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How the territory mapping technique reflects yearly fluctuations in the Collared Flycatcher *Ficedula albicollis* numbers?

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Abstract. The territory mapping technique censuses of the Collared Flycatcher *F. albicollis* were conducted on 25.5 ha plot in the Białowieża National Park. Conducted at the same time within the same plot, an intensive study on the ecology of the Collared Flycatcher allowed us to precisely assess the true number of breeding pairs (all nests were found). The combined version of mapping technique yields numbers which are an average 67% (min. 54, max. 92%) of the true numbers of the *F. albicollis* breeding pairs. This underestimation is negatively related both to the breeding losses in the Collared Flycatcher ($r = -0.87$, $p = 0.010$) and to its breeding density ($r = -0.64$, $p = 0.125$). Despite this underestimation the year-to-year changes in numbers obtained by both methods are positively correlated and highly significant ($r = 0.84$, $p = 0.017$). After an arithmetical formula was applied (i.e. 1.82 * mapping result – 7.33) only an average 14% of bias occurred.

Key words: Collared Flycatcher *Ficedula albicollis*, bird census, Bialowieza National Park, nest predation

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INTRODUCTION

The territory mapping technique in the USA referred to as spot-mapping, is a widely used method for censusing breeding territorial birds. An improved version of this technique called, according to Tomiałojć (1980), combined mapping was applied. The main improvements of it were later incorporated into a new standard version of mapping technique (Marchant 1983, Bibby *et al.* 1992). The combined version gives better results for many bird species, with the errors usually not higher than 10%. For some "difficult" species or "difficult" (high density) situations however, underestimates were found to be order of 20–30%. The accuracy of this version was tested in many studies (e.g. Enemar *et al.* 1976, Morozov 1994, Tomiałojć & Lontkowski 1989, Wesołowski 1985). These tests have shown that combined mapping usually gives results with the error of 10–20%. Therefore, for careful calculations of the community parameters some arithmetical corrections were suggested (Tomiałojć & Lontkowski 1989).

The main purpose of this study was an assessment of the efficiency and accuracy of the combined mapping version when censusing the Collared Flycatcher *F. albicollis*. The species is one of the most numerous bird species in the natural lime-oak-hornbeam stands of the Białowieża National Park (Walankiewicz 1991). The second aim of the study was to improve the mapping technique in a manner which would allow us to get as precise an assessment of the Collared Flycatcher numbers as possible.

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STUDY AREA

The 25.5 ha study plot W is located in the Białowieża National Park (hereafter BNP), North-Eastern Poland. It is covered by 170–250-year-old lime-oak-hornbeam *Tilio-Carpinetum* forest. The main species of trees are hornbeam *Carpinus betulus*, lime *Tilia cordata*, oak *Quercus robur*, maple *Acer platanoides* and spruce *Picea abies*

This primaeval deciduous forest has never been clear-cut and remains free of any management. Human presence is restricted to mainly tourists (Tomiałojć 1991). There are no nestboxes. All secondary cavity nesters, including the Collared Flycatcher, which is one of the most numerous bird species in the natural lime-oak-hornbeam stands, breed in natural tree cavities. For more details on the study area see Tomiałojć *et al.* (1984).

METHODS

A study plot census of the whole bird assemblage, including the Collared Flycatcher, has been conducted by the combined mapping technique since 1975 (Tomiałojć 1980). Ten visits (or eleven if weather conditions were adverse), including one performed in the evening, were paid each year between 10 April and 25 June. This version differed from the old international recommendations (I. B. C. C. 1969) in the following points: (a) special attention was paid to the contemporary records of simultaneously active birds, (b) significant amount of nest searching added, and (c) duration of a single visit to the plot was prolonged to six hours per 25 ha.

The study plot was checked by proceeding along marked lines, 100 m apart, though leaving the line for side-penetrations when necessary, and each time choosing a different route across the plot. Every year the censuses were performed by the same 3–4 experienced people.

All records of the Collared Flycatcher from field maps were assembled on species maps for their evaluation. Then, "paper territories" were drawn around the clusters of records. By one record we understood, a seen or heard, singing or non singing male, any observation of a female, observation of a pair, or a group of fledglings. The contemporary records of conspecific singing males were indicated on the map with the help of dotted lines. Such contemporary records were considered the most important clues for the presence of two distinct territories. In order to avoid subjectivity in judgment, the field counts were conducted by the observers (T. Wesolowski, L. Tomiałojć) not acquainted with the true distribution and abundance of the species. Later "paper territories" were drawn and the numbers estimated by analyzers having no knowledge of true numbers.

At the same time within the same plot, an intensive study work on the ecology of the Collared Flycatcher was conducted (e.g. Walankiewicz *et al.* 1997). It included precise assessments of their true numbers. To obtain them the plot W was inspected by two to four people from the first day of *F. albicollis* arrival. Every day the observers searched systematically for the singing of Collared Flycatcher males, though the females were also recorded.

There are two periods when *F. albicollis* cavities are easy to find. The first is during the arrival time of males, when they sing loudly and reveal their cavities, the second is at the end of the breeding season when nestlings in cavities are being intensively fed. The second period is much less effective, however.

Despite flycatcher conspicuousness, it is difficult to detect all the pairs during a standard mapping procedure. This is because the male arrival period from winter quarters lasts only three weeks on average (Mitrus *et al.* 1996). Some males after arrival sing only for 2–3 days and stop when they obtain a mate. There were some cases recorded when a male sang only one day, and then became silent.

All cavities where males were spotted were marked and later repeatedly checked from the ground for signs of any activity. Later, the contents of such cavities were inspected several times using a ladder or spurs. The purpose of this was to collect data on breeding success. According to our deep belief, probably all the breeding cavities were found each year. So called male-cavities, i.e. occupied by a male only and not accepted by female, were excluded from further analysis. As a breeding cavity was defined only as one in which at least one egg was found. A successful nest was defined only in which at least one young fledged. We did not

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include into the analysis the nests (no more than two per year) with very late clutches (from June) regarding them as the second breeding attempts of birds which lost their first clutch. This verified from the time when females laid their eggs and they revealed very low brood losses rate at that stage (authors data). The number of nests which were found in all years we treat as the true number of pairs because polygynuous males under BNP conditions occur in very low rate.

During more than ten years of ringing the Collared Flycatcher males in plot with nestboxes (100 boxes within 15 ha — up to 40 nests per year) only one polygynuous male was caught (data of W. Walankiewicz).

Statistical significance of differences was determined using Pearson's correlation.

RESULTS AND DISCUSSION

Accuracy of breeding numbers

During each of the seven years of intensive active searching for the nests 25 to 65 Collared Flycatcher breeding holes were found in the study plot. The very high intensity of the work which we spend on this search ensures that they represent true numbers of breeding Collared Flycatchers. According to the combined mapping method in the same years only 17 to 36 pairs (i.e. mapping territories) were found in the same area (Tomiałojć & Wesołowski 1994, 1996). So, on average there is only 67% accuracy of the combined mapping results. It is clear that even this version of the method underestimates the flycatcher numbers (Tab. 1).

Despite this underestimation the year-to-year changes in numbers obtained by both methods are positively correlated and highly significant ($r = 0.84$, $p = 0.017$, Fig. 1). According to Verner (1985) when results are consistently biased year by year to the same extent and in the same direction, they are good enough for at least some comparisons.

Table 1. The basic field data on BNP Collared Flycatchers. * The number of all double-registrations of singing males recorded during whole breeding season within the plot. ** All records of Collared Flycatchers in given year devided by number of mapping territories. *** One nest was on the border of the plot.

[Tabela 1. Dane dotyczące muchołówki białoszyjej w Białowieskim Parku Narodowym. * Liczba jednoczesnych stwierdzeń śpiewających samców na badanej powierzchni w ciągu całego sezonu lęgowego. ** Liczba wszystkich stwierdzeń muchołówki białoszyjej w danym roku podzielona przez liczbę terytoriów. *** Jedno z gniazd umieszczone było na granicy terenu badań.]

Years	True numbers	Mapping territories	Breeding looses (%)	Double-registrations *	Records per mapping territory**
1989	35.5***	25.5	41.5	43	4.4 ± 0.96
1990	43	23	66	65	3.9 ± 0.81
1991	25	17	46	30	4.2 ± 0.86
1992	30	27.5	9.5	69	4.6 ± 1.25
1993	64.5***	36	44.9	92	4.7 ± 1.21
1994	45	27.5	40.4	84	5.0 ± 1.02
1995	48	31.5	32.3	90	4.7 ± 1.13

The average number of records per one mapping territory has appeared to be density independent ($r = 0.31$, $p = 0.498$). The average number of double-registrations per study plot in any given year was positively and significantly correlated with true numbers ($r = 0.81$, $p = 0.027$).

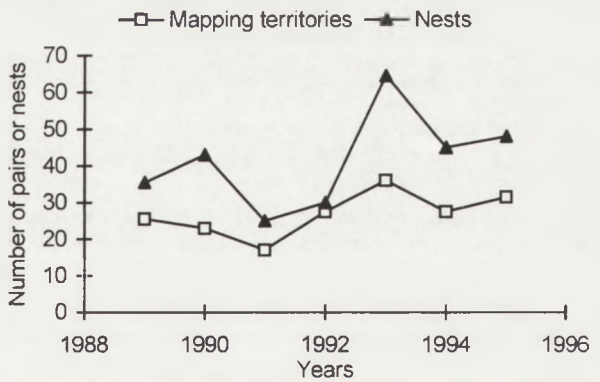

Fig. 1. Number of mapping territories (pairs) in relation to the true number of the Collared Flycatcher nests (pairs), $r = 0.84$, $p = 0.017$.

[Ryc. 1. Porównanie liczby terytoriów (par) otrzymanych metodą kartograficzną z rzeczywistą liczbą gniazd (par) muchołówki białoszyjej.]

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We think that, there are several possible reasons which led to the mapping method underestimation. Below some reasons of this are discussed i.e. specific breeding biology of the Collared Flycatcher, high breeding density, influence of breeding losses.

Influence of breeding biology

The Collared Flycatcher can build nests very close to each other (Walankiewicz 1991). On the mapping species maps there were drawn up to 3–3.5 territories in one hectare area. Up to six nests were recorded within 1 ha. Comparison of the Collared Flycatcher mapping territories distribution with distribution of the nests found within the same plot reveals that in many cases the mapping territories embrace two or even three nests belonging to definitely different pairs (Fig. 2). This means that too few of the contemporary records of conspecific singing males were registered during ten standard mapping visits, so the observers elaborating such mapping data had not enough information to split neighboring "territories".

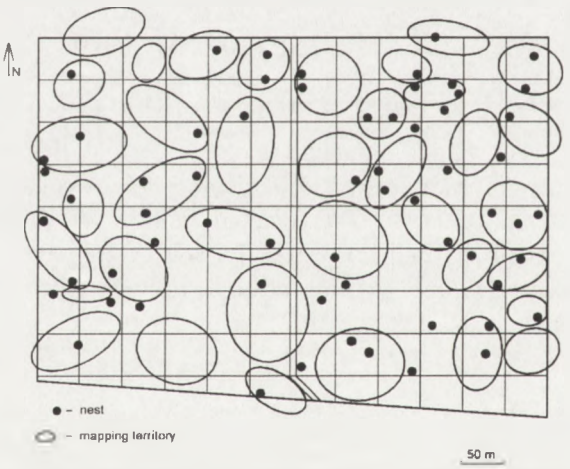

Fig. 2. Distribution of the Collared Flycatcher "mapping territories" compared to the distribution of nests found during intensive searching (map of the 1993).

[Ryc. 2. Porównanie rozmieszczenia terytoriów muchołówki białoszyjej, wyznaczonych metodą kartograficzną z rozmieszczeniem gniazd (mapa z roku 1993).]

An additional reason is the very inconspicuous behavior of females. When a new male arrives and starts singing in the vicinity of a previously mated male, the earlier settled male usually does not react until the intruder approaches very close (i.e. only several meters) to its nesting cavity. They may sing in the same tree crown, without aggressive reaction. In several cases we observed less than a ten meter distance between two nests in which the nestlings were simultaneously fed by different males. Those males were not heard to sing simultaneously in spite of daily checks.

Low detectability of the mapping technique is evidently caused by specific Collared Flycatcher breeding behavior and by high density. For instance, we observed that males stop singing almost immediately after they mated. Verner (1985) describing assumptions of the spot mapping method stated that "at least one bird per territory produces cues frequently enough to permit repeated location on successive visits to the plot". It is clear, therefore that in BNP the Collared Flycatcher has not fulfilled the fundamental of Verner's (1985) assumption because of its very short period of singing.

Timing of the census

During our intensive search and uniformity of search through the season most of the new cavities with singing males were detected only at the beginning of the season. During this short period (late April — mid May) only 3 mapping visits were conducted. In the middle of May even active searching for Collared Flycatcher nests becomes inefficient because the male activity decreases. For instance, a number of new found nests per day is negatively and significantly correlated with date of the season ($r = -0.84$, $p = 0.004$). Later, Collared Flycatcher females while they feed their nestlings enter cavities very fast, usually not alarmed even at the presence of the observer. Since middle May, under Białowieża conditions, during a few mapping visits left to perform, there is a very low chance to record flycatchers or to find active nests. At that time only unmated males sing as well as a few males which lost their clutches due to predation. In June, when nestlings in cavities are being intensively fed, the detectability of *F. albicollis* only slightly increases (Fig. 3).

Role of breeding losses

It seems that the accuracy of the mapping technique depends also on the level of Collared Flycatcher breeding losses. Predation pressure in the old-growth Białowieża forest is severe, as even 73% *F. albicollis* nests could be plundered (Walankiewicz 1991). Therefore, in the years with heavy breeding losses, the detectability of Collared Flycatchers is lower than in

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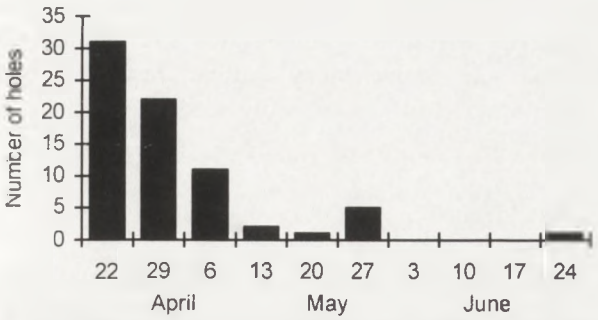

Fig. 3. Number of new Collared Flycatcher's holes recorded during the course of breeding season 1994, r = –0.84, p = 0.004.

[Ryc. 3. Liczba nowo znajdowanych dziupli, zajętych przez muchołówkę białoszyją, w ciągu sezonu lęgowego 1994.]

years of low breeding losses (Fig. 4). This could be explained by a shorter time which birds spend by the cavity when the nest is destroyed. Additionally, under BNP conditions in plot W no more than two pairs (4%) of the Collared Flycatcher re-nested. So, the underestimation of Collared Flycatcher numbers is negatively correlated with the level of nest predation (r = –0.87, p = 0.010). This means that the more nests that are robbed the lower proportion of breeding pairs being detected by the mapping method.

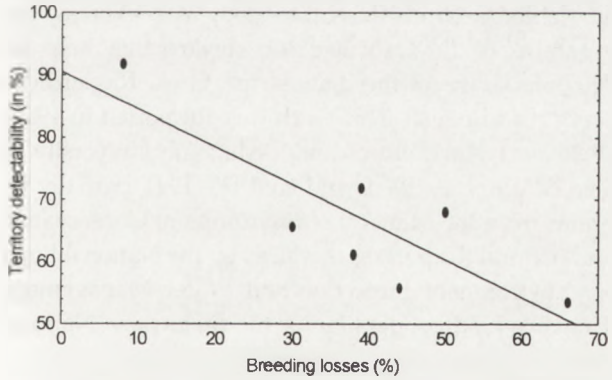

Fig. 4. The relation between the rate of breeding losses and the detectability of the mapping method estimates, r = –0.87, p = 0.010.

[Ryc. 4. Zależność wykrywalności metody kartograficznej od poziomu strat lęgowych.]

Density-dependence influence on mapping results

There is a clear pattern in the mapping method bias i.e. a stronger underestimation in years of high Collared Flycatcher density. In such years the mapping method detected only 54–66% of the *F. albicollis* true breeding numbers, which means a bias of c. 33%. The underestimation was lower during years of low Collared Flycatcher density when 68–92% pairs were detected (Fig. 1).

