

The Disturbing Effects
of Orienteering and Hunting
on Roe Deer (*Capreolus capreolus*)

by
JOHNNY LUND JEPPESEN

Med et dansk resumé:
Den forstyrrende indvirkning
af orienteringsløb og jagt på
rådyr (*Capreolus capreolus*)

Резюме на русском языке:
Беспокоящее воздействие состязаний в беге
с ориентировкой и охоты на косуль (Capre-
olus capreolus).

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Abstract

Johnny Lund Jeppesen, 1987: The Disturbing Effects of Orienteering and Hunting on Roe Deer (*Capreolus capreolus*). Dan. Rev. Game Biol. 13 (3).

During 1980-84 reactions of roe deer (*Capreolus capreolus*) to orienteering events and hunting were recorded using direct observation and radiotelemetry. Roe deer fled into cover ($\bar{x} = 432$ m) during small orienteering events (below 100 runners), and usually stayed there. Disturbing effects of orienteering activities were greater in March than in June, mainly because the visibility in deciduous forests is greater in March. Orienteering events in June, however, are not advisable because this coincides with parturition in roe deer. Deer were forced from cover and fled a longer distance ($\bar{x} = 847$ m) during battues and drive hunts. Roe deer moved from home ranges during both forms of disturbance and stayed from 0-7 hours at the refuge-area, before returning, typically at nightfall. It is least disturbing to roe deer to arrange large orienteering events in July-August. Further recommendations concerning orienteering and roe deer are given.

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Introduction

Roe deer (*Capreolus capreolus*) and other forest living ungulates normally live in or close to dense vegetation. They depend upon concealment as one anti-predator 'strategy'. Deer usually escape when disturbed by eluding the pursuer in cover within a well-known home range. Thus trickery, as opposed to covering a linear distance, is the usual escape strategy (HIRTH & MCCULLOUGH 1977). Flight normally occurs when the intruder has come within the flight distance where escape by stealth is no longer possible (op. cit.).

In the cultivated Danish landscape humans frequently occur in the environment of roe deer. When localised activities such as logging and agricultural work in the fields take place within the home range of roe deer, they move to other parts of their home range for the duration of such activities.

The behaviour of roe deer when disturbed varies according to the intensity and source of disturbance, from no appreciable reaction, over a gradient of reactions, to a headlong flight (see Table 1). They may become habituated to *predictable* events such as highway traffic (Table 1), which they learn is not dangerous (own observations, see GEIST (1971) on ungulates). Likewise, roe deer may grow accustomed to activities like jogging and hiking on forest roads in Danish forests close to larger towns (own observations).

Nonetheless, stray dogs and humans hiking away from roads, as well as battues and orienteering events, are *unpredictable* and often dramatic events that deer associate with danger (see discussion on ungulates in GEIST 1971, 1978, GEIST et al. 1985). Deer do not habituate to such events.

Also climatic factors may influence the reactions of roe deer. On windy days contrary to calm days roe deer are more ner-

vous and show stronger reactions to disturbances (own observations). On such days there are lots of noises and smells in the forest, and it seems, as if the deer run rather than rely on their senses, which MCCULLOUGH (1969) likewise found in Tule elk (*Cervus elaphus nannodes*).

During the period 1980-84 the Game Biology Station has studied reactions of roe deer and red deer (*Cervus elaphus*) to various forms of human disturbance. Effects of human disturbance on a population of red deer is described by JEPPESEN (1987a,b,c), whereas this paper describes reactions of roe deer to hunting and orienteering events. Especially orienteering events have become a matter of concern. In the late 1970's problems arose between foresters and orienteers, and it became increasingly difficult for the latter to get permission to arrange orienteering events in Danish forests. During several large orienteering events hunters and foresters observed that roe deer took flight out of the forests. During the days following such events almost no deer were observed in their usual habitats. Hunters and foresters, therefore, feared that a (large) part of local roe deer populations were expelled from forests during orienteering events. Hence the following questions concerning disturbing effects of orienteering events on roe deer emerged: How far do roe deer take flight; to what degree do they return to their home ranges - and when; how much do form ('courses', sanctuaries) and size of orienteering events influence reactions of roe deer; - size of forests and distribution of cover vs. open areas; how do orienteering events affect roe deer during the breeding season and other seasons of the year; - and what precautions may be taken to reduce effects of orienteering events on roe deer?

As regards the disturbing effects of orienteering and hunting on roe deer: how do they differ?

Table 1. Behaviour of roe deer when disturbed, combined with an attempt to place the behavioural expressions on a gradient indicating the underlying stress-level.

Increasing stress-level					
<u>Calm situation</u>	<u>Alert reaction</u>	<u>Alarm reaction</u>	<u>Flight, A</u>	<u>Freezing reaction</u>	<u>Flight, B</u>
<p>No appreciable reaction:</p>	<p>Head raised, eyes and ears turned towards the source of disturbance:</p>	<p>With display of white rump patch, while uttering a characteristic bark, possibly stamping the ground with its forelegs:</p>	<p>An 'easy' bounding gait, perhaps with display of white rump patch:</p>	<p>Roe deer may react by 'freezing' and occasionally by 'ducking' (bending the 'knees' a little on all 4 legs).</p>	<p>Running as hard as possible with no rump patch display, no 'easy' bounding and with the neck held level:</p>
<p>Occurs when feeding in open areas, e.g. close to a heavily trafficked highway.</p>	<p>Occurs in all forms of perceived irregularity e.g. sporadic occurring cars or walking persons approaching on forest roads. If the roe deer are habituated to this kind of traffic, they resume normal behaviour when the disturbance ends. If the source of disturbance gets within the flight distance the alert reaction may be followed by a short flight after which the intruder is fixed from a safe distance (perhaps while shamgrazing (Kolb 1979) or urinating (viz. displacement activity)).</p>	<p>Occurs when perceiving a not located irregularity, e.g. smell of humans or during the breeding season of fox. Barking ceases when the intruder is exposed (compare with Tule elk (<i>Cervus elaphus nannodes</i>) (McCullough 1963)). Barking in roe deer occurs particularly during the breeding season and in both sexes. Alarm reaction may lead to alert reaction, but normally flight A is released.</p>	<p>The 'easy' bounding and the white rump patch that are obvious to a predator, appear in forest living ungulates to be used in noncritical situations when the predator is at a distance (Hirth & McCullough 1977).</p>	<p>May occur if a person gets within flight distance before noticed by the deer. This resembles the reactions of neonates (Lent 1974, own observations). If the person stops, the deer take flight, most often type B. If he slowly passes, the deer may be standing in the same position, until the distance becomes safe, after which it quickly takes cover.</p>	<p>Occurs when deer become badly startled or surprised at close range (see also Hirth & McCullough 1977), or as in a battue where deer are driven out of dense cover at close range.</p>

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The help and assistance in making observations of roe deer during orienteering and hunting events by orienteers and hunters, plus colleagues and friends at the Game Biology Station are much appreciated. The Danish Orienteering Union is thanked for its collaboration, and I also acknowledge the map-constructions and planning of orienteering events at Kalø provided by the orienteering club 'Pan' in Århus. Special thanks are given to radio technician Bo Gaardmand, who besides building radio transmitters for roe deer, also participated in the often laborious radio-tracking of roe deer. The help from Tommy Asferg, Helmut Strandgaard, and R. Terry Bowyer, who commented critically on the manuscript, is much appreciated. Else-Marie Nielsen is thanked for help in word processing and proofreading of the manuscript, and Poul Hartmann for drawing figures.

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Study area

The study area is part of Kalø estate in east Jutland, and consists of 400 ha of fertile land, of which the Ringelmose forest composes 165 ha (Fig. 1). The rest is agricultural land divided by hedgerows and coverts. The

area is bounded to the south by the sea (Kalø Bay), and 500 m west of the Ringelmose forest is another forest of the same size. North of this lies Rønde town, whereas neighbouring areas to the north and east consist of agricultural land. The rolling landscape slopes evenly towards the sea. Heavily trafficked highways bound the study area in three directions whereas a small road runs along the east side.

The Ringelmose forest is rather open with deciduous trees on two thirds of the area, and is covered by a network of forest roads, which is typical for Danish forests. Among the areas of tall standard of mostly beech (*Fagus sylvatica*) there are young, dense plantings, some of which are fenced (Fig. 1). The distribution and age of tree species were described by STRANDGAARD (1972), but after heavy windfalls in November 1981 large parts (about 22 ha) of old stands of spruce (*Picea sp.*, *Abies sp.*) and beech have been replaced by open areas of rich herbaceous vegetation. Later, some of these areas have been planted with oak (*Quercus sp.*) and spruce.

In spring the population of roe deer in the study area is approximately 100 animals. About 90% was individually marked with collars during the study period.

Roe deer are not hunted at Kalø, but hunting does take place on other game species. Besides, the roe deer were subjected to capture and marking procedures during winter (Dec.-Feb.). The roe deer at Kalø appear less wary than roe deer in districts where they are hunted. Therefore, it cannot be excluded that Danish roe deer in general may react stronger to disturbances than deer at Kalø. Year-round logging occurs in one or more sections of Ringelmose forest. Further, joggers exercise daily on forest roads.

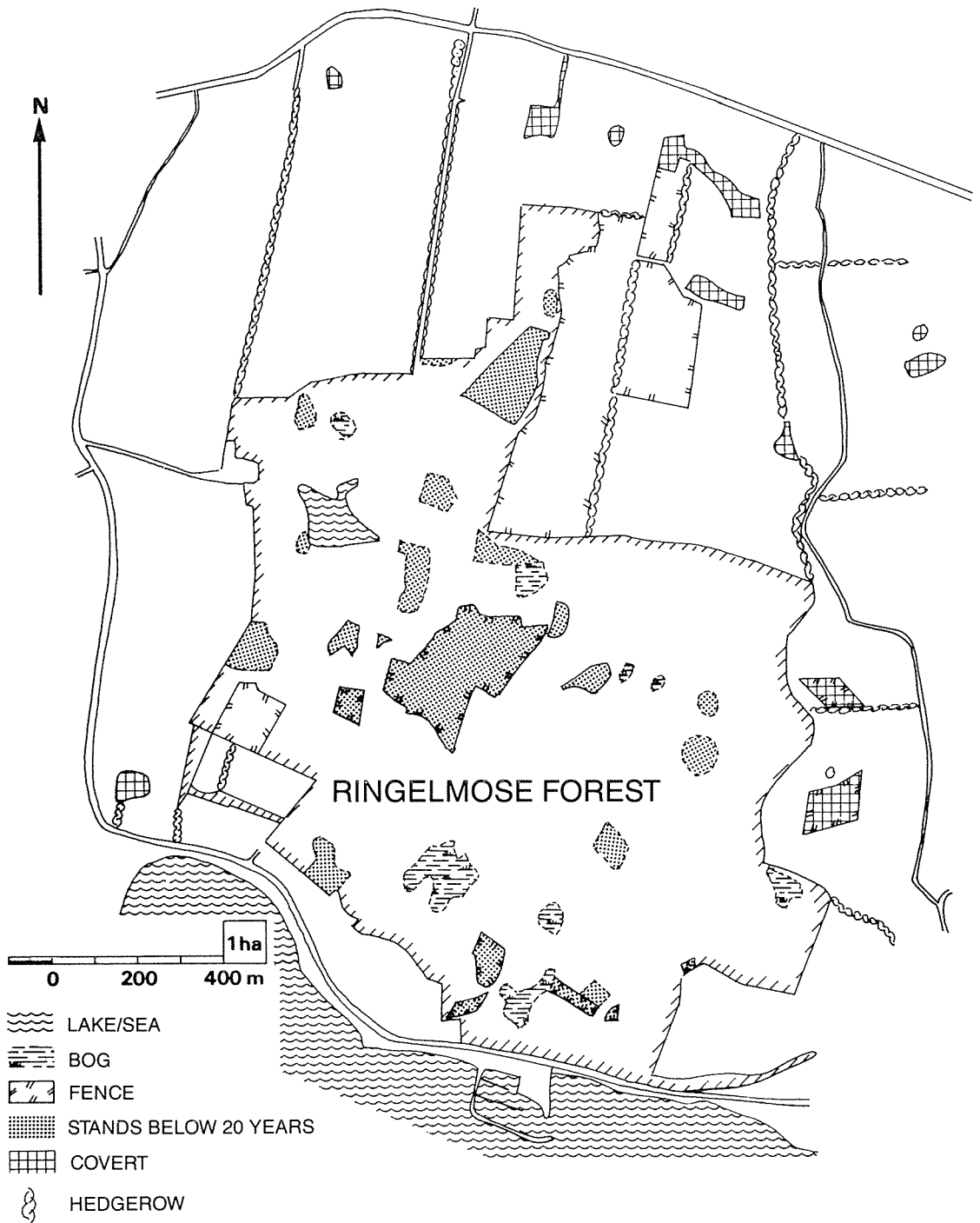


Fig. 1. Map of the Kalø study area.

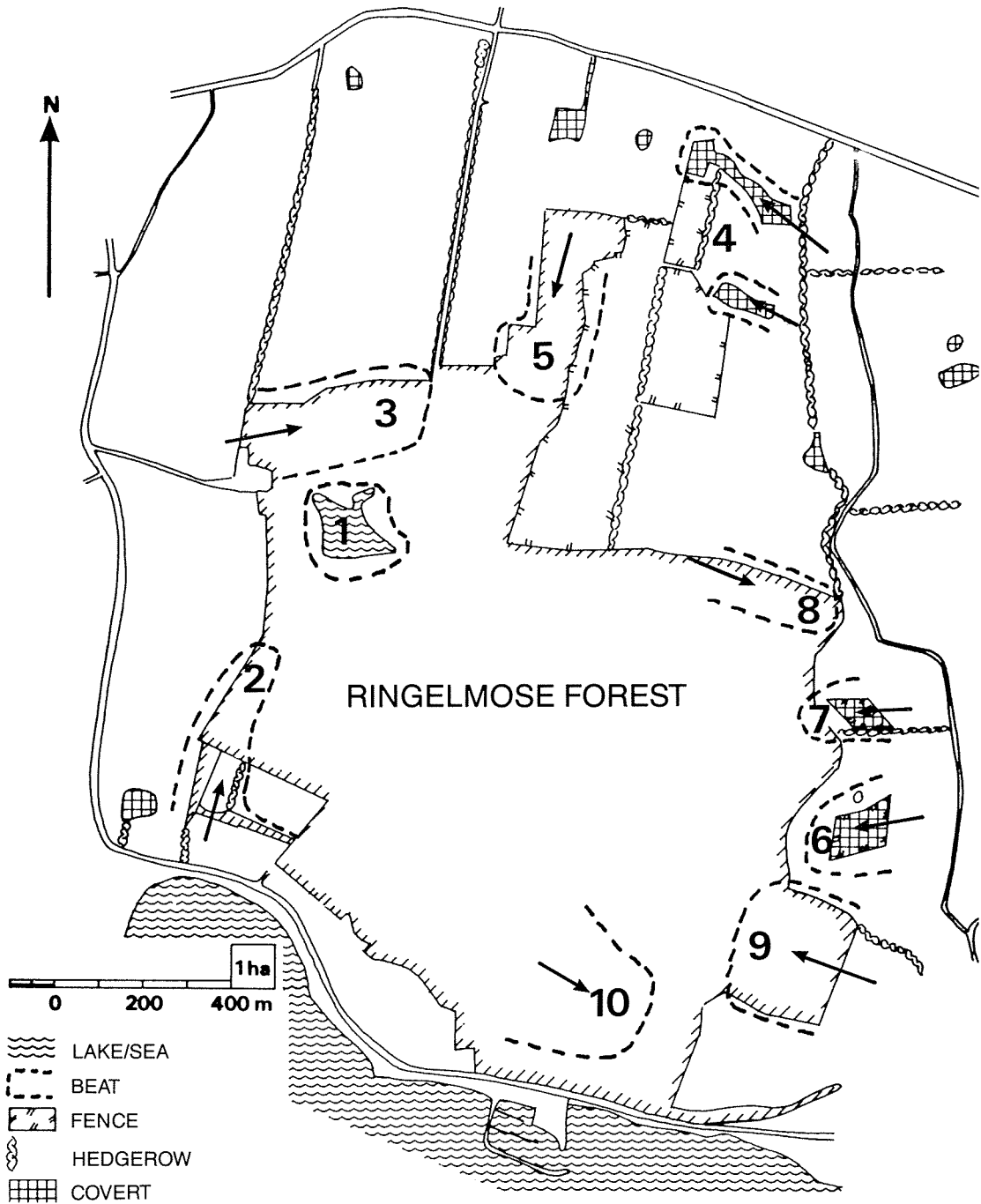


Fig. 2. Utilisation of study area: a) during a battue with 10 beats, November 6th, 1981 (arrows indicate directions of movement of the line of beaters);



b) during a small orienteering event June 15th, 1982. The individual routes through the forest chosen by 78 runners.

Material and methods

During this study 27 roe deer (15 females and 12 males) were equipped with radio-collars (see description of capture and marking in STRANDGAARD (1972)). Movements, home ranges and activity patterns of radio-marked roe deer were recorded as described by JEPPESEN (1987d,e, in prep.), using much the same type of equipment and methods developed at Grimsö in Sweden (CEDERLUND et al. 1979, CEDERLUND & LEMNELL 1980).

Hunting

Reactions of roe deer were registered during 4 large battues (in November 1980–83) and 5 drive hunts (3 in November 1981, –82, –83, and 2 in January 1983). A battue at Kalø in November takes place between 9 and 15 o'clock (the daylight hours). The battues were divided into 8 or 10 beats covering a total of 35–40 ha. The size of each beat varied between 1 and 10 ha, and the duration between 5 and 25 minutes (\bar{x} = 15 minutes). Most beats were the same each year, and located along the forest edges and in coverts in the fields, known to hold much game (see Fig. 2).

About 15 hunters and 25 beaters participated in the battues. Distances between persons in the line of beaters were, from less than 1 m to 15 m. The line of beaters occasionally stopped and much noise was produced by clapping the hands, knocking on trees and shouting. In drive hunts, fewer hunters and no beaters participated - the beats were driven through by a few hunters with dogs. Drive hunts were conducted with less noise, and it was primarily the dogs, running to and fro, that drove the game towards the hunters. During battues the number of game killed was 50–100 (red fox (*Vulpes vulpes*), brown hare (*Lepus capensis*), pheasant (*Phasianus colchicus*),

wood pigeon (*Columba palumbus*), mallard (*Anas platyrhynchos*)). Drive hunts most often concerned red fox (one fox hunt a week in Dec.–Jan. each year).

Observers, selected beaters and hunters recorded their observations of roe deer (number, behaviour, direction of flight) during the battues on dictaphones. In most cases, observations were brief (deer fleeing in dense vegetation), and the same deer were often observed by several persons. Thus, only a rough estimate of the number of roe deer in each beat was possible.

Locations and activities of radio-marked roe deer were recorded during beats, as well as before and after hunting. Thus, direct observations and radio-telemetry procedures can supplement each other.

Orienteering events

During orienteering events, each participant runs an individual race in which the fastest route from post to post is to be found. Thus, it is the topography and thickness of the forest and the placing of posts, as well as experience and constitution of the runners, that determine which route each runner chooses. There are 'courses' of varying difficulty. Utilisation of the area during an orienteering event is shown in Fig. 2. Orienteering events during the night mostly take place on the forest roads.

In 1982–83 eight smaller orienteering events were arranged (Table 2). Activities and reactions of radio-marked roe deer were registered before, during, and after these events. At some events observers were posted on forest roads and on points of survey along the forest edges. Further, participating runners reported their observations of roe deer during the events.

Results

Hunting

Observation: During battues, 0–17 roe deer were observed per beat, with an average of 5–6 per beat. A total of 40–60 roe deer was driven out of the beats during each battue at Kalø. This makes up about one third of the autumn population of roe deer in the study area.

Practically all roe deer present were driven out of the beat during a battue. When hunters and beaters took positions around the beat, the roe deer sought refuge in dense cover. There was much variation within beats as to when roe deer were driven from cover. Whether deer took flight early or late in a beat depended upon the location of the deer (and the cover), but often they did not leave the cover until the line of beaters came close (5–10 m).

When the line of beaters came close to the deer (often but a few metres) it took flight, with head and neck held level. Sometimes when a deer runs zigzagging among the beaters, it bumps into a person, tree or fence. During battues more than half of the observed roe deer moved back through the line of beaters, or to the side among the hunters posted there, whereas only a few ran towards the hunters at the front.

When one of the small coverts between the fields was surrounded by beaters and hunters immediately before the beat was initiated, nearly all roe deer fled instantaneously. In very few cases, a roe deer stayed in cover until it was driven out by beaters at a very close range.

Radiotelemetry: Reactions of 13 radio-marked roe deer (10 females, 3 males) were recorded on 36 occasions during battues and drive hunts, of which deer were located 26 times within a beat and in 10 cases outside the beat. In 25 cases the deer took

flight out of the beat; in one case it stayed within the beat (a maizefield).

During flight the deer often ran out of the forest across the fields to the forest or a hedgerow. Within the forest the deer always fled to a section with dense vegetation or to a small marsh with a tall undergrowth.

The distribution of distances covered by roe deer during flight is shown in Fig. 3. The mean of these distances was 847 m (median = 750 m). In 17 of 25 cases where deer took flight across the open fields, the mean was 1,141 m (median = 1,117 m). In the remaining 8 cases the flight took place through the forest, the mean being 525 m (median = 325 m). This is a statistically significant difference ($0.01 < p < 0.02$; me-

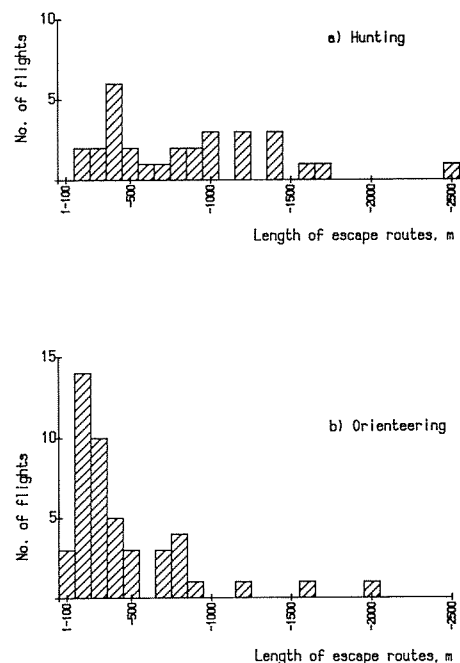


Fig. 3. Length of escape routes during a) hunting (battues and drive hunts) and b) small orienteering events.

dian test). In 8 of 25 cases where a deer was located in a beat, the deer took flight out of its home range. Out of 10 times when deer were just outside a beat, they stayed in cover in 5 cases whereas they took flight in 5 cases ($\bar{x} = 310$ m).

Most often ($n = 21$) the escape route covered a long, almost straight line; occasionally ($n = 4$) it was somewhat circuitous, so that the route travelled was long, but the distance between start and finish was short.

The roe deer remained in the refuge area from 0–7 hours; in 16 of 25 cases they returned to the area from where they had been driven. In the remaining 9 cases deer resumed normal feeding activities within their home ranges. In 4 cases the deer began to move back through the forest in the daylight hours, whereas there were no cases where deer began moving back across the fields before sunset. Seventyfive percent of the roe deer left their refuge cover at night-fall.

Radio locations of marked roe deer in the area that were not close to a beat during hunts, have shown, that these deer followed their usual habits alternating between feeding and resting activities. Apparently these deer were not affected by the hunting.

Orienteering

Observation: Four of the eight events included very few runners (Table 2), and one event took place after dark where only reactions of radio-marked roe deer were recorded. Concerning the 3 largest events, 85% of the runners observed roe deer on March 19th, whereas the number was 71% on April 16th and 54% on June 15th. The mean number of roe deer per observation on the three dates was in March 1.9; in April 1.3; and in June 1.1 (medians = 1.05; 0.63; 0.55). These values differed significantly ($p < 0.001$; median test). The percentage of roe deer observed during the first half of

the event, was on the three dates 41, 76 and 42, respectively, of all observed roe deer.

Observations of roe deer made by runners were evenly dispersed in the forest during each event. This can be related to the fact, that the runners during these events have utilised most of the area in the forest (Fig. 2). The posted observers mainly observed roe deer near the edges of the forest and in the fields. Besides, the observers saw some roe deer that were not affected by the orienteering events, feeding in the fields; those deer are not included in Table 2. Ninetyfour percent of the observed roe deer were seen running, some of these at a slow speed (29%) but most were running fast (71%).

Radiotelemetry: Reactions of 12 radio-marked roe deer (7 females, 5 males) were recorded 55 times during orienteering events. When the deer became aware of the first runners, they typically ran into cover. Generally, the deer took cover in dense vegetation, often young plantings, but also used marshes with a tall undergrowth, or hedgerows and coverts. In 47 cases deer ran into vegetative cover within their home ranges whereas on 8 occasions they left their home ranges. At least in 7 cases a roe deer shifted cover once or a few times during an orienteering event.

Irrespective of the cause of disturbance, individual deer often took flight in the same direction. On several occasions the flight also ended at the same place. There was a great deal of variation, however, depending upon in which direction the deer were forced by the situation.

Mean distance covered during flight was 432 m (median = 260 m). A median test reveals that the distribution is significantly different ($p < 0.01$) from the distribution of distances covered during hunting (see also Fig. 3). There is no significant difference

Table 2. Data concerning observations of roe deer during eight small orienteering events in the Ringelrose forest during 1982 and 1983.

Date	No. of participants	Duration of event in hours	Observations made by runners:		Observations made by observers:		No. of observers	Observed during first half of events (%)	
			no. of observations	no. of roe deer	no. of observations	no. of roe deer			
15 June	82	78	2	42	47	25	25	6	42
24 August	82	15	1¼	7	7	7	8	5	
9 October	82	10	1½	4	6	2	2	4	
12 March	82	12	1½	7	13				
13 March	83	12	1½	2	2				
19 March	83	39	1½	33	63				41
16 April	83	80	2½	57	75	32	53	10	76
31 August	83*	26	2½						

* - Night orienteering event

between the distribution of distances run by males and females ($p > 0.8$; median test).

Roe deer resumed normal feeding activities within their home ranges when orienteering events had finished. Deer that took flight out of home range stayed away 3 to 5 hours, before they moved back at nightfall.

During the night-orienteering event on 31 August 1983 the reactions of 3 radio-marked deer were recorded. Female no. 307A ran 700 m to dense cover in the southern part of her home range (Fig. 4). Male no. 202A ran 250 m to the forest edge, but later moved 300 m into the forest; and

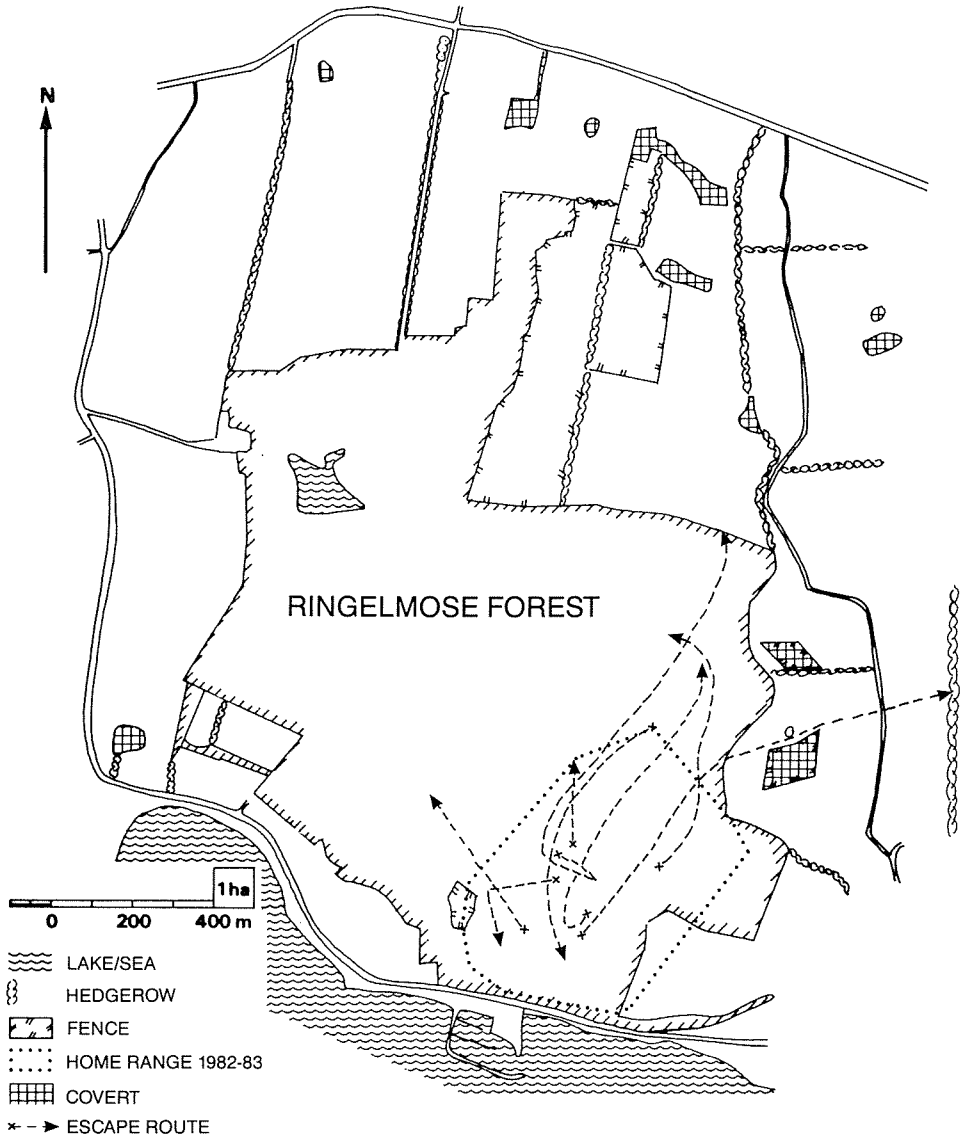


Fig. 4. Escape routes of female roe deer no. 307A, recorded in 1982 and 1983.

female no. 306A moved three times (200 m, 400 m, 250 m), and finally bedded at the edge of the forest. Deer did not take flight immediately at the start of the night-event

when the first runners with head-lamps appeared, but took flight 15 or 30 minutes later. Several orienteers had observed roe deer lying next to where they were running.

Discussion

The daily activity pattern of roe deer at Kalø is typically bimodal, with peaks at sunrise and sunset (JEPPESEN 1987d, in prep.). Most of the year the deer are more active at night than during daylight. Large parts of the forest is normally free from disturbance during the day (as well as during the night), and the deer feed and ruminate in the open areas of the forest (JEPPESEN 1987e, in prep.). Thus, unless disturbing events like hunting and orienteering occur, most roe deer are found in open areas of the forest.

There are several important factors affecting flight behaviour and the escape cover used. Decisive is the position of the individual deer at the moment of disturbance, viewed in relation to the source of disturbance, and to the possibilities of shelter within its home range. Thus, it is the locations of available cover, and the distribution of forest and open land - together with how abrupt and intense the disturbance is perceived by the deer - that determine, in what direction and how long an escape route the deer may run. CEDERLUND et al. (1981) showed that the escape routes of bucks were longer than those of does during larger Swedish orienteering events. This does not appear to be the case for roe deer at Kalø.

Often the distance to the nearest cover within the forest is not as long as it is when deer are fleeing across open fields to a hedgerow or a covert. Mean distances run by deer during flight from hunting was twice as long in fields as within the forest. Furthermore, elements in the landscape are

limiting the directions in which flight can occur. Thus, radio-marked roe deer never crossed, during flight, the heavy trafficked highways, bounding the study area to the south, west and north (Fig. 1). The escape route either led away from, or along the highway. In a few cases, however, unmarked roe deer did cross the highway to the west during flight. Moreover, the possibilities of fleeing out of the forest towards the south were limited, as the area is bounded by the sea. In several cases, flight within the forest stopped at its edge. This may be due to a reluctance in deer to move out in the open when fleeing.

Hunting is conducted only in part of the area (Fig. 2), and most beats at Kalø were the same from hunt to hunt. There were several roe deer whose home ranges did not overlap the beats, and therefore they never were exposed to the disturbing effects of hunting. Only one beat is driven through at a time, and the rest of the forest is undisturbed by such activities.

During an orienteering event most of the roe deer in the forest were affected. Most of the forest's area was utilized by runners (Fig. 2). Deer ran into cover as soon as they noticed the first runners, and many stayed there, until the event was over. Often the first cover was not effective enough when the runners became more numerous. This applies especially in a relatively open forest like Ringelmosse forest. Therefore, the deer may flee into a new cover several times, and perhaps eventually out of the forest. During large orienteering events, with more than 500 participants, in other rather open



Roe-buck, badly startled, running as fast as possible – the behaviour termed Flight B, in Table 1, page 5. (Photo: J.L.J)

Danish forests it was observed that up to half the estimated population of roe deer in a forest had taken flight out of the forest (JEPPESEN, unpubl.).

The typical pattern after both hunting and orienteering was that roe deer moved back to their home range at nightfall. Swedish roe deer, that were driven out of their home ranges by dogs, all returned within 24 hours (NÄSLUND 1979), and this was also typical for white-tailed deer (*Odocoileus virginianus*) in similar situations (MARCHINTON et al. 1970, CORBETT et al. 1971, SWEENEY et al. 1971, GIPSON & SEALANDER 1977). A few white-tailed deer, however, remained away for up to 7 days before they returned (CORBETT et al. 1971). Danish red deer exposed to hunting and orienteering returned, in most cases, to their home ranges within 4 days, but some remained away for several weeks (JEPPESEN 1987a). Like roe deer at Kalø, red deer returned under cover of darkness.

There were no signs of increased movements in an enlarged home range as a reaction to disturbance in roe deer at Kalø, as it was recorded in red deer (JEPPESEN 1987a), elk (*Cervus elaphus canadensis*) (KNIGHT 1981, KUCH et al. 1985), and white-tailed deer (HOOD & INGLIS 1974, DORRANCE et al. 1975). In extreme cases cervids may leave preferred areas completely, as was seen in red deer in New Zealand during control campaigns (BATCHELER 1968). Where orienteering (sport and military) takes place in smaller Danish forests at least once a week, examples are known, where roe deer no longer occur. Furthermore, roe deer have left the 'dog-forests' (forests, where dogs are allowed to roam freely).

That the percentage of orienteerers observing roe deer dropped from 85 at the event at Kalø in March to 54 in the June-event, is probably ascribed to the better visibility in the forest in March (the forest is 'transparent' due to the reduction in

vegetative cover in winter). At this time of year the deer are only able to find cover in dense, young plantings. After the first week in May when the beech bursts into leaf, the visibility in the forest becomes very poor, and later in summer the undergrowth is often tall making it much easier for the deer to hide.

The mean number of roe deer registered per observation during orienteering events dropped from 1.9 in March to 1.1 in June. This reflects the spatio-social pattern of roe deer. In March roe deer occur mainly in groups, as they do throughout winter. In April this pattern changes, as the bucks become territorial, and the pregnant females also disperse more evenly in the area. In the middle of June when most female deer at Kalø have given birth, roe deer almost only occur singly (in male territories and in smaller female 'breeding territories'). TURNER (1979) observed that at this time of the year, female roe deer stayed in cover when resting, and were more cautious than at other times of the year.

The orienteers reported a larger number of observed roe deer on March 19th than on June 15th (63 vs. 47), even though there were only half as many runners in March. As mentioned before, this was due to the visibility in the forest being good in March, and that each observation in March often involved several roe deer (groups). The general impression was that the roe deer reacted stronger to orienteering in March than they did in June. During the March 19th-event, for example, four radio-marked roe deer took flight far out of their home ranges. The impact, thus, was stronger with half as many runners. This does not signify, however, that summer is a better time for orienteering, as the breeding time is always a critical time for the new-born fawns, and especially if their mothers are cut off the possibility of contacting them.

At these small orienteering events that

did not last more than 2½ hours, even quite small (½–1 ha), but very dense thickets or marshes with a tall undergrowth, satisfied the demands of the deer for cover. In some cases almost all the runners passed by very close to the cover of a radio-marked roe deer, and the deer did not move. At larger orienteering events lasting 4–5 hours and with more than 500 runners, the thickets used for cover must be somewhat larger (see p. 18).

At these larger orienteering events lasting 4–5 hours, about 75% of the observations of roe deer were normally made during the first half of the event (JEPPESEN, unpubl., JEPPESEN 1984). A quite similar reaction was seen in red deer (JEPPESEN 1987c). Several roe deer took flight out of the forest or into dense cover during the first half of an orienteering event, but still deer were forced out of cover during the rest of the event, because of the influence of runners' behaviour. Owing to runners on long 'courses' advancing relatively late into new regions of the forest, comparably few roe deer were observed during the first half of the small events at Kalø on March 19th and June 16th (Table 2).

The flight distance (the distance to which a person can approach an animal without causing it to flee (ALTMANN 1958)) is shorter at night than during the day (see discussion in JEPPESEN 1987a), and during the night-orienteering event at Kalø, several runners observed roe deer lying close to where they were running. The three radio-marked deer moved a great deal during the night event, but as the runners, because of darkness, mainly stick to the forest roads and the quite open forest areas, the impact of a night-orienteering event is to be regarded smaller than a comparable event during daylight.

When roe deer within the forest are disturbed by one or a few persons, they react, as described, most often with a relatively short flight into the nearest cover. On the

other hand, roe deer that are startled in a small habitat, like a hedgerow or a covert, have to flee a longer escape route across the fields, before they reach cover (at Kalø often 1 kilometre). This happens *each* time, the deer are disturbed in such habitats, that most often are not wide enough to provide sufficient cover for roe deer. If the deer try to stay, the 'disturber' gets very close, - thus within flight distance. Quite a few roe deer stay in these habitats during the daylight hours, and under normal conditions they are free from disturbance for several days in succession. But hedgerows and coverts are vulnerable habitats, because the roe deer are forced to leave the habitat completely for that day, whether the disturbance is caused by one person, a stray dog, or a hunting party.

Recommendations concerning orienteering events

From what is learned at orienteering events at Kalø and in other Danish forests, a number of measures may be recommended, to diminish risk of roe deer becoming stressed to an unacceptable degree. This applies especially to larger orienteering events, whereas deer rarely risk being caught among crossing runners during small events with less than 100 participants.

The sanctuaries in which the roe deer can seek shelter during an orienteering event (the so-called 'game-pockets') function well. These sanctuaries are areas within the forest where entrance by runners is prohibited. Sanctuaries for roe deer should be scattered throughout the forest, as individual deer show strong attachments to their home range. The size and locations of these sanctuaries depend on where the densely overgrown parts are within the forest, and how large they are. To have any effect during larger orienteering events, the

size of sanctuaries should be at least 2 hectares (preferably larger), and be totally dense. It is essential that the runners respect the sanctuaries, partly when placing the 'courses', and partly by means of roping off relevant sanctuaries. Forest paths and roads that lead into a sanctuary should be barred. Sanctuaries along the forest edge may stop fleeing deer, and this is especially important near busy highways, and where deer fences run along the edge of the forest.

In open deciduous forests during summer there is often a rich undergrowth that provides good shelter for roe deer, whereas there is little undergrowth from November until May. During this period, only dense stands function as sanctuaries for roe deer. Thus, it is recommended in open forests that the forest service provides cover scattered in the forest, so that deer are able to seek shelter within their home ranges. Moreover, forests containing many fences are unsuitable for larger orienteering events, as roe deer fleeing out of home ranges and into fences risk a broken neck, or other serious injuries (examples from Danish forests are known).

To the greatest possible extent the different 'courses' should be gathered into certain regions with the same running direction (running corridors). This ensures that the sanctuaries are respected, and that the deer can avoid the runners by running aside when the first runners appear. Start and goal, respectively, should be positioned in one place. In case of start from different locations in the forest, the deer are easily 'trapped' among runners coming from different directions.

It is important that the placing of 'courses', as is the normal practice in Denmark, takes place in concert with the forest service, which most often has a good local knowledge of where the deer stay in the daytime.

In cases where deer are being chased from the forest, it is important with refuge

areas near the forest (neighbouring forest, scrub, hedgerows and coverts).

Roe deer are often in poor condition in late winter (February–March). At the end of the gestation period (April–May) and during the nursing period (May–June) the females are vulnerable to disturbances, partly because of their large energy demands at this time (see JEPPESEN 1984, 1987a), partly because the chances of survival for the new-born fawns depend on the area being free from disturbance. Furthermore, there is an indication that pregnant females may have an abortion because of physical exertion during flight.

Two fully developed fetuses of roe deer, weighing 2/3 of normal birth weight, were in April 1983 found in a Danish forest, lying 5 metres apart. The discovery was made 4 days after a large orienteering event with 2,000 participants, and veterinary investigations concluded that it was an abortion probably not caused by disease. It is reasonable to assume that it was an abortion caused by exertion during the orienteering event. GEIST (1978) mentions that exertion can cause abortion in reindeer and horses.

On hot days the deer may suffer from heat-stress in connection with strong physical exertion.

Hence, large orienteering events ought not to be arranged in the period March–June (no orienteering events at all take place during winter in Denmark).

During summer, a large part of the roe deer population in an area occurs in open country. At this time of the year there are not so many deer within the forest. Considering the forest's better ability of providing cover during summer, it may be recommended that larger orienteering events are arranged in the period July–August, until the corn fields are harvested, and the deer from the fields again return to the forests. This causes a brief disturbance to roe deer in their rutting season (July–August), but

here (as in all cases) the number of runners should be adjusted to the size of the forest. Irrespective of season it is hardly reasonable to arrange events with 2,000 orienteers in an open deciduous forest of only 200 ha. The impact of even 700 runners in a forest of this size appears to be strong. In predominantly coniferous forests, with good cover in large areas, larger orienteering events may be arranged with smaller effect on roe deer.

As stress-factors are cumulative (BAILEY 1984) it is necessary to consider the total impact of all disturbances in an environment. Therefore, the recreative arrangements in the forests ought to be coordinated in a manner that considers the needs of deer in the best possible manner.

Conclusions

Behaviour of roe deer when disturbed is to some degree determined by their wariness, and this depends among other things on their previous experiences with humans. In populations exposed to hunting the deer are more wary and secretive than in populations where hunting is prohibited (see discussion in JEPPESEN 1987a).

During battues, like those described in this paper, the acute disturbance is probably the most intense that the deer meet with. Here humans directly force their way into the most dense cover with the aim of flushing the game. As humans drive through the beat walking on a line while making noise, the roe deer are able to follow the events of the beat, and may therefore be able to survey the beat to a certain degree. They escape the stressing situation, as soon as they take flight, after which they calm down in a less disturbed refuge area. The beating only takes place in a confined area at a time. A few roe deer at Kalø were, however, exposed to two beats during a battue, as they fled from one beat to another.

During the small orienteering events at Kalø the impact of the disturbance was not particularly strong. Practically all roe deer in the forest were influenced by an event, but the deer reacted to the first runners in their surroundings by instantly seeking shelter in dense vegetation. Here most stayed during the 1–2 hours that the disturbance around them continued. Orienteers avoid dense vegetation and marshes as it saves time and energy to run around them. After the events had ended the roe deer resumed their normal activities.

That the effects of small orienteering events are not strong, apply for single events. It is quite another matter if orienteering events are arranged each week (or in the case of large events: each month) in a forest. Then the disturbing effect is multiplied, with a possible expelling of deer as the result (see p. 16). The same applies to battues and drive hunts.

Observations during large (700–1,000 runners) and very large (more than 2,000 runners) orienteering events in Denmark have shown, that the disturbing impact of these on roe deer is considerably stronger

than that of small orienteering events. The number of runners in the forest during a larger event that lasts 4 hours, is usually largest after 1½ hours, with more than half of the runners in the forest simultaneously during the second hour (GUSTAVSSON 1980, ANDERSEN et al. 1986). Roe deer that reacted with a short flight into cover when the first runners appeared, often had to flee again because of the increasing disturbance. Several deer often changed their direction of flight before they succeeded in escaping out of the forest. It was in such situations that a number of moose (*Alces alces*) and roe deer died from acute stress, during extremely large orienteering events (10–15,000 runners) in Sweden (SENNSTAM 1974, BORG 1974, SENNSTAM & STÅLFELT 1976). OLSSON (1976), for example, reported that two moose had died 10–15 minutes after the first contact with runners. In Denmark, only a few roe deer are known to have died from stress or physical injuries during orienteering events (JEPPESEN unpubl.). There is a great risk that rapid flight may cause severe injuries, when the deer run into obstacles like for example fences.

Dansk resumé

*Den forstyrrende indvirkning af orienteringsløb og jagt på rådyr (*Capreolus capreolus*)*

I perioden 1980–84 er reaktioner hos rådyr i forbindelse med mindre orienteringsløb (Tabel 2) og jagt (klapjagt og drivjagt) blevet registreret. Undersøgelserne er foretaget på Kalø i Østjylland (Fig. 1), hvor radiomærkede rådyrs aktiviteter og bevægelser i terrænet blev fulgt ved hjælp af pejleudstyr. Endvidere bidrog deltagende løbere samt jægere og klappere plus posterede observatører med observationer af rådyr (antal, adfærd, bevægelsesretning), mens for-

styrrelserne stod på. I vurderingen af materialet indgår desuden rådyrobservationer foretaget ved større orienteringsløb andre steder i landet.

På Kalø er der ikke drevet jagt på rådyr i undersøgelsesperioden eller i flere årtier før, men jagt på andet vildt forekommer. Rådyr på Kalø er ikke så sky som rådyr, der er udsat for direkte jagt.

Ved store orienteringsløb med adskillige hundrede løbere, og af en varighed på 4–5 timer

er det typisk, at ca. 75% af rådyrobervationerne er forekommet under løbets første halvdel, hvor de fleste dyr er flygtet i tæt dækning eller ud af skoven. Store (700–1.000 løbere) og meget store (over 2.000 løbere) orienteringsløb i Danmark har en betydelig voldsommere forstyrrende indvirkning på rådyr end små løb. Virkningen er ikke særlig stor ved de små løb, når der er tale om enkeltstående begivenheder.

Under de små orienteringsløb på Kalø, som foregik over størstedelen af skoven (se Fig. 2), løb rådyr typisk en relativ kort strækning i dækning (gennemsnitlig 432 m, se fordelingen Fig. 3); eventuelt mere end én gang under samme løb.

Under jagerne, hvor vildtet blev presset ud af den dækning, det var søgt ind i, løb rådyrene en længere flugtstrækning, - gennemsnitlig 847 m (Fig. 3). Jagt gennemføres kun i en del af området, og i én velafgrænset sådanne gang. Rådyrene slap fri af den stressende påvirkning, straks de flygtede, og faldt derefter til ro på et uforstyrret areal. Ved flugt ud over markerne løb dyrene dobbelt så langt som ved flugt inde i skoven (1.141 m vs. 556 m).

Under begge former for forstyrrelse blev der registreret rådyr, som forlod deres home range eller flygtede helt ud af skoven. Uanset forstyrrelsens art opholdt Kalø rådyr sig fra 0–7 timer på tilflugtsstedet. De begyndte typisk at bevæge sig tilbage ved mørkets frembrud.

Tæmmelig små (ned til ca. ½ ha), tætte bevoksninger eller moser med høj urtevegetation opfyldte rådyrenes krav til dækning ved de små orienteringsløb på Kalø, der varede op til 2½ time. Ved større løb med over 500 løbere og af en

varighed på 4–5 timer er det påkrævet at friholde større, tætte bevoksninger. Halvdelen af den anslåede bestand af rådyr i en løvskov på 200 ha er registreret flygte ud af skoven ved orienteringsløb med over 500 løbere. I skove med overvejende nåletræer og med god dækning på store arealer kan der arrangeres store løb med mindre effekt på rådyrenes adfærd end i åbne løvskove.

Den forstyrrende indvirkning af de små orienteringsløb på Kalø var større i marts end i juni. I marts er løvskoven "gennemsigtig", og dyr og mennesker kan se hinanden over store afstande. Rådyr ses her i småflokke, og der er mange "konfrontationer" mellem løbere og rådyr. I juni er visibiliteten i skoven meget mindre, bøgen er sprunget ud, og undervegetationen er på vej op. Rådyr observeres nu stort set kun enkeltvis på grund af deres sociale adfærdsmønstre. I juni var der langt færre konfrontationer mellem løbere og rådyr. Det er dog ikke bedre at arrangere orienteringsløb i juni end i marts, da yngletiden er kritisk for de nyfødte rålam, især hvis moderen bliver afskåret fra muligheden for kontakt med dem.

Det vurderes at være mest skånsomt for rådyr, hvis større orienteringsløb afholdes i juli–august, inden kornet på markerne høstes, og mange dyr derfra vender tilbage til skoven.

Der gives en beskrivelse af rådyrs adfærd, når de udsættes for forstyrrelse (Tabel 1). Betydningen af forstyrrelser i små biotoper som levende hegn og remiser vurderes. Publikationen afsluttes med en række anbefalinger vedrørende orienteringsløb.

Резюме на русском языке:

Беспокоящее воздействие состязаний в беге с ориентировкой и охоты на косуль (*Capreolus capreolus*).

В периоде с 1980 по 1984 г. регистрировались реакции косуль в связи с небольшими состязаниями в беге с ориентировкой (Таблица 2) и охотой (облавой и с загонщиