

The population of Bittern *Botaurus stellaris* in the Diaccia Botrona marsh, Central Italy: four years of census (1991-94)

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Abstract - The Bittern population of a marshland in Central Italy was censused using a network of listening stations. This technique appears to be sufficient to quantify the population being examined, but does not allow an accurate analysis of the positions of the booming males.

The data in the literature, dating from 1974, indicate that the population studied had a progressive increase up to the early 1990s (from 0-1 to 14-18 males) and then a phase of decline (with 7-9 in 1994). These variations seem mainly due to the changes in the marsh vegetation. This was positive at first, thinning out the reedbeds, then negative with their progressive reduction.

However, the role of primary importance of the studied population in Italy has been confirmed.

Introduction

In many parts of their natural West European range, the local breeding populations of the Bittern are at present in decline, mainly as a consequence of the reclamation of wet areas (Day 1981). The same is true for the scattered Italian populations, even if in some areas the situation is little known and if in general the available information does not derive from specific investigations (Brichetti 1992). From the descriptive picture known so far, the most important Italian breeding population of Bittern appeared to be that of the Diaccia Botrona marsh. Nevertheless, no research had been carried out previously with specific techniques to establish the characteristic features of its presence, if we exclude a preliminary investigation on the occurrence of the species in Tuscany (Romè 1982) or some papers referring generically to the avifauna of this marshland area (Di Carlo and Heinze 1975, Allavena 1976, Romè et al. 1981, Romè and Travison 1982).

This work presents the particular techniques used and the results obtained during four years of census of the population of Diaccia Botrona, along with a discussion on the reasons that have probably caused the numerical variations observed. This is a part of a wider research project, aimed at investigating the status and consistency of the Bittern in the marshland areas of Tuscany and at determining its environmental preferences.

Methods

Study site

The Diaccia Botrona marshland extends east of Castiglione della Pescaia (Province of Grosseto, Central Italy: 42°47' N - 10°55' E) covering an area of about 800 ha, just behind the coastal dunes (Figure 1). It consists of two basins (Diaccia and Botrona), which are witness to its origin as an overflow basin, separated by a canal (Collettore canal) that communicates more or less directly with the sea. Covered until several years ago by beds of *Phragmites australis* and other freshwater phytocenosis characterized by *Nymphaea alba* and *Iris pseudachorus* (Bicchi 1983), over the years it has greatly changed its vegetation structure due to massive penetration of marine water. These changes have consisted in the reduction of reedbeds, in the extension of phytocenosis in which *Bolboschoenus maritimus* and *Juncus* spp. prevail, and those constituted by *Arthrocnemum fruticosum* and *Halimione portulacoides*, limited at one time to the areas more directly connected to the final stretch of the Collettore canal. The beds of *Phragmites* at present are irregularly scattered and developed in beds of less than a meter in height. The most dramatic effect, however, has been that on the extensions of open water, which, no longer limited to a few ponds, now cover wide

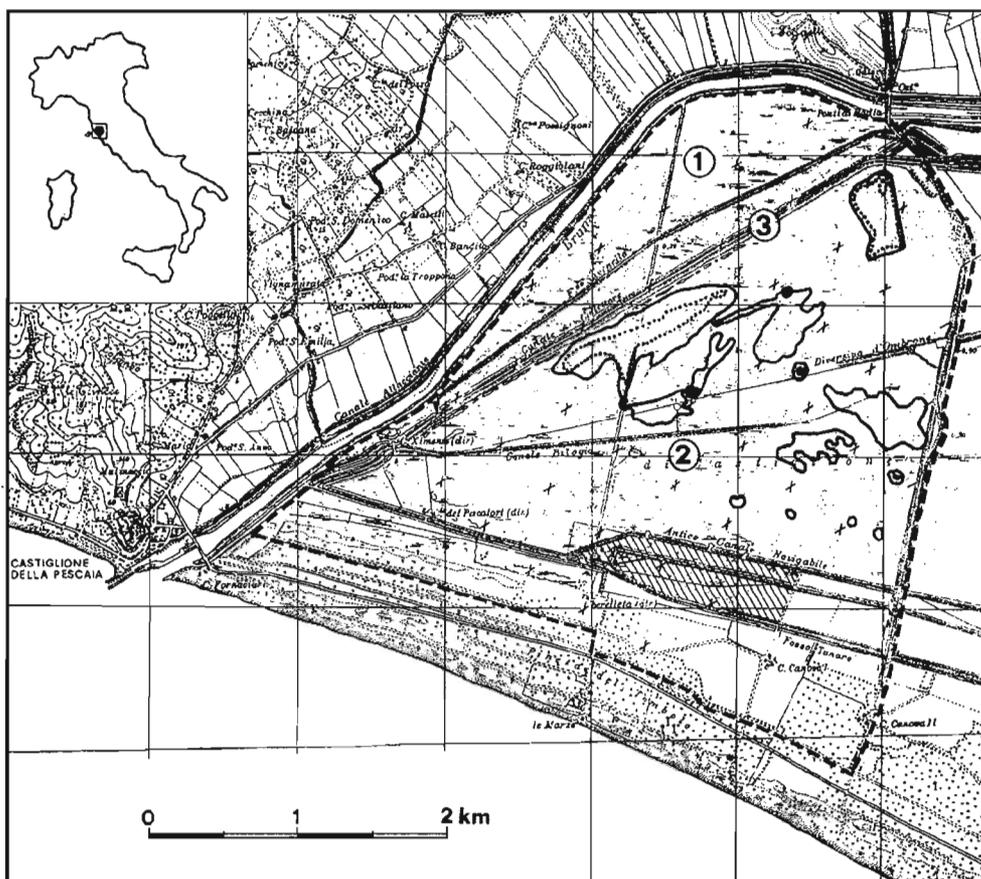


Figure 1 - Map showing the study area. The symbol 1 indicates the Botrona basin, that is separated from the Diaccia basin (2) by the Collettore canal (3). The shaded part indicates a fish farming area. The extension of the flooded areas is also indicated: black dots show the ponds present in 1985; the dotted lines encompass the flooded areas in 1990, while the continuous lines those flooded in 1992 (1985 and 1990 from aerial photographs by Military Geographical Institute; 1992 from personal aerial survey).

areas. These changes are much more noticeable in the Daccia basin with respect to the Botrona basin, because of its direct connection with the Collettore canal itself and with some fish farms, which use large bodies of marine water.

Census technique

The Bittern population was censused checking the booming males. Due to the impossibility of aurally distinguishing individual birds grouped together in the middle of the marshland from the margins of the area, a network of listening stations was set up which extended throughout the area occupied by the species, identified with previous sightings. The links of the network were of 500 m and the sectors identified rhomboidal because they were established on the basis of the orientation of the canals crossing the marshland (see Figure 2). Each sector has a surface area of about 20 ha. Four observers moved synchronously between the stations, tagged in the field with coloured flags,

following routes that allowed sufficient overlapping of the listening zones so as to be as precise as possible in the identification of the position of the booming males (boomers). The censuses were repeated at least three times a season, in accordance with Bibby et al. (1992), each time covering the same surface area. Except for one occasion, when an afternoon time was experimented, the censuses were carried out in the morning. In particular: in 1991 and 1992, as it was not possible to annotate the data relative to all the contacts in moments of maximum booming activity, the census was started an hour after dawn; because of a lowering in the booming rate, in order to record a sufficient number of contacts, the listening period had to be extended to dawn during the season 1993 and before the dawn during 1994 (see Figure 3). Night surveys were also carried out although they were partial due to obvious problems of a practical nature. Each listening period lasted 30 minutes (15 during the night censuses). For every contact there was registration of

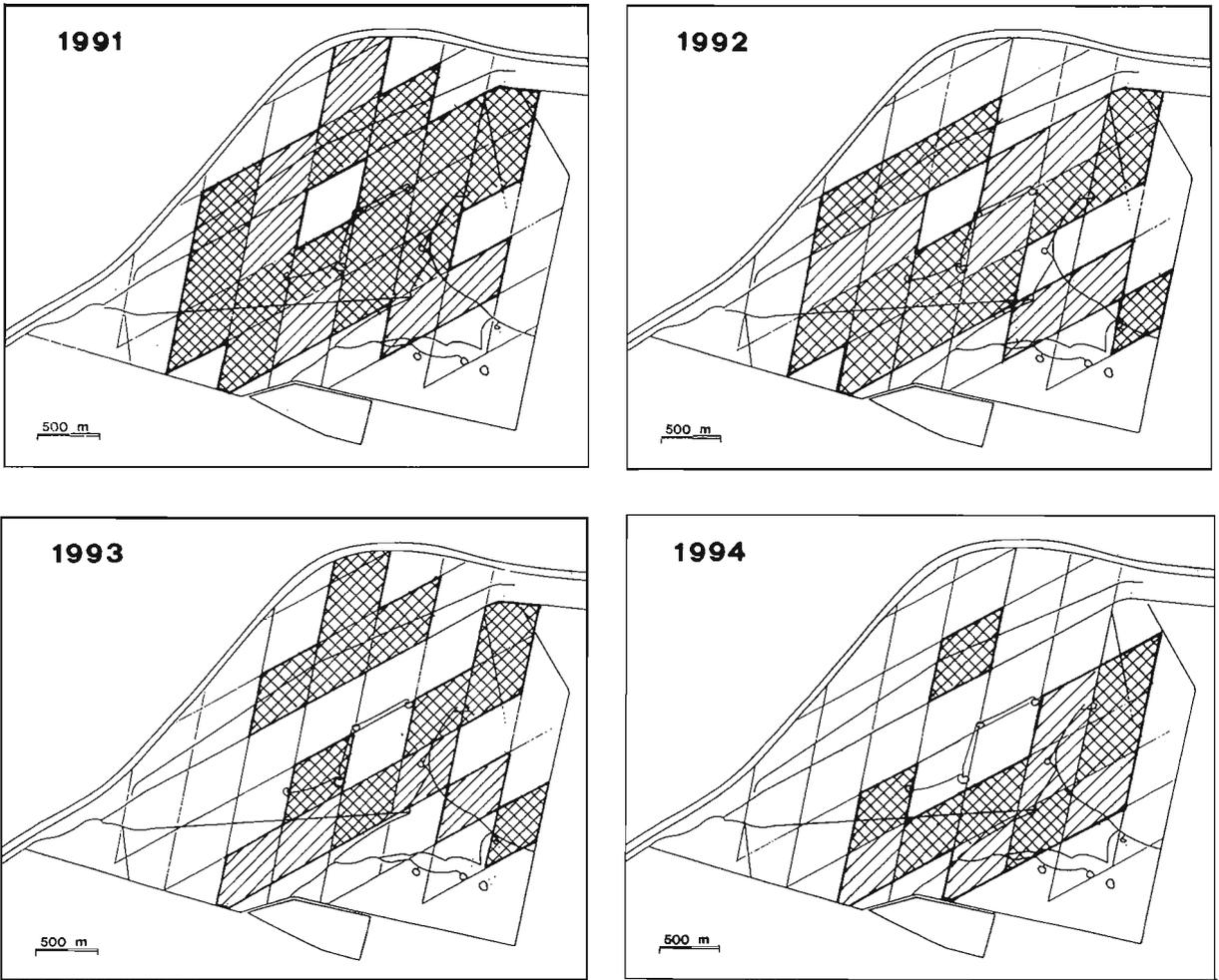


Figure 2: Area occupied by booming Bitterns; double dashed line = constant presence; single dashed line = sectors probably occupied or occupied in different days by the same individual (see text).

