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# Capture efficiency of small birds by mist nets

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The capture efficiency of 25-mm mesh-size mist nets was evaluated by direct observation in two habitats in a marshland in central Hungary. Bird activity was 0.85 birds/ mist net-h in reedbed and significantly less, 0.28 birds/mist net-h on a wet meadow. Vertical activity as well as capture efficiency was significantly different between the two habitats. Overall, 37% of the birds that hit the net escaped. The middle shelves of 4-shelved net were the most effective in both habitats, with a retaining efficiency of 67-75%. The bottom shelf retained 75% of birds in a pure reedbed but only 33% in a wet meadow area. The top shelves retained fewer birds than the middle ones and there was less between habitat difference (53 vs. 42% efficient in reedbed and wet meadow, respectively).

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## 1. Introduction

Mist nets, due to their ease of operation and effectiveness to catch birds when unattended, are widely used in ornithological studies. A mist net, when appropriately set up, is barely visible. Birds fly against the loosely hanging net, lose their momentum, become entangled, and are subsequently recovered from the net.

Standardised mist netting is a common bird censusing and monitoring technique, and several long-term projects have adopted it (Baillie 1990, Hagan *et al.* 1992, DeSante *et al.* 1993). As any sampling method with a passive catching device, where capture (sampling) results from the activity of the target organism, conditions influencing activity necessarily influence the numbers captured. Such effects for mist netting birds include mesh size (Heimerdinger and Leberman 1966, Pardieck and Waide 1992), material (Dorsch 1983), visibility and weather conditions (Karr, 1979, 1981, 1990, Jenni *et al.* 1996), habitat type (Bairlein 1981), bird size (Jenni *et al.* 1996), flight and territorial behaviour (Remsen & Good 1996). Nonetheless, a literature review (Remsen & Good 1996) found that many studies fail to mention, consider or attempt any correction of biases due to the above factors.

During a bird migration project in central Hungary, we observed mist nets in two plant associations, in order to determine their capture efficiency. In this paper we report that the retaining efficiency of the most frequently used mesh size, 25 mm, was about 63% for sparrow-sized small passerines. This escape frequency was different from that found in Switzerland and Italy (Jenni *et al.*, 1996).

## 2. Study area and methods

Our study site was located in the Ócsa Landscape Reserve (OLR), about 20 km SE of Budapest, Hungary. This reserve contains a number of different habitats, including reedbeds, wet meadows, bushes, poplar and alder forests. The OLR is the largest remaining wetland between the Danube and Tisza rivers on the Hungarian lowland. Such wetlands dominated the area until large-scale river regulation occurred in the last century. OLR has been the site of a long-term bird migration monitoring program since 1983 (Csörgõ, unpublished).

Mist nets set up at two sites representing the two dominant plant associations of the area were included in the observations. The first one was in a pure, dense reedbed (maximum vegetation height 2.7 m), the second one in a wet meadow with tall vegetation composed of (sparse) reed *Phragmites communis*, elderberry *Sambucus nigra*, and various tall herbs, grasses and vines. The maximum vegetation height in this habitat was 4.5m (due to a few tall elderberry bushes), but the main vegetation height was not different from that of the reedbed. The top line of the nets was about 20 cm above the top of the vegetation. Taller trees (up to 10 m) were min. 50 m away from the mist net sites. The mist nets (obtained from the British Trust for Ornithology, Thetford, U.K.) were made of black, tethered material, were 12 m long, and 2.7 m tall. The mesh size was 25 mm across, which is the most frequently used type in Europe to catch small passerines. Both mist net lines were 144 m long (12 nets × 12 m long each), and were about 400 m from each other.

Observations took place between 17-24 August 1993, during the early phase of the autumn migration, in fine, still weather during the early morning hours (06:30-09:00) when bird activity was at its peak. Two observation sessions were taken during the evening activity period, between 18:00-20:00, on 17-18 August, 1993. Results were not different from the morning ones and the data were pooled. Observers took position about 10 m from the nearest net to be observed, hidden among the vegetation and behaving unobtrusively, watching four mist nets along the mist net line.

All birds that were, even if briefly, retained by the net were recorded. The species (if identifiable), position, and its eventual fate (escaped or captured) were also noted. All birds observed were of warbler size (Hungarian band size class 'A', inner diameter 5 mm). The body masses in this group range between 12-25 g. We classified them as similar in size, and did not evaluate the observations by size class. Mist nets were patrolled every hour.

Statistical tests were performed following Sokal & Rohlf (1995).

## 3. Results

### 3.1. Bird activity and general capture efficiency

A total of 133 mist net-hours were spent observing mist nets. During this time, 83 birds came into contact with the nets: 52 of them were caught, 31 escaped, giving an overall retaining efficiency of 62.6% (Tab. 1). On the meadow, the active density was, on average, 0.28 birds mist-net$^{-1}$ hour$^{-1}$ (*s.d.*= 0.27). Eighteen birds hit the net, and nine of these were caught, giving

Tab. 1. Mist net effectiveness at the Ócsa Landscape Reserve, central Hungary, August 1993.

| Species | Caught | Escaped | % caught |
|---|---|---|---|
| Sylviid warbler, *Sylvia borin/S. atricapilla** | 17 | 5 | 77.3 |
| Acrocephalus warbler, *Acrocephalus* spp.** | 8 | 0 | 100 |
| Greenfinch, *Carduelis chloris* | 1 | 0 | 100 |
| European Robin, *Erithacus rubecula* | 0 | 1 | 0 |
| Swallow, *Hirundo rustica* | 2 | 1 | 66.7 |
| Savi's Warbler, *Locustella fluviatilis* | 1 | 0 | 100 |
| Grey Flycatcher, *Muscicapa striata* | 0 | 1 | 0 |
| Black Redstart, *Phoenicurus ochruros* | 1 | 0 | 100 |
| Unidentified small passerine | 22 | 23 | 48.9 |
| Overall | 52 | 31 | 62.6 |

* 1 Garden Warbler, *S. borin*; all others Blackcaps, *S. atricapilla*
** 3 identified as *A. schoenobaenus*; 5 were *A. scirpaceus/palustris*

an overall success rate of 50%. In the reedbed habitat, mean active density was 0.85 birds mist-net$^{-1}$ hour$^{-1}$ (*s.d.*= 0.49), with an average retaining success of 70.3%. Overall, 43 of the 65 birds that hit the net were captured. The difference in activity between the two habitats was significant (Spjøtvoll-Stolin T'-test, T'=3.684, d.f.= 15, $P<0.05$).

### 3.2. Species composition

The most common birds seen were *Sylvia* and *Acrocephalus* warblers. The species identified were: Blackcap (*Sylvia atricapilla*), Sedge Warbler (*Acrocephalus schoenobaenus*), Reed/Marsh Warbler (*A. scirpaceus/palustris*; this species is very difficult to confidently identify in the field when silent), Black Redstart (*Phoenicurus ochruros*), European Robin (*Erithacus rubecula*), Spotted Flycatcher (*Muscicapa striata*), Savi's Warbler (*Locustella fluviatilis*), Swallow (*Hirundo rustica*), and Greenfinch (*Carduelis chloris*).

The exact position of birds taken from the mist nets for ringing during the hourly mist net patrols was not noted. At ringing, only the capture area (mist net line) was recorded. An exact evaluation of the species or individual mist nets was thus not possible. The species composition of the birds ringed, originating from the reedbed + wet meadow mist net lines during the periods of observation was dominated by warblers: from the total of 87 birds, 41 were sylviids, and 30 were *Acrocephalus* spp. (Csörgõ, unpublished). The most common species were Blackcap, Reed Warbler, Greenfinch and Swallow (the last during the evening only).

### 3.3. Vertical distribution of activity & capture efficiency

The vertical distribution of activity was significantly different from uniform in both habitats (G-test, reedbed: G=27.62, d.f.=3, $P<0.001$; wet meadow G=21.26, d.f.=3, $P<0.001$). There was also a significant difference between the two habitats in the vertical distribution of both activity (Fig. 1, G-test, G=18.19, d.f.=3, $P<0.001$) and retaining efficiency (Fig. 2, G-test, G=27.50, d.f.=3, $P<0.001$).

In the reedbed, birds preferred to move at the level of the second shelf rather than higher (Fig. 1a). Very few moved near the bottom. The retaining efficiencies of the lower three shelves were almost identical: 67%, 75% and 75% (second, third, and bottom). The top shelf was less efficient (53%). Birds moving at higher levels in this habitat were underrepresented in the catch (Fig. 2a).

Birds on the wet meadow habitat tended to move high: >40% of birds contacted the net at top shelf level (Fig. 1b). The

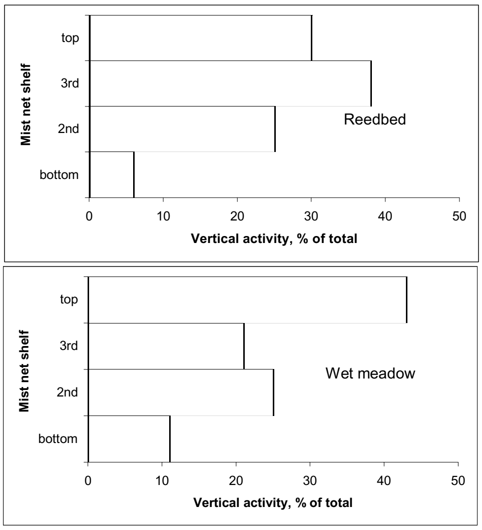


Fig. 1. Vertical distribution of bird activity in mist nets in two marshland habitats, a reedbed and a wet meadow at Ócsa, Hungary. Number of birds observed: reedbed *N*=65, wet meadow *N*=18.

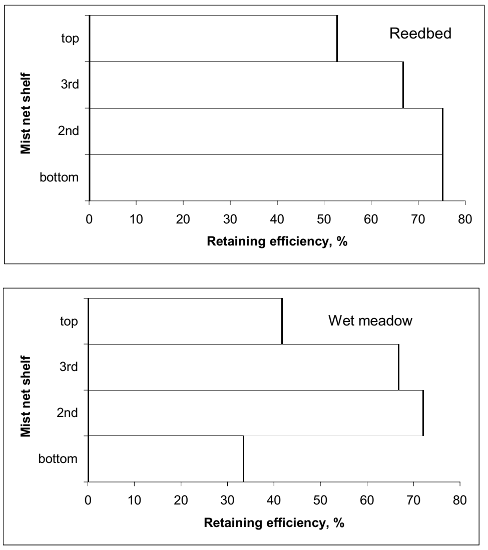


Fig. 2. Retaining efficiency of the different mist net shelves at the two marshland habitats at Ócsa, Hungary. Number of birds observed: reedbed, *N*=65, wet meadow, *N*=18.

retaining efficiency of the top shelf was 42%. Few birds seemed to move at the lowest level of vegetation (3 of 28 individuals) and one of these only was retained in the bottom shelf. The two middle shelves retained 67% (second) and 72% (third) of the birds (Fig. 2). Consequently, birds moving at this height within the habitat were over-represented in the catch. For example, only 25% of all birds observed came into contact with the net at the level of the third shelf but 33% of the total catch came from this height.

### 3.4. Species-specific capture efficiencies

Although not all birds were identified to species, differences between species were evident. The *Sylvia* species were caught with a high efficiency (Tab. 1) and this varied little between shelves and habitats. This agrees with the findings of Jenni *et al*. (1996) who reported 0% escape for Blackcap and Garden Warbler (*S. borin*).

The observed retaining efficiency for the *Acrocephalus* warblers was also high. However, this is suspect as *Acrocephalus* spp. are plain-coloured birds and difficult to identify. It is probable that due to individual observer differences, those *Acrocephalus* spp. individuals that were not retained were not identified confidently and were recorded under the 'unidentified' category. If we classify all the unidentified birds as *Acrocephalus* spp., the calculated retaining efficiency would become 30/53 = 56.6%. The true retaining efficiency for *Acrocephalus* spp. probably fell between these two values. Jenni *et al*. (1996) found 68% capture success rate for Sedge Warbler (*A. schoenobaenus*), and 53% for Reed Warbler (*A. scirpaceus*). This seems to support our argument.

## 4. Discussion

As most of the observers were not trained ornithologists, birds that flew against the mist net and bounced back were not identified and thus not counted. Our estimate of the 'escape' probability is therefore conservative.

Size is an important factor in capture probability, and a difference of 15g in mass (in this case reflecting size differences between species, not the same species with different fat level) results in significant differences in catchability (Jenni *et al*. 1996). In addition, our observations showed that different species as well as birds moving at different levels reacted differently to the mist net. As a consequence, the capture probability varied by species and movement height.

It is plausible to assume that capture position would influence the intensity of attempted escape behaviour of a bird initially captured. Birds captured low on the wet meadow may well perceive an increased risk from ground-active predators, and struggle longer to escape than birds that are caught higher. Similarly, birds trapped in the top shelf and visible to aerial predators could be aware of their risky situation and struggle more vigorously to escape.

