levels of variance were also a feature of the one hectare counts for P. leopardus. This probably reflects clumping at a higher level; the association of fish with different topographic features within a major reef region such as the back reef. High variance in numbers per unit area is probably a consequence of the biology and behaviour of large non-territorial reef fish, and not something that can be manipulated easily by changing sample size within the logistic limits.

Sale and Sharp (1983) use techniques developed from aerial surveys of large terrestrial animals using small planes to correct for a supposed bias in reef fish visual counts caused by increasing transect width. However, in aerial surveys using a plane the observer is of necessity limited to a set height on a line down the centre of the transect, whereas a diving observer can, and in most cases should, move to and fro in order to search all areas of the chosen transect with equal care. This is especially true for species such as _P. leopardus_ that are sometimes associated with shelter sites such as _Acropora_ sites (Goeden, 1978); possible shelter sites in the transect must be searched as the area is counted. No relationship between transect width and density estimate of the type proposed by Sale and Sharp (1983) is evident in the results from the two widths of count used in this study.

The different sizes of counts used here do show, however, that if too large a count area is chosen, or the area is insufficiently delineated, then bias is introduced because the area can not be searched accurately. In this case, 40% of the fishes detected with 50 x 20m transects were missed in one hectare counts made on the same section of reef.

Other sources of bias in making visual fish counts may result from the behaviour of the species being surveyed, but these sources can usually be minimised by varying the count technique. For instance, fish that are repelled by the observer are most accurately counted with an instantaneous technique (method #4 above) where delineation of the transect and counting take place simultaneously. The same technique can also be used for species such as many wrasses that are attracted to the observer.

Perhaps the most important potential source of bias in visual fish counts is observer experience. For any comparative work the same observer(s) should be used for the entire program to minimise the effects of this bias. Extensive training should be undertaken by inexperienced observers, or by observers counting species not previously studied, before data is collected.

Visual censuses are the only reliable method for obtaining replicate estimates of fish density from a given area without destructive sampling. As has been pointed out, and as this work reiterates, they may be subject to possible bias from a variety of sources. However, proper choice of transect size and count technique to suit the fish species or group under consideration, and adequate training of the observers, can reduce these biases to a minimum.

