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A field evaluation of the Finnish 3-man chain: a method for estimating forest grouse numbers and habitat use

Rolf Brittas[1] & Mats Karlbom[2]

[1]Swedish Sportsmen's Association, Research Unit, Box 7002, S-750 07 Uppsala, Sweden
[2]Dept. of Zoophysiology, Uppsala University, Box 560, S-751 22 Uppsala, Sweden

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The Finnish 3-man chain, a strip transect method for estimating grouse numbers, was tested using radio-tagged birds, 20 Capercaillie and 39 Black Grouse, in 104 field trials.

The proportion counted by the census chain was 54–58% for adult Capercaillie without young and 61–64% for Black Grouse. Only one Black Grouse brood of 11 was not recorded by the chain. Most uncounted Capercaillie ran aside from the strip, while most uncounted Black Grouse remained crouching on the strip. Overall about 80% of the combined number of adults and juveniles should be detected in an average production year with this transect method.

The density of covering vegetation influenced the tendency of Black Grouse to remain on the strip. Nevertheless, since almost all of the observed birds moved only short distances, habitat estimates at sites where birds flew up appeared to be a good estimate of the habitat of undisturbed birds.

1. Introduction

The 3-man-chain (Rajala 1962, 1974), has been widely used for estimating the population density and breeding success of forest grouse in Finland and Sweden (e.g. Lindén & Rajala 1981, Marcström et al. 1988). Similar methods have been used in the United States and the Soviet Union (e.g. Hickey 1955, Semenov-Tian-Shansky 1959, Viht 1974).

The 3-man chain is a strip transect method in which 3 people walk 20 m apart in line abreast. Since each person records all birds detected within 10 m on either side, the chain covers a strip 60 m in width. According to Rajala (1974), however, both Capercaillie (*Tetrao urogallus*) and Black Grouse (*T. tetrix*) without young tend to run away, so that some birds are unseen by the 3 persons. Because of this tendency, it has been argued that grouse numbers are underestimated by the 3-man chain, and that the habitats occupied by birds located with this method are not representative of those utilized by undisturbed birds.

Despite this known source of error, little has been done to test the accuracy of the method. We used radio-tracking to evaluate how Capercaillie and Black Grouse reacted when approached by a 3-man chain. We determined the proportion of birds observed, and the accuracy of habitat observations obtained with this method.

2. Material and methods

The study was performed in the surroundings of Boda Wildlife Research Station, in a state owned forest of 32 km^2. The area is situated about 20 km

inland from the Gulf of Bothnia, at the border between the southern and middle boreal zones of Sweden (61°N, 16°E). Forests were intensively managed, and 42% of the area consisted of Scots pine (*Pinus silvestris*) plantations that were less than 20 years old. Older forest was usually mixed coniferous with Scots pine and Norway spruce (*Picea abies*) interspersed with deciduous species, such as birch (*Betula* spp.), aspen (*Populus tremula*) and alder (*Alnus incana*). The ground vegetation was dominated by bilberry (*Vaccinium myrtillus*), heather (*Calluna vulgaris*) and wavy-hair grass (*Deschampsia flexuosa*).

Twenty Capercaillie (14 males and 6 females) and 39 Black Grouse (24 males and 15 females) were caught on leks or in snow burrows (Willebrand 1988). They were fitted with necklace transmitters (Kenward 1987) which weighed 28–30 g in the case of Capercaillie and 15–17 g in the case of Black Grouse, and had an expected lifetime of 24 and 10 months respectively. The transmitters contained a mercury switch which immediately altered the pulse of the signal when the bird was active, thus indicating whether a bird remained motionless or was running or flying.

To test whether a known radio tagged bird was recorded by a 3-man chain, the location of the bird was estimated accurately without disturbing it. One portable receiver and hand-held yagi antenna was used by a tracker in the 3-man chain (called "the counters") and another receiving system by a separate observer. The counters and the observer (which could communicate using a portable tranceiver) took up positions more or less at right angles relative to the bird from a distance of about 150 and 100 m, respectively. In a few cases the field tests were interrupted at this stage, since the radio signal indicated that the bird changed its activity due to disturbance.

When both trackers had a good bearing, a compass course was set for the 3-man chain. The chain started to move towards the bird, while the separate observer tape-recorded the radio signal to register any changes. The chain followed the compass course, and while walking the tracker who was part of the chain checked that the original position of the bird was between the outermost counters as the chain passed. The trial was stopped when the counters saw the bird fly up or when it was obvious that they had passed the bird without observing it. After each trial the observer used both his own observations and the tape-recording of the activity changes, to estimate the distance moved on the ground by the bird, as well as the distance to the census chain when birds changed their activity.

The habitat where the bird was originally located and where it flew up or crouched was assessed within a circular test area of 10 m radius (Marcström et al. 1982, 1983). The record included time, location, weather, topography, type of stand and vegetation type (classified according to Hägglund & Lundmark 1977). A diversity index (the total number of ecotones between successional stages or different vegetation types within 50 m in four perpendicular directions), and a cover index (the proportion of ground covered by branches, bushes and tall field layer species at 30–100 cm above ground) were also recorded.

The field work was completed between 21 July and 15 August 1986 and 9–17 August 1988. Up to 3 trials were performed with each individual, with an interval of at least 3 days between different trials. In all, 104 trials with 59 individuals were performed. A bird was counted when it was observed flying up within the 60 m strip transect.

Since trials on the same bird could not be considered to be statistically independent observations, significance tests between different bird categories were based on the first trial for each individual.

3. Results

3.1. Accuracy of counts

Adult birds of both species were frequently missed by the counters (Table 1). Only 54% of male Capercaillie and 58% of females without young were counted in the 60 m strip transect, with 64% and 61%, respectively, for male and female Black Grouse. During trials with Black Grouse, broods were observed relatively more frequently than adults without young, but there

were too few birds to detect a significant difference (Fisher exact test, 2-tailed: P = 0.151). In two of 11 trials with broods 1–2 individual chicks crouched unobserved when the other brood members were flushed, and these were only detected afterwards when the counters walked around after the trial.

Individual grouse were about as likely to be detected in their first trial as in their last. In neither bird category did the proportion differ significantly (Fisher exact tests, 2-tailed: P = 0.242). In neither species did the proportion of counted birds differ significantly between males and broodless females (Fisher exact tests, 2-tailed: Capercaillie P = 0.628, Black Grouse P = 0.230). Data from these categories were therefore pooled for further analysis.

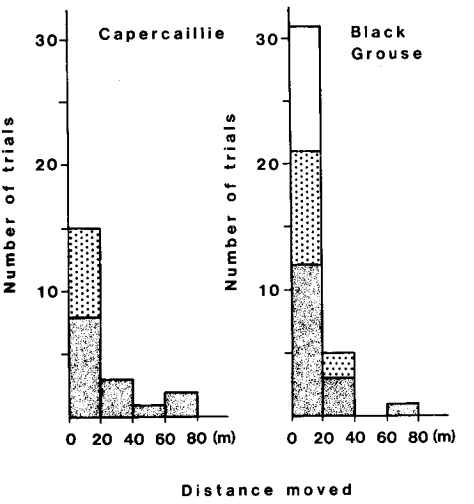

Fig. 1. Estimated distances moved before flying up, shown by counted Capercaillie and Black Grouse when approached by a 3-man chain in a field test. Grey = Males, stippled = Females without chicks and white = Broods.

3.2. Type of reaction of counted birds

Reaction distances varied considerably. In 16% of the trials when Capercaillie were counted the birds changed their activity when the chain was 80–100 m away, yet no activity change was registered until the distance was 20 m or less in 17% of the trials (for individuals, mean ± SD = 52 ± 27 m, n = 9; for trials 55 ± 27 m, n = 18). The most common first reaction of Capercaillie (50% of trials) was to walk a few metres to a position with better cover, where the bird later flew up. Most other birds (38%) flew up without a preceding movement. Adult Black Grouse started to react 10 to 80 m from the chain, (for individuals: 46 ± 24 m, n = 9; for trials: 46 ± 20 m, n = 15). In this species the most usual (60% of trials) first reaction was to crouch, before starting to walk or flying up. The mean distances to the nearest counter when flying up, were 22 ± 11 m (n = 10) and 13 ± 11 m (n = 13) for individual Capercaillie and Black Grouse, respectively.

Most birds counted within the strip had moved only small distances before they flew off (Fig. 1). This was evident both from the estimated changes in position, and from the registration of the activity changes. In the case of the Capercaillie, such movements were estimated as up to 20 m in 15 of 21 trials, and Black Grouse moved even less. Movements further than 40 m were noted in only 3 of 21 trials with Capercaillie and in 1 of 27 trials with adult Black Grouse.

Table 1. The proportion of individuals and trials where a known radio tagged bird was counted by the counters in the 3-man chain, when flying up within the 60 m strip transect. M = males, F = females.

	Capercaillie		Black Grouse		
	M	F	M	F	Broods
Birds (N)	14	6	24	9	6
Trials (N)	26	12	36	19	11
% counted					
in first trial	57	33	71	44	100
in all trials	54	58	64	58	91

3.3. Type of reaction of uncounted birds

In up to 10 percent of the trials where birds were uncounted, the birds ran out of the strip transect and were seen rising outside the strip (Table 2). About half of the unobserved Capercaillies ran away on the ground without being seen. In other

trials (29%) the birds flew away at up to 100 m distance, without being seen or heard. The most common (66%) reaction of uncounted Black Grouse was to crouch in the strip when the chain passed. Sometimes, however, these birds ran out of the strip after the census chain had passed. The only unobserved Black Grouse brood also crouched in the strip. This was in a pine plantation in which extremely dense field vegetation covered 60–70% of the ground.

Although the proportion of uncounted birds did not differ between the first and last trials, uncounted Capercaillie tended to react differently after their first encounter with the chain. Among the individuals studied more than once, only 1 of 7 uncounted birds ran away in its first trial, compared to 6 of 7 in their last trial (Fisher exact test, 2-tailed: P = 0.029). Uncounted Black Grouse, however, reacted similarly in first and last trials (Fisher exact test, 2-tailed: P = 0.545). On the other hand, adult Black Grouse crouched in the strip more often in places with dense cover than in open habitats. More than 30% of the ground was covered by vegetation in 10 of 11 trials when birds crouched, compared with 3 of 7 trials when birds were uncounted for other reasons (Fisher exact test, 2-tailed: P = 0.047).

3.4. Habitat estimations

In order to test whether the habitats occupied by counted birds are representative of those utilized by undisturbed birds, we compared the distributions of habitat assessments at locations recorded by

a) observation by the chain (only counted birds) and by
b) radio tracking before trials (all birds).

For adults of both species these distributions did not differ significantly. Concerning topography, type of stand (Table 3), vegetation type (Table 4) and diversity index, the distributions of the two estimates (a and b) corresponded well (for individuals: $\chi^2 \leq 1.98$ d.f. = 2–6, $P \geq 0.748$). Distributions of cover index estimates recorded by observation and by radio tracking did not differ significantly either (Capercaillie: $\chi^2 = 1.067$ d.f. = 3, P = 0.785; Black Grouse: $\chi^2 = 5.34$. d.f. = 3, P = 0.149), although the cover index was sometimes different in cases where counted birds moved before they flew. In most cases of such movements Black Grouse moved to places with better cover (Fig. 2), and within this species there was a tendency to overestimate the cover index (CI) slightly (CI observed by chain = 4.53 ± 1.61 (for individuals, n = 19) CI radio located = 3.67 ± 1.49 (for individuals, n = 30), t = 1.873, P = 0.071). The limited sample of Black Grouse broods

Table 2. Reactions (%) shown by known radio tagged adult birds which were not counted in the 60 m strip transect by the counters in a 3-man-chain.

	Capercaillie		Black Grouse	
Trial:	first	all	first	all
N:	10	17	10	20
Observed				
Flying outside strip	10	6	10	10
Unobserved				
Running away	20	47	50	24
Crouching in strip	30	18	40	66
Flying away	40	29	–	–

Table 3. A comparison of habitat assessments (%) in different forest stands at places located by observation by the counters in a 3-man chain, and by radio location of undisturbed birds before field trials. Only data for the first trial with adult individuals without young are presented. The forest stands were categorised as: Clearcutting = trees <0.5 m high, thicket stage = trees 0.5–3 m high, young stand = trees > 3m high — 10 cm dbh (diameter at breast height), maturing stand = trees 10–20 cm dbh, mature stand = trees > 20 cm dbh.

	Capercaillie		Black Grouse	
	chain	radio	chain	radio
N:	10	20	21	33
Clearcuttings	0	0	3	5
Thicket stage	0	0	14	24
Young stands	20	20	67	55
Maturing stands	10	20	0	3
Mature stands	40	35	5	3
Other stands	30	25	10	12

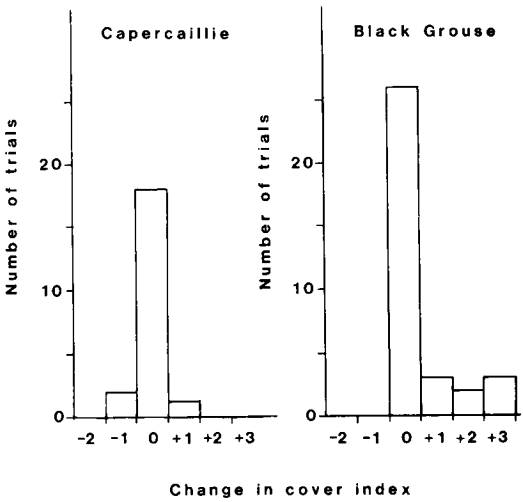

Fig. 2. The difference in cover index between places where counted Grouse (a) were observed by the chain and (b) were radio located before trials. The cover index is the proportion of ground covered by branches, bushes and tall field layer species at 30–100 cm above ground in a test area of 10 m radius, 1=1–10%, 2=11–20% ...). A positive value corresponds to a movement to a place with better cover when approached by a 3-man chain in a field trial.

(n = 6) showed that the 3-man chain is a good method for estimating brood habitats, since no brood moved noticeably.

Table 4. A comparison of habitat assessments (%) in different vegetation types at places located by observation by the counters in a 3 man chain, and by radio location of undisturbed birds before field trials. Only data for the first trial with adult individuals without young are presented.

	Capercaillie		Black Grouse	
	chain	radio	chain	radio
N:	10	20	21	33
Lichen	10	10	0	3
Herb	40	40	48	38
Grass	0	0	29	28
Sedge	0	0	10	9
Bilberry	40	35	10	9
Cloudberry	10	10	0	3
Crowberry	0	5	5	9

4. Discussion

The Finnish 3-man chain strip transect method recorded only 54–64% of the adult grouse without broods in our study area, which led to an underestimation of tetraonid densities. Because birds outside the outermost observers might show a greater tendency to be unobserved compared with birds between the observers (Rajala 1974), the proportion of uncounted birds might have been even higher if we had tested for this. The tendency of uncounted Capercaillie to run away more often in the last trials is difficult to explain. The limited data suggests that it is rather uncommon for birds which have not been disturbed recently to run away. However, experience from both line transects (Rajala 1974) and radio tracking (own observations), indicates that it is quite a common reaction for Capercaillies to run away unseen when approached by man.

An important question is whether the bias of the density estimate would be similar in different areas and from year to year. Since Black Grouse tended to crouch unobserved more often in places with dense covering vegetation than in open habitats, the accuracy of counts may vary between areas. The forests in the study area generally had a relatively dense shrub layer, which possibly contributed to the large proportion of unobserved birds. Perhaps numbers of adult birds can be recorded to a larger extent in a more open habitat, as in more northern areas of Fennoscandia. As shrub cover varies little from year to year, this bias may not seriously violate between-year comparisons within one area.

Since females with broods were apparently observed more frequently than single hens, numbers of adult females may be better estimated in years with good breeding than in poor years. Such a bias could partly explain the large and relatively variable over-representation of females found with the current method in Finnish studies (Rajala 1974, Lindén 1981). Further methodological studies are needed to determine the extent of regional and annual variation in the different sources of bias. Such studies should also evaluate the effects of grouping. In Black Grouse the formation of male flocks with up to 15–20 individuals, sometimes makes it difficult to obtain a representative estimate (Marcström et al. 1988).

Because of the relative ease of observing broods, total grouse numbers are better estimated than adult numbers. If one uses the proportions of counted adult birds from Table 1, one assumes that 90% of the birds in broods are counted and uses the average breeding and sex ratio data from Lindén (1981; for Capercaillie and Black Grouse: N juveniles/N adults = 0.571 and 0.590, N broods/N hens = 0.522 and 0.527, N females/N adults = 0.600 and 0.542), it appears that about 80% of the Capercaillie and 82% of the Black Grouse will be counted by the strip transect in an average production year. Since some young birds were not detected when the chain flushed a brood by walking fast, extra searching should be resorted to whenever a brood is detected.

Since only a small proportion of the counted radio-tagged birds had moved appreciable distances before they were flushed, habitat estimates based on bird locations by the 3-man chain apparently showed a high degree of accuracy. However, people in the chain tended to observe a higher proportion of Black Grouse in open habitats than in places with dense cover. Since birds tended to move to places with better cover before they flew (Fig. 2), the combined effect was a tendency to overestimate the cover index.

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Sammanfattning: **Utvärdering av den Finska 3-mannakedjan för inventering av skogshönsantal och -habitatval**

Den s.k. Finska 3-mannakedjan, som är en metod för linjetaxering av skogshöns, utvärderades med hjälp av radiopejling av 20 tjädrar och 39 orrar, vid totalt 104 fältförsök.

Andelen fåglar som registrerades av inventeringskedjan var 54–58% bland vuxna tjädrar respektive 61–64% bland vuxna orrar. Av 11 orrkullar var det endast en som inte registrerades av inventerarna. Sammantaget registrerar en 3-mannakedja omkring 80% av det totala antalet fåglar (vuxna och ungfåglar) under ett genomsnittligt föryngringsår. Flertalet oregistrerade tjädrar sprang åt sidan, medan den vanligaste orsaken till att orrar inte registrerades var att de tryckte osedda när inventerarna passerade. Tendensen att trycka osedd var mest utpräglad på platser med tät vegetation.

De registrerade fåglarna förflyttade sig endast korta sträckor innan de flög upp. Biotopregistreringar vid fåglarnas uppflogsplatser visades vara representativa för ostörda fåglars biotopval.

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