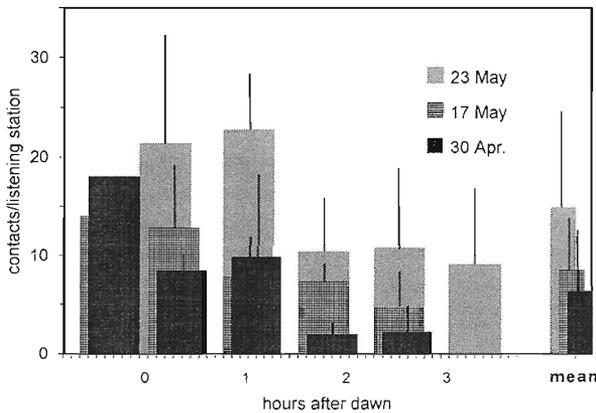


Figure 3: Booming activity in the three census days of 1994; mean number of contacts per listening station at the same time and global mean. The histograms without standard error are based on data of a single observer.

the time, number of booms (component elements of the call), the estimated sector of origin and their intensity. This last parameter was assessed according to three decreasing empirical classes: class 1, boomer certainly at less than 500 m; class 3, boomer certainly at more than 500 m; class 2, boomer at a middle-distance. The data were accompanied by the description of any particular features of the emission, for which a standard code was used during the research.

We avoided stimulating the call emission of the Bitterns by means of recordings in order to keep the disturbance limited merely to the presence of the observers. Table 1 describes the census effort.

The data collected by each research worker were arranged chronologically in a list; then, for each sampling the estimated positions of the boomers were

Table 1. Census effort.

Census date	Minutes of listening (number of contacts)		
	day	night	total
1991 March 19, April 9, May 8 and 29	1860 (322)	45 (33)	1905 (355)
1992 April 13, 14 and 15	1920 (368)	240 (112)	2160 (480)
1993 April 25, May 22 and 23	1590 (177)	60 (44)	1650 (221)
1994 April 30, May 17 and 23	1650 (506)	75 (34)	1725 (540)
Total			7440 (1596)

indicated on a map, indicating for each individual the degree of certainty deriving from the number of observers that had heard it, from the intensity and from the number of contacts for that individual. The information obtained in this way was then summarised on an annual map, taking into account the degree of certainty in the single listening sample and its constancy between the various samplings: adjoining sectors occupied alternatively in successive censuses were considered to be occupied by the same boomer. We considered as territorial the individuals heard at least on three surveys; uncertain those heard only one or two times, or in more surveys but at a low intensity or a very limited number of times per survey.

Regarding the distribution of territorial males relative only to the sector in which they were checked and not to the whole marshland area, the ratio between the minimum occupied area and the minimum number of territorial males was referred to as Maximum Density; and Minimum Density as the ratio between the maximum occupied area and the minimum number of territorial males.

Results

The number of boomers sampled was 14 (max 18) in 1991, 10 (12) in 1992, 8 (10) in 1993 and 7 (9) in 1994. Figure 2 shows the sectors occupied by the territorial males in the research period. The areas occupied by Bitterns turned out to be those where the reedbeds grow in better conditions (although they are scattered and not so high as usual) and are often associated with *Bolboschoenus maritimus* and *Juncus* spp. Table 2 shows the relative densities registered in the four years, expressed as number of hectares per territorial individual. It is worth noting that there were adjoining sectors occupied alternatively in 1992 (two cases) and 1993 (one case). In 1993 this was probably determined by a shift of the booming male towards still flooded areas, after the previously occupied area had dried up due to drought conditions.

Table 2. Relative densities in the four years (hectares/individual).

	1991	1992	1993	1994
Maximum density	22.8	26.0	22.5	20.0
Minimum density	31.4	34.0	35.0	26.7

During the four years no certain evidence of nesting was found, nor were there useful indications as to the total population, which, due to the sometimes polygynic habits of the Bittern, may not be proportional to the number of booming males.

Figure 3 gives an example of the rhythms of booming activity of the population, expressed as the average number of contacts per listening station in different hours, during the three census days of 1994. Whilst the general daily trends appear to be essentially similar with a noteworthy decrease in the number of emissions in the hours following dawn, it is worth noting the greater activity found on May 23, practically double that of the two previous census days.