References

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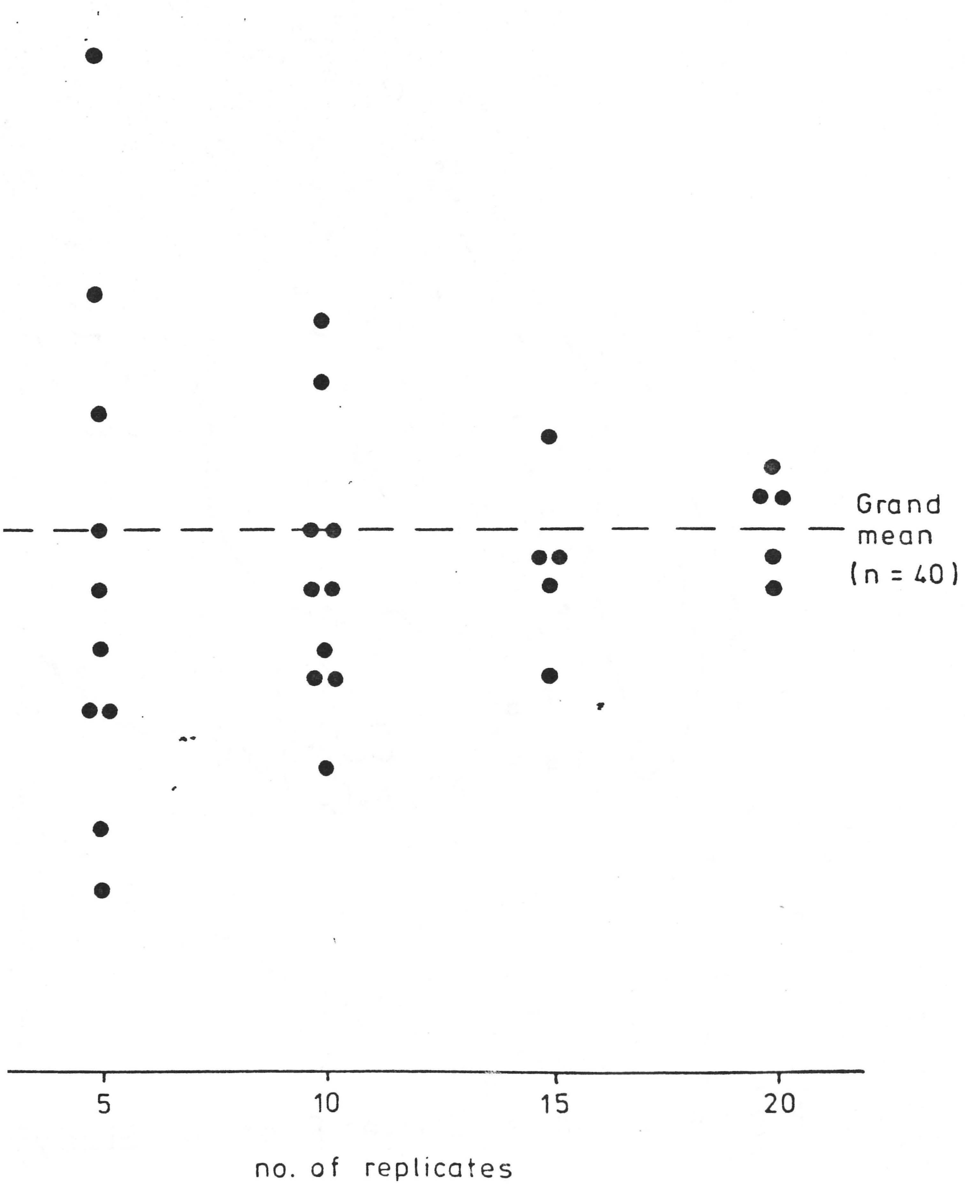
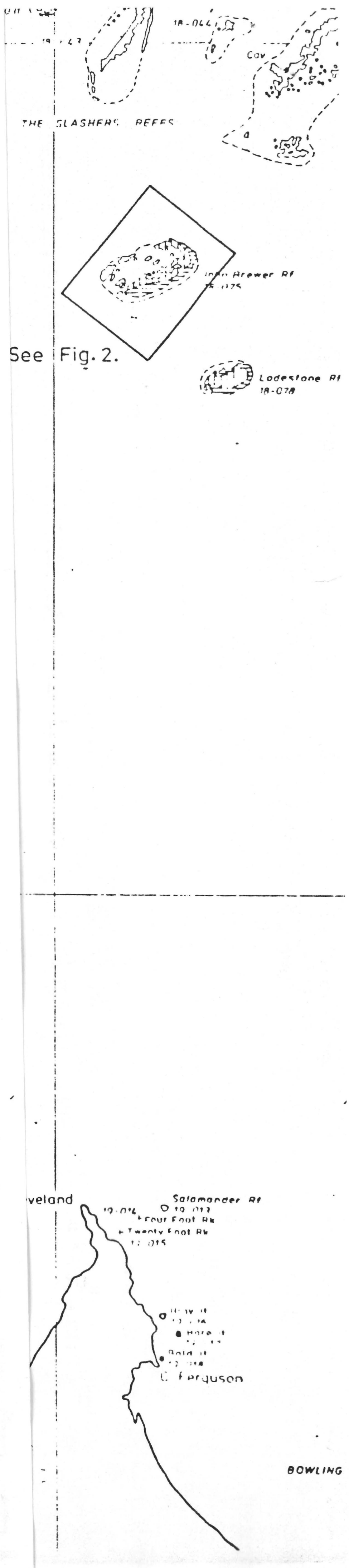
Table 1. Plectropomus leopardus density - results using different count areas and techniques

All counts made on the same 1.5km section of back reef at John Brewer Reef.

Count Area	Replicates										Mean ± sd	Mean per ha	Relative density
50 x 20m instantaneous (baseline)	5	4	7	4	4	4	1	5	1	5	4.0 ± 1.8	40	1.00
50 x 20m group 1	5	7	2	5	5	1	1	2	5	5	3.8 ± 2.1	38	0.95
50 x 20m group 2	5	5	5	6	1	4	10	2	0	2	4.0 ± 2.9	40	1.00
50 x 20m group 3	2	2	2	6	3	8	2	3	3	2	3.3 ± 2.1	33	0.83
60 x 20m	2	2	4	7	3	8	5	3	4	2	4.0 ± 2.1	33	0.83
75 x 20m	3	3	6	8	5	9	6	7	5	4	5.6 ± 2.0	37	0.93
50 x 10m	1	2	0	1	1	5	1	2	1	1	1.5 ± 1.4	30	0.75
60 x 10m	1	2	2	2	1	5	4	2	1	1	2.1 ± 1.4	35	0.88
75 x 10m	2	3	3	2	2	5	5	4	2	3	3.1 ± 1.2	41	1.03
150 x 67m hectare	24	35	23	28	10	(5 only)					24 ± 9.1	24	0.60

3. P. leopardus density : means of random groups of replicates drawn from 40 50 x 20 m counts





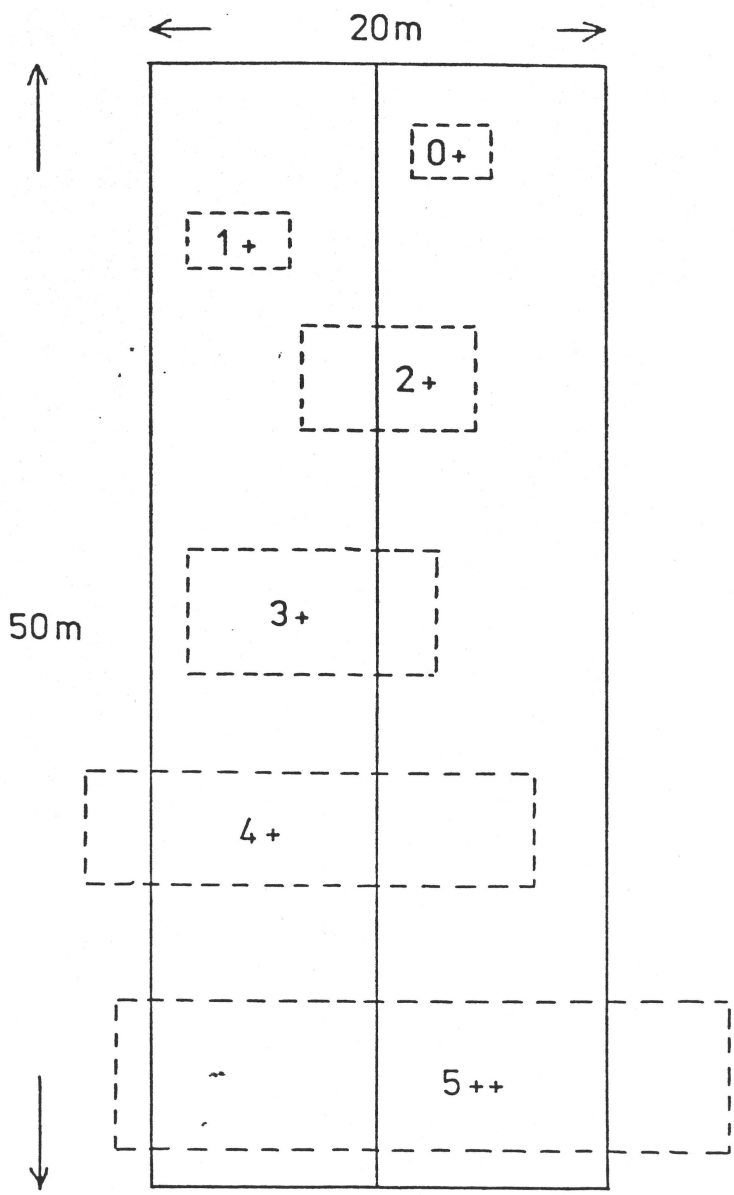


Figure 4. Ten minute search areas for different age class (0+ - 5++) *P. leopardus*, compared with 50 x 20 m transect area (data from Goeden 1978)