Correlation between true breeding density and the percentage of pairs detected by combined mapping suggests (r = –0.64, p = 0.125, Fig. 5) that during years of high Collared Flycatcher density observers have slightly tended to detect a lower portion of breeding pairs than in years of lower density. A similar phenomenon was also found for the Song Thrush *Turdus philomelos* (Tomiałojć & Lontkowski 1989). This density-related source of bias in bird counts is a result of a "saturation effect". It occurs when so many birds are detectable at one time that the observer is unable to distinguish or record them all (Järvinen & Väisänen 1976, Walankiewicz 1977).

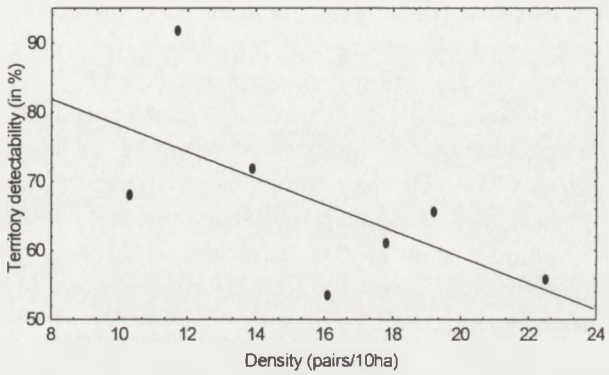

Fig. 5. The relation between the true breeding density of the Collared Flycatcher and the mapping method accuracy (detectability), r = –0.64, p = 0.125.

[Ryc. 5. Zależność wykrywalności metody kartograficznej od zagęszczenia muchołówki białoszyjej.]

Another source of bias related to high breeding density possibly appears during drawing of the mapping territory. The Collared Flycatcher breeds in BNP often in clusters which remains semi-colonial breeding. Fuller & Marchant (1983) described similar problems associated with cluster analysis for semi-colonial species during an assessment processes.

How to cope with the mapping method underestimation?

The censusing method should always be adapted in details to the requirements of the biology of the species. It should not be a schematic one (Tomiałojć 1974). According to Verner (1985), the results of tested methods are good enough for interspecific

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comparisons even if they are biased year by year to the same extent (proportionally). In line with the above statements, and our present results we recommend the following measures:

Firstly, in the time when the Collared Flycatcher starts to occupy cavities observers should mark any cavity where birds were seen. Later the vicinity of each such cavity should be checked several times for any activity of the birds. Collared Flycatchers often do not react while they feed nestlings, even when the observer is very close i.e. several meters from the cavity. Therefore, the observer should spend more time observing bird activity at those cavities where the birds were spotted earlier.

Secondly, we propose to introduce a simple arithmetical correction for this species as it was proposed by Tomiałojć & Lontkowski (1989) for the Song Thrush. In the case of the Collared Flycatcher, formula is 1.82 * number of mapping territories –7.33. This formula was calculated as a regression from the true numbers and numbers of mapping territories (Tab. 1). The Fig. 6. compares mapping results corrected this way with the true numbers of the breeding nests. After this correction was made, the underestimation was reduced to the average 14% (maximum 42%).

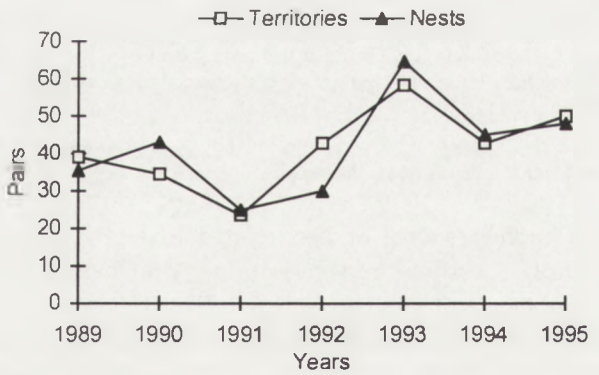

Fig. 6. Corrected number of "mapping pairs" in relation to the true number of nesting pairs, (r = 0.84, p = 0.017).

[Ryc. 6. Porównanie rzeczywistej liczby gniezdżących się par z liczbą „terytoriów kartograficznych" po naniesieniu poprawki.]

The question emerges, whether or not such corrected numbers should be applied in the papers dealing with a whole bird community. We suggest not using such corrected numbers of the Collared Flycatcher for comparisons with the whole bird assemblage until the values of the other bird species are not corrected. We advise applying the corrected Collared Flycatcher results to the intraspecific comparisons only. Many similar tests for other European bird species are badly needed.

CONCLUSIONS

The combined version of the mapping technique yields the numbers which are only 67% (54–92%) of the true numbers of the *F. albicollis* breeding pairs. This underestimation is significantly negatively related both to the breeding losses in the Collared Flycatcher and to its breeding density. After an arithmetical formula was applied an average 14% bias occurred (maximum 42%) Despite this underestimation the tested method gives results good enough for year to year comparisons of the Collared Flycatcher densities.

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STRESZCZENIE

[Jak metoda kartograficzna oddaje fluktuacje liczebności muchołówki białoszyjej *F. albicollis*?]

W latach 1989–1995 w Białowieskim Parku Narodowym na 25,5-hektarowej grądowej powierzchni oceniano zagęszczenia muchołówki białoszyjej *Ficedula albicollis* na podstawie intensywnie wyszukiwanych dziupli lęgowych. Jednocześnie inni doświadczeni obserwatorzy na tej samej powierzchni oceniali liczebność muchołówki kombinowaną metodą kartograficzną. Metoda kartograficzna wykrywa średnio 67% (54–92%) rzeczywistej liczebności *F. albicollis* (ryc. 1). Zarówno w latach kiedy poziom strat lęgów spowodowanych przez drapieżniki jest wysoki (ryc. 4), jak i w latach wysokiego zagęszczenia muchołówki białoszyjej (ryc. 5), dokładność metody kartograficznej maleje, tzn. mniejszy procent par jest wykrywany. Pomimo zaniżania wyników metoda kartograficzna oddaje fluktuacje liczebności *F. albicollis* ($r = 0,84$, $p = 0,017$). Po wprowadzeniu poprawki (1,82 * liczba par uzyskana metodą kartograficzną –7,33) błąd wynosi średnio 14% (ryc. 6).

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BIRD RINGING 100 YEARS

In 1999 it will be 100 years since the Danish teacher Hans Christian Cornelius Mortensen started to ring birds systematically. In order to celebrate the event an international scientific conference will be held at Ebeltoft, Denmark, 30 September – – 4 October 1999. The Conference is arranged by EURING, the Zoological Museum, Copenhagen, and the National Environmental Research Institute, Kalø, Denmark.

Among the main objectives are to summarize our current knowledge concerning the following topics: history of bird ringing, bird migration, dispersal of birds, catching/ringing techniques, population dynamics, mortality/survival rates, ringing results in the management and conservation of birds, and bird ringing in future.

The conference will be held in English and will include three full days of meetings with plenary sessions, symposia/workshops, as well as a poster session.

Excursions to important bird areas will be arranged immediately after the closing of the conference.

More information:

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100 LAT OBRĄCZKOWANIA PTAKÓW

W 1999 roku mija 100 lat, odkąd duński nauczyciel Hans Christian Cornelius Mortensen rozpoczął systematyczne obrączkowania ptaków. Dla uczczenia tej rocznicy, w Ebeltoft (Dania) w dn. 30.09 – 4.10.1999 r. odbędzie się konferencja naukowa zorganizowana przez EURING, Muzeum Zoologiczne w Kopenhadze i Narodowy Instytut Badań Środowiskowych (NERI) w Kalø (Dania).

Jednym z głównych celów konferencji jest podsumowanie obecnego stanu wiedzy dotyczącej następujących zagadnień: historii obrączkowania ptaków, migracji i dyspersji ptaków, metod chwytania/obrączkowania, dynamiki populacyjnej, zjawiska śmiertelności/przeżywalności, wykorzystania rezultatów obrączkowań w badaniach i ochronie ptaków, przyszłości obrączkowań.

Językiem konferencji będzie angielski. W czasie trzech dni spotkań planowane są sesje plenarne, sympozja/warsztaty, sesja posterowa.

Po zakończeniu konferencji przewiduje się wycieczki na tereny nteresujące pod względem ornitologicznym.

Informacje: Ib Clausager (adres jw.)

Materiały konferencyjne wraz z formularzem zgloszeń są dostępne w Internecie:

http://www.dmu.dk/news/birds.htm

http://rcin.org.pl