

Assessment of two methods for estimating Little Bittern *Ixobrychus minutus* populations in fluvial habitats in Central Spain

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Two techniques for estimating the relative abundance and density of Little Bitterns *Ixobrychus minutus* were compared for three stretches of the river Tormes (Salamanca, central Spain). Transects consisted of counting the number of breeding individuals detected when walking at 1 km/h along the river bank, whereas during the point-station methodology bird behaviour was recorded and territories mapped for 30 minutes every 250 meters of riverbank. Estimations of relative abundance expressed in terms of the number of pairs/hour sampling effort were 29% higher for the point-stations than for the transects, highlighting the greater efficiency of the point-stations. Due to differences in the sampling effort, the point-station method detected 2-3 times more territories than the transects, thereby indicating that the standardised sampling efforts (1 km/h) used in the transects seriously underestimated the total number of breeding pairs. The point-station method could play in the future an important role in Little Bittern studies, although further analysis of its performance is still required.

Key words: Little Bittern, *Ixobrychus minutus*, ardeidae, density, survey methods, Central Spain.

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The Little Bittern *Ixobrychus minutus* is widely distributed throughout the world, but has undergone a generalised decline in recent decades in Europe that has, nevertheless, been followed by a slow recovery in recent years (Kushlan & Hafner 2000, Barbier 2006). Although traditionally it is thought that large breeding populations are concentrated in estuarine habitats (Kushlan & Hafner 2000, Barbier 2006), the density of the species along rivers remains poorly known.

Population size is an important issue in conservation ecology, but due to its cryptic coloration, habits and small population size, estimating the population size of this species is time-consuming and complex when using traditional bird-census methods (Swift *et al.* 1988, Fouces & Estrada 1992, Morin & Bommé 2006). Thus, species-specific and also site-species-spe-

cific sampling procedures have been widely used to census bittern populations. Shimada *et al.* (2001) used both point and transect estimations for evaluating density changes in lake habitats, but did not examine their effectiveness. In the Florida Everglades, Frederick *et al.* (1990) recorded Least Bitterns *Ixobrychus exilis* by means of airboat transects, which would seem to lead to potentially serious disturbance to breeding birds and would not be applicable in freshwater continental habitats. Another potential method for census work with this species involves sound recordings, which seem to generate reliable data in marshlands (Swift *et al.* 1988, Fouces & Estrada 1992, Gibbs & Melvin 1993, Morin & Bommé 2006).

In this work, we compare the performance of a station-based technique and a method using transects along river banks.

Material and methods

Study area

The study was conducted along three stretches of the river Tormes (province of Salamanca, central Spain) near the towns of Salamanca and Ledesma. Both study sites lie on characteristic stretches of the river's floodplain where the river is wide (> 60 m) and there are high nutrient levels that permit the growth of riparian forests composed of poplars (*Populus* spp.) and willows (*Salix* spp.) with a variable degree of shrub cover. In places the riparian forest has been cut down. Helophytic vegetation (reeds *Phragmites australis*, bulrushes *Typha* spp. and bur-reeds *Sparganium erectum*) has colonized large areas and covers about > 10% of the water surface.

The river Tormes in Salamanca was divided into two independent stretches, one 7-km long (Sala1) and the other 4-km long (Sala2), as per García & Hernández (2007). Both sites were sampled in 2005 and 2006 (referred to as Sala1-05, Sala1-06, Sala2-05 and Sala2-06). At Ledesma, a stretch of river of nearly 4 km was surveyed in 2006 for purposes of comparison (Led-06).

Abundance estimation and comparisons between methods

Two different methods were assessed during the study period: Transects are usually employed for getting data regarding bird densities (e.g. Bibby *et al.* 2000). Applied to aquatic species, they are conducted by walking an estimated distance along river banks counting all the species located, and then the results are standardised as the number of birds per kilometre (KAI index) and per the time-sampling effort. The stretches studied were walked at about 1 km/hour and all birds seen or heard were recorded. Each of the transects described above (that is, Sala1-05, Sala1-06, Sala2-05, Sala2-06 and Led-06) were sampled three times a year. Because the results of the three samples were fairly similar, the estimation of abundance used during the analysis was taken as the mean obtained from the three replications. Only breeding Little Bitterns were counted during the transects and evidence of breeding was assessed as in the European bird breeding atlas.

Point-territory estimations consist of a series of 30-minute observation periods performed

at sampling stations with good views over the river every 250 meters along the river bank (García & Hernández 2007). The specified distance between stations depended on where the riparian vegetation allowed a reasonable surface area of the river (> 1 ha.) to be monitored. During the observation periods all records of the Little Bitterns were plotted on an aerial photograph of the site and behaviour was noted (including both direct observations and singing males; Bibby *et al.* 2000). The minimum number of territories present was then evaluated from the spatial data following Bibby *et al.* (2000). Roughly, this consists of estimating the minimum number of occupied territories on the basis of territorial behaviour and the distance between territorial birds (e.g. if two males were observed at the same time, then two territories were counted). Only those pairs for which breeding was confirmed were considered (using the criteria of Hagemeyer & Blair 1997); the population estimation derived from this method was the sum of all the definite territories detected. Given that territory mapping is relatively time-consuming, replicates cannot be obtained during fieldwork. Both techniques were carried out by the same person and each stretch was sampled at least three times each year.

These techniques provide values of relative abundance that are dependent on sampling effort and also give an approximation of the minimum numbers of breeding Little Bitterns. These two indexes cannot be directly compared, although an estimation of the minimum number of territories detected by each method could be evaluated given that it is likely that this value approximates closely to the real number of Little Bitterns.

To assess the effectiveness of the two methods, an index was obtained by dividing the relative estimations of abundance (both in terms of no. pairs/km and no. pairs/hours) obtained from point-map sampling and those calculated from the transects. Hence, a value close to one would signify that both methods were equally suitable.

Results

Transects provided lower estimates than the point technique for both the relative abundance and the minimum number of breeding pairs (Table

Table 1. Results of the Little Bittern surveys using transects and territory mapping at the study sites for both relative abundance (no. pairs detected/hour and no. pairs detected/km) and the overall estimation of the no. of pairs along each stretch of river. For the relative abundance indexes the mean is shown at the bottom of the table; the population estimation corresponds to the sum of the total number of pairs detected.

*Note that the sampling effort required for 1 km of river bank using the station methodology is twice the effort needed for the transects.

Resultats del seguiment del Martinet Menut utilitzant transectes i mapeig de territoris als llocs d'estudi pel que fa a abundància relativa (nombre de parelles detectades/hora i nombre de parelles detectades/km) i estima del nombre de parelles en cada tram. Per als índex d'abundància relativa es mostra la mitjana al final de cada taula, mentre que l'estima de la població és la suma del nombre total de parelles detectades.

* Noteu que l'esforç necessari per mostrejar 1 km amb el mètode de les estacions de mostreig és doble que per als transectes.

	Pairs/hour		Pairs/km*		Estimated no. pairs	
	Transect	Station	Transect	Station	Transect	Station
Sal1-05	0.25	0.43	0.50	1.5	2	6
Sal1-06	0.67	0.70	0.58	2.33	4	7
Sal2-05	0.40	0.50	1.00	1.75	4	7
Sal2-06	0.50	0.63	0.60	1.67	3	5
Led-06	0.33	0.50	0.50	1.00	2	4
Mean/Overall	0.43	0.55	0.64	1.65	15	29

1). Of the two different sampling efforts used in this work, point sampling provides higher estimations of abundance than transects, averaging 2.89 ± 0.87 times higher for the no. pairs detected/kilometre surveyed (Table 2). Extreme values were recorded from Sala1-06, where the abundances estimated from point sampling were four times larger than those from the transects. However, when the sampling effort was taken into account, the number of breeding pairs detected per hour of sampling effort for the two methods was much closer (1.23 ± 0.18 ; Table 2).

Table 2. Comparison of the performance of the two techniques calculated by dividing the estimations derived from the station methodology by those from the transects.

* Note that the sampling effort required for 1 km of river bank using the station methodology is twice the effort needed for the transects.

Comparació del resultat de les tècniques mesurat com la divisió entre l'estima del mètode de les estacions per l'estima obtinguda amb els transectes.

* Noteu que l'esforç necessari per mostrejar 1 km amb el mètode de les estacions de mostreig és doble que per als transectes.

	Pairs/hour*obs Station/Transect	Pairs/km*obs Station/Transect
Sal1-05	1.72	3.00
Sal1-06	1.04	4.02
Sal2-05	1.25	1.75
Sal2-06	0.64	2.78
Led-06	1.52	2.00
Mean ± variance	1.23 ± 0.18	2.89 ± 0.87

Discussion

Territory mapping detected 2-3 times more breeding pairs than transects (Tables 1 and 2). Therefore, it would seem that territory mapping is a better tool for estimating the minimum number of breeding Little Bitterns present along a given river. Differences in the effectiveness of methods used at different localities are hard to interpret, although it is likely that whenever there is a higher density (see the results shown in Table 1) some birds will not be counted as a different from a nearby bird.

Transects have been widely used to calculate for a given area the minimum abundance of aquatic birds such as the Little Bittern (e.g. Blanco & Velasco 1997, Bibby *et al.* 2000, Barbier 2006). The methodology used in this study is standardised (1 km/hour) and seems to suggest that previous transect-based works have underestimated minimum population sizes by a factor of two to three.

Indeed, another source of bias exists since in transect sampling the confirmation of reproduction is not allowed for; it is hard to estimate which birds are breeding and which are migrants given that Little Bitterns in the Iberian peninsula migrate over a broad period of time that overlaps with the breeding period (García & Hernández 2007; own data). Moreover, the technique of territory mapping gives a more robust estimation of population size and avoids

problems derived from migration patterns. As well, transect sampling cannot ensure that animals are not counted twice; territory mapping, on the other hand, reduces the chances of this occurring.

We suggest that work on this species should consider the use of point estimations with territory mapping for obtaining suitable estimations of Little Bittern populations. Furthermore, we believe it is important to test the performance of the station-based method at several other sites located throughout the species' whole range.

Resum

Avaluació de dos mètodes per a l'estima de poblacions de Martinet Menut *Ixobrychus minutus* en rius del centre d'Espanya

S'ha realitzat una comparació de l'efectivitat de dues tècniques per estimar l'abundància relativa i la densitat del Martinet Menut en tres trams del riu Tormes (Salamanca, Espanya central). Els transectes consistien en comptar el nombre d'ocells reproductors a una velocitat de 1 km/h al llarg del riu. En les estacions de mostreig es va registrar el comportament dels ocells i es van mapar els seus territoris cada 250 metres durant 30 minuts. Les estimes d'abundància relativa, expressades como a nombre de parelles/hora d'esforç de mostreig, van ser un 29% superiors per a les estacions de mostreig que per als transectes, evidenciant la major efectivitat de les estacions. A causa de les diferències en l'esforç de mostreig, el mètode de les estacions va detectar 2-3 vegades més territoris que els transectes, mostrant que els transectes amb un esforç estàndard de mostreig (1 km/h) infraestimen notablement el nombre absolut de parelles reproductores. El mètode d'estacions pot jugar un paper important en treballs sobre el Martinet Menut, encara que són necessaris més estudis sobre la seva eficiència.

Resumen

Evaluación de dos métodos para la estima de poblaciones de Avetorillo Común (*Ixobrychus minutus*) en ríos del centro de España

Se ha realizado una comparación de la efectividad de dos técnicas para estimar la abundancia relativa y la densidad del Avetorillo Común en tres tramos del río Tormes (Salamanca, España central). Los transectos consistían en contar el número de aves

reproductoras a una velocidad de 1 km/h a lo largo del río. En las estaciones de muestreo se registró el comportamiento de las aves y se mapearon sus territorios cada 250 metros durante 30 minutos. Las estimaciones de abundancia relativa, expresadas como número de parejas/hora de esfuerzo de muestreo, fueron un 29% superiores para las estaciones de muestreo que para los transectos, poniendo de relieve la mayor efectividad de las estaciones. Debido a las diferencias en el esfuerzo de muestreo, el método de las estaciones detectó 2-3 veces más territorios que los transectos, mostrando que los transectos con un esfuerzo estándar de muestreo (1 km/h) infraestiman notablemente el número absoluto de parejas reproductoras. El método de estaciones puede jugar un papel importante en trabajos sobre el Avetorillo Común, aunque son necesarios más estudios sobre su eficiencia.

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