Discussion

The techniques described produced the above results in a relatively limited amount of time, but required the contemporary presence of four observers. In environmental situations different from those actually experienced (e.g. presence of tight reedbeds or more extensive areas of deep water) such a regular network of listening points could not have been established and their would have had to be adapted to the hydrological or topographical features of the site. The present technique therefore is easily applicable only in areas with thin vegetation and shallow water.

The number of audible contacts in a given day seems to be variable, with the possibility of quite significant

differences from day to day. This phenomenon, at present little known, can evidently influence the efficiency of the censuses and consequently the estimated number of booming males present in a given area. Further research into the phenology of the booming activity is therefore necessary in order to improve this census technique. The variations in the number of contacts registered in different years (see Table 1) must therefore be generically ascribed both to differences in the booming activity and to variations in census period: in particular the increased number of contacts during 1994 must be due to the registration of the dawn peak. In our opinion, the census efficiency was not biased by the number of contacts because in order to localize a given specimen any number of contacts that is superior to five, result to be redundant. The results obtained can be considered sufficiently near to the real number of territorial males present, as the various observations of flight displays and that of a booming male, were carried out in sectors indicated by the census as occupied. However, it must be emphasised that with this method it is very difficult to precisely locate the boomers and that the presence of two territorial males in the same sector would be identifiable only if they sang almost at the same time or if they had easily distinguishable boomings.

The breeding population of Bittern in the Diaccia Botrona marsh has been confirmed as the most important in Italy, according to present knowledge of the distribution and consistency of the species (Brichetti 1992), even if other research has identified the increase of another Tuscan population at a similar level of importance (Puglisi and Cima, unpublished data).

In the light of present knowledge regarding the presence of the species in the Diaccia Botrona (Table 3), it seems that it was characterised by increasing numbers until the end of the 1980s and then entered a negative phase.

The Bittern populations are reported to show accentuated numerical chorological fluctuations: they are able to numerically compensate for and increase the number of individuals lost during particularly severe winters in the more northern areas of its range (Broberg 1986) or also occupy artificial and temporary wet areas (Bibby and Lunn 1982). In Great Britain, where the breeding populations are not

affected by the colder winters (Bibby 1981), the species is in clear numerical regression after the phase of expansion following recolonisation of the country (Day and Wilson 1978 in Voisin 1991), even though at present the Bittern occupies all the suitable areas (Bibby and Lunn 1982). In the absence of direct limiting factors (anthropic disturbance or persecution, climatic adversity), the main factor in determining the presence of the Bittern appears to be environmental physiognomy, the species being particularly eclectic and adaptable in terms of its prey (Brichetti 1992, Cramp and Simmons 1977, Gonzales et al. 1984, Loison 1991, Voisin 1991).

It is not possible to identify the factors determining the above mentioned fluctuations of the Bittern population because an accurate ecological analysis of the environmental variations that the Diaccia Botrona marshland has undergone is completely lacking. A description, although generic, of the evolution in the characteristics of this marshland is at present only possible through the analysis of the aerial photographs available in the Military Geographical Institute (the years 1954 1985 and 1990) and from what can be inferred from an unpublished report of the local Hunting Club (Federazione Cacciatori di Grosseto). According to this data, a thick and uninterrupted reedbed covered almost all the marsh until 1963 when, due to hunting activity, some ditches and ponds were opened. Beginning probably in the first years of the 1980s, due to the penetration of marine water, the vegetation underwent a progressive thinning out, which has continued exponentially with time, showing the most dramatic changes in the last three years. The increasing in the surface of the open waters have been underlined in Figure 1. A vegetation map relative to the year 1982 is reported in Bicchi (1983), while the situation relative to the year 1992 can be found in Di.S.C.A.U. (1993). We consider it likely that the hunting management and then the first phases of thinning out of the vegetation, made the area more attractive for the Bittern, creating extensive areas covered with vegetation dense enough to allow the birds to hunt without being seen. According to Voisin (1991) the species needs flooded beds of thick vegetation interrupted by swamps, ponds and ditches. However, preliminary elaboration of data taken in another Tuscan wetland seems to indicate that in the

Table 3. Estimated number of boomers present in the Diaccia Botrona marshland in the years indicated.

1974 ^a	1975 ^a	1976 ^b	1980 ^c	1981 ^d	1983 ^e	1991	1992	1993	1994
1	0	1-2	1-2	5	4-5	14-18	10-12	8-10	7-9

a: Di Carlo & Heinze, 1975; b Allavena, 1976; c: Romè & Trivison, 1982; d: Romè, 1982; e: Brichetti, 1992.

reproductive period the bird prefers to nest where the vegetation is not particularly thick, avoiding the densest beds (Puglisi and Cima, unpublished data). It is difficult to assess the impact of hunting. It is known that hunting activity also affects the presence of species which are not hunted (see Spagnesi et al. 1988), such as the Bittern, but it is necessary to point out that there was consolidation of the population being examined prior to the prohibition of hunting activity in 1989. It is likely that this was possible because there was hunting only three days a week from 13 fixed positions, leaving extensive areas of refuge, with limited periods of disturbance.

The present decline of the population is due to the changes in the vegetal associations and the increase in the extension of the open water areas. It is worth emphasising that this population has shown an adaptive capacity to environmental conditions which are apparently very unsuitable and which go against the selectivity generally attributed to the Bittern. It seems likely that this is due to the fact that the environmental modifications have occurred gradually and that the species is resident in the Diaccia Botrona. In fact, migratory Ardeidae associated, although in a different way, with the reedbeds, such as the Lesser Bittern *Ixobrychus minutus* and the Purple Heron *Ardea purpurea*, have not nested in the area for several years (Puglisi et al., in press). It should however be mentioned that in recent years Diaccia Botrona has been very little exploited by man, so offering calm conditions which are difficult to find in Italian wet areas. On the other hand, the above mentioned facts, together with nesting in apparently unusual environments (*Scirpus* beds: Hancock and Kushlan 1989) or of boomers in rice paddies (G. Alessandria, pers.com.) could simply denote a lack of understanding of the environmental preferences of the species.

Together with the decline in the population observed in the four years of study, there has been a reduction in the occupied surface area within the marshland, but, with the techniques used, relevant variations in relative density were not found. These, although they fall within the norm for the species (Cramp and Simmons 1977), are not indicative of the real home ranges of individuals. In fact, also within the sectors occupied there are areas which are unsuitable for the species (e.g. extensive pools of open water and carpets of *Arthrocnemum*). Furthermore, outside of the breeding season feeding individuals are found almost throughout the marsh. During nesting, perhaps because of their more elusive behaviour in this period, or due to greater nocturnal activity, the feeding areas are difficult to identify. However, occasional observations indicate that during the reproductive

period individuals move between the two basins of the marshland and that ditches around the edge of Diaccia Botrona are used by foraging birds. Nevertheless, the actual area used by a Bittern could only be defined, in our view, by means of telemetry.

Riassunto - La popolazione di Tarabuso della palude Diaccia Botrona (GR) è stata censita utilizzando una rete di stazioni di ascolto. Tale metodologia appare sufficiente per quantificare la popolazione in esame, ma non consente la localizzazione precisa dei maschi in canto.

I dati riportati in letteratura, a partire dal 1974, indicano che la popolazione ha conosciuto un progressivo incremento fino ai primi anni Novanta (da 0-1 a 14-18 maschi) e quindi una fase di declino (fino a 7-9 nel 1994). Tali variazioni sembrano attribuibili principalmente al deperimento della vegetazione: questo sarebbe stato positivo in una prima fase, diradando i frangimenti, negativo con l'effettiva scomparsa di questi ultimi. Il ruolo di primaria importanza a livello nazionale della popolazione studiata è risultato confermato.

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