### 4.1. Comparison with other locations

Jenni *et al*. (1996) reported escape frequencies from three European locations, all of them more southerly than ours. Their evaluation and observation regime was somewhat different, so a direct comparison cannot be made. However, the overall escape rate at Lake Neuchatel, Switzerland, and Col de Bretolet on the Swiss-French border was much lower (7.7-10.5% under moderate or slower wind conditions) than in Hungary. Interestingly, escape rates of two common *Acrocephalus* species were high (29-46%). At our study site, few *Acrocephalus*-sized bird seemed to escape (0-23%).

The vertical distribution of capture effectiveness between reedbed habitats at Ócsa, Hungary and Lake Neuchatel, Switzerland (Jenni *et al*. 1996, Fig. 4), was not different (G-test, G=1.05, $P<0.6$). However, in the other comparable habitat ('bush' in Switzerland and 'wet meadow' in Hungary) there was a significant difference in vertical distribution of the retaining efficiency (G-test, G=17.6, d.f.=3, $P<0.001$). This indicated that there could be behavioural differences (for example in flight speed, vertical within-habitat activity, or awareness) by migrants along the migratory route.

### 4.2. Consequences of bird escape from nets

What is the significance of these observations? Birds build a mental picture of their habitats and, using this local information, behave so as to acquire resources they need and minimise risks (Weber *et al*. 1998). By using mist nets, where capture depends on the activity of the target, we introduce a 'risk' factor into the environment and induce birds to change their behaviour. This would be of little consequence if all birds would react the same way. Our sample would not be biased, because the capture effectiveness would change uniformly within the study population. We believe this is not the case. Not only birds captured and released but escapes such as observed in this study could contribute to the net avoidance behaviour of birds that is often observed during prolonged mist-netting. It is common experience that activity levels seemingly decrease during prolonged mist-netting sessions, even if all captures plus recaptures are counted. During migration studies, it is also frequently observed that an increase in activity level signal the arrival of a new, "naive" group of migrants (Lövei, unpublished).

Another consequence of the species-specific reactions to mist nets is that the quantitative species composition of the mist net catch is not a true representation of the density relationships of the bird assemblages sampled. This has been realised earlier (e.g. Karr 1968). There seems to be no similar evaluation of the possible consequences of this capture method for population studies. Population estimates using a capture-recapture method are not necessarily adversely affected: several of them allow for unequal probability of capture, distinguishing, for example, between local and transient birds (Manly 1977). For migration studies on individual species, we see the following problems:

- the possibility of overestimating fattening rates due to a higher probability of capturing and/or recapturing fat birds due to their reduced manoeuvring ability in flight;
- underestimating the ratio of small, lean birds in the population because they have a superior manoeuvring capability and thus avoid capture with a higher probability

Further, if mist nets are continuously in operation at standard sites for long, this could cause an underestimation of the length of stopover. This would result because the longer the bird stays, the more familiar it will become with the area, and this familiarity could decrease the probability of recapture.

A possible way to decrease these errors could be to establish a standard set of mist net locations, but not having actively catching mist nets at all of them, and frequently alternating the actual sites where mist nets are set up. It remains to be tested if this way of operation would be effective in reducing experimental errors of the type mentioned above.

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## Összefoglalás


### Függönyháló fogási eredményessége kistermetû énekesmadarak vizsgálatakor

A 25 mm szemnagyságú függönyhálók fogási eredményességét értékeltük direkt megfigyelésekkel két élõhelyen az Ócsai Tájvédelmi Körzetben. A madarak aktivitása szignifikánsan különbözött a nádas, illetve száraz nádas élõhelyeken. Az elõbbiben 0,85 madár/háló×óra aktivitást, az utóbbiban csak 0,28 madár/háló×óra aktivitást figyeltünk meg. Az aktivitás hálózsebek magassága szerinti eloszlása szignifikánsan egyenlõtlen volt mindkét élõhelyen és egymástól is szignifikánsan különbözött. Mindösszesen, a hálóba került madarak 37%-a szökött meg az óránkénti ellenõrzés megérkezte elõtt. A két élõhely között nagy különbséget találtunk: a nádasban a hálók a beléjük került madarak átlagosan 70%-át tartották vissza, míg a száraz nádban csak átlagosan 30%-ot. A legkevesebb madár a négy zsebes háló két középsõ zsebébõl szökött meg. Ezek a zsebek a belekerült mada-

rak 67-75%-át visszatartották. A legalsó zseb a belekerült madarak 75%-át visszatartotta a nádasban, de csak 33%-ukat a száraz nádas élõhelyen. A legfelsõ zsebek mindkét élõhelyen kevésbé voltak hatékonyak, mint a középsõk, de az élõhelyek közötti különbség itt kisebb volt (53% a nádasban, illetve 42% a száraz nádban).

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