Minimum Breeding Population Of Bearded Tits *(Panurus biarmicus)* On The Tay Reedbeds In 2000: An Analysis Of Tay Ringing Group Mark-Recapture Data.

Dr Will J. Peach. Conservation Science Dept. RSPB, The Lodge Sandy, Beds. SG19 2DL

Summary

Closed mark-recapture population models were applied to summer mist-netting data for Bearded Tits *Panurus biarmicus* captured at four sites along the Tay reedbeds in 2000 by the Tay Ringing Group. Analyses were based on capture-recaptures of 100 individual adult Bearded Tits during the months May-August, and assumed a closed adult population during this period. Between-site movements indicated that this was a reasonable assumption up until mid-July, and the analyses allowed for the few late summer movements. The adult Bearded Tit population at these four sites was estimated to be **190 individuals** (95% confidence limits of **148-271 individuals**). Information was also provided on adult sex ratio and breeding condition, local productivity (ratio of adults to young) and local movements.

Introduction

Bearded Tits were first sighted in the Tay reedbeds in 1992 when 3 juveniles were observed at Seaside Dyke by M Nicoll (Moyes & Moyes 2001). Since then efforts to adequately monitor the size of the local population have been hindered by the large size of the reedbed, and the lack of experienced census workers, and views have differed considerably as to the true size of the Tay reedbeds population. In 2000, members of the Tay Ringing Group (TRG) undertook regular summer mist-netting at four sites with the aim of using mark-recapture population models to estimate local population size. This report presents an analysis of the TRG data collected in 2000.

Methods

Data collection and analysis

Bearded Tits were captured in mist nets at four sites along the Tay reedbeds (Moyes & Moyes 2001). The four sites all lie along a 5km stretch of the northern bank of the river between Errol and Kingoodie. Although catching effort was standardised on each visit (84m of net for 5.5 hours), for logistical reasons the numbers of visits to each site varied (8 at Seaside Dyke, 12 at Kingston, 6 at Tay Lodge and 12 at Powgavie). The total number of adult Bearded Tits captured was sufficient for mark-recapture analyses to be carried out for three of the four study sites (Seaside Dyke, Kingston and Powgavie). Only four adult birds were trapped at Tay Lodge during May-August (fewer than expected birds nested in this area during 2000, Moyes and Moyes 2001) and this was not enough to allow mark-recapture analyses for this site.

Because rather few adult Bearded Tits were captured during some visits, adjacent catch samples were pooled across visits in order to provide adequate samples for analysis. The pooling was

conducted so as to provide roughly similar numbers of adult captures in each pooled set of visits and to minimise the loss of information about recaptures. The pooling was carried out as follows:

Site	Analysis Visits	Capture dates in 2000
Seaside Dyke:	Visit 1	1 May, 7 May
	Visit 2	20 May
	Visit 3	3 June
	Visit 4	17 June, 2 July
	Visit 5	30 July, 5 August
Kingston	Visit 1	6 May
	Visit 2	20 May
	Visit 3	5 June, 10 June
	Visit 4	18 June, 30 June
	Visit 5	8 July, 23 July
	Visit 6	5 August, 9 August
	Visit 7	12 August, 13 August
Powgavie	Visit 1	12 July
	Visit 2	20 July, 25 July
	Visit 3	5 August, 6 August, 7 August
	Visit 4	8 August, 12 August, 13 August, 27 August

It was originally intended that Seaside Dyke, Kingston and Tay Lodge would be the main three study sites, but unexpectedly few birds were found to be breeding at Tay Lodge. Although there were no May or June visits to Powgavie, there were still sufficient data from this site to allow mark-recapture estimates of population size to be calculated for that site.

Population size estimates were calculated for each of the three sites (Seaside Dyke, Kingston and Powgavie) by fitting a series of closed population models each allowing for different sources of heterogeneity in the data. The software package CAPTURE (White et al. 1982) was used for this analysis. The following models were fitted to the data from each of the three study sites:

Model Description

Mo	Equal catchability model (assumes all animals equally catchable on each visit)
Mh	Heterogeneity model (assumes each animal has its own capture probability)
Mb	Trap response model (allows for trap-shyness or trap-happiness after first capture)
Mbh	Combined heterogeneity & trap response model (allows for heterogeneity and trap response)
Mt	Time variation model (allows capture probability to differ between visits)

The CAPTURE software fits each of the above models and advises which model best describes the data being analysed. The heterogeneity model is believed to be particularly appropriate for many study species and two forms of this model are fitted by software CAPTURE: the standard 'jackknife' estimator and the Chao estimator (Chao 1988) which is more appropriate when capture rates of animals are low.

Were the sub-populations of Bearded Tits closed?

A key assumption of all these models is that the population is closed (i.e. no immigration or emigration) for the duration of the study. Software CAPTURE provides a test of the closure assumption, and for the Tay Bearded Tit data the assumption was upheld (P-values of the closure test: Seaside Dyke, P=0.19, Kingston, P=0.90, Powgavie, P=0.16). The closure test for the small Powgavie sample suggesting that some immigration/emigration may have been occurring at that site.

I investigated the closure issue further by examining movements of adult birds between the four catching sites. The four sites are located in a line along the northern bank of the Tay, the ordering (from SW to NE) and approximate distances between sites being: Tay Lodge - 1.5km - Seaside Dyke - 2.5km - Powgavie - <1 km - Kingston. There were no recorded movements between the main two catching sites of Seaside Dyke and Kingston, suggesting little mixing of birds between those two sites. Of the 12 recorded between-site movements (all recorded after 11 July), 11 involved the late summer netting at Powgavie (6 between Kingston and Powgavie (<1km), and 5 between Seaside Dyke and Powgavie (2.5km)) and 1 was between Tay Lodge and Seaside Dyke (1.5km). It may be that adult Bearded Tits become more mobile during late July and August, perhaps in response to the end of nesting.

An overall population size estimate covering the four capture sites (and allowing for between-site movements) was derived by combining the mark-recapture estimates for Seaside Dyke and Kingston (off-site recaptures were included in these analyses), with an estimate for Powgavie that excluded the 11 birds originally ringed at Kingston and Seaside Dyke. The 3 new birds trapped at Tay Lodge were added to this estimate to give an overall minimum population estimate for the 4 sites.

Results

For each of the three main capture sites, tests in software CAPTURE indicated that the most appropriate model was the equal catchability model (Mo), followed by the heterogeneity model (Mh). Population size estimates are presented for both of these models (see Table 1), but because the heterogeneity model makes fewer unrealistic assumptions about the behaviour of birds (i.e. in reality capture probabilities are likely to differ between individual birds (White et al. 1982)), I give more weight to the estimates from that model. In all models, capture probabilities were quite low (0.15 at Seaside Dyke, 0.10 at Kingston and 0.12 at Powgavie), and when this is the case estimates from the Chao heterogeneity model may be more reliable than the jackknife heterogeneity model (Rexstad & Burnham 1991).

With one minor exception, population size estimates for individual sites were very similar under different models, especially the two forms of the heterogeneity model (Table 1). The one exception was for Powgavie for which the Chao heterogeneity model failed to estimate population size (Table 1) (probably due the small sample size), and for this site the jackknife heterogeneity estimate is probably the most reliable. Taking the jackknife heterogeneity models as the most reliable, the best estimate of the combined population size for the four sites studied in 2000 is **190 individual adult bird**s (95% confidence limits: 148-271). Thus, we can be 95% certain that the true number of adult bearded tits at these four sites in 2000 lies between 148 and 271.

The relatively high population estimate (c. 190) compared to the numbers of birds captured (100), reflects a general pattern of new, previously un-captured adult birds continuing to be common in mist-net catches throughout the summer.

Table1: Population estimates for each of the four study sites. The most reliable estimates are highlighted in bold.

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Site	Nos. adults Trapped	Population estimates (SE) from best models:		[95% confidence limits]
		Mo	Mh (jackknife)	Mh (Chao)

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Site	Nos. adults Trapped	Mo	Mh (jackknife)	Mh (Chao)
Seaside Dyke	38	71 (14.9) [54-114]	**68 (10.4)** **[54-95]**	66 (14.7) [49-111]
Kingston	46	80 (13.4) [62-117]	**88 (13.8)** **[69-124]**	86 (19.5) [63-144]
Powgavie (excluding birds trapped at other sites)	13	36 (20.4) [19-115]	**31 (6.7**) **[22-49]**	13 (0.0) [13-13]
Tay Lodge (only three birds not trapped at other sites)	3	3	3	3

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| Grand Total (allowing for between site movements) | 100 | 190 [138-349] | **190** **[148-271]** | 168 [128-271] |

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Discussion

The ringing studies carried out in 2000 have clearly demonstrated the importance of the Tay reedbeds as a breeding site for Bearded Tits. One hundred adult birds were captured at just four sites, and mark-recapture models indicate that approximately 190 individual adults (minimum 148) were probably present within those four netting areas during May-August 2000.

Although the relatively small sizes of the catches caused the population estimates to be rather imprecise (wide confidence limits), the conclusions are still biologically useful. There is no reason to suppose that the mark-recapture analyses may have overestimated population size; on the contrary, both common sources of bias (heterogeneity and trap shyness) cause population size to be underestimated. Thus, our estimate of 190 adult Bearded Tits for the four study sites is probably reliable and should probably be considered as a minimum estimate.

Considering that the UK population of Bearded Tits was estimated at 339-408 pairs in 1992 (Campbell et al. 1996), the probable importance of the Tay reedbeds is immediately obvious. Given that the sex ratio of the caught samples was roughly 50:50 (Moyes & Moyes 2001), a population estimate of 190 adults probably equates to approximately 95 pairs in 2000.

The future monitoring of the Bearded Tit population of the Tay reedbeds requires careful consideration. The 2000 ringing study has clearly demonstrated the importance of the area for this species and has conclusively shown that an estimated 190 adults (and *at least* 148 adults)

were present at just four sites. If birds bred at other sites, the total population will obviously be higher. As well as allowing population size to be estimated, ringing studies also provide information on a range of other important biological parameters including:

- an index of annual breeding success (the ratio of adults: young in the catches)
- annual survival rates of adults and young (from between-year recaptures)
- confirmatory evidence of breeding (brood patches and cloacal protuberances)
- information on movements (from retraps/resightings)
- information on moult and, potentially, diet (from faecal samples)

Ringing studies on the Tay reedbed would also provide valuable comparative information to that being gathered in John Wilson's long-term study at Leighton Moss, Lancashire.

The other way to monitor Bearded Tits on the Tay reedbeds would be to carry out systematic censuses during the breeding season. However, Bearded Tits are notoriously difficult to census as they do not sing and their reedbed habitat is often impenetrable (Gilbert et al. 1998). Ideally, observations should be made from elevated positions above the reedbed (often difficult in practice). A census-based approach would require at least three visits (and preferably six) between mid-April and late May. Areas where birds are regularly seen should be targeted for additional detailed census observations to map confirmed and probable nest sites. This detailed additional work might require about 1 hour of observation for an area of about 200m x 200m (Gilbert et al. 1998).

One possible scenario for the future might be to continue detailed monitoring using ringing studies at a few key sites, with a more extensive 'quick-and-dirty' census method which might aim to locate and roughly quantify other breeding groups of Bearded Tits. From a methodological perspective, it would also be interesting to carry out census work on the same sites as intensive ringing studies. The RSPB is planning such a comparative study at Leighton Moss in 2001 (John Wilson, pers. comm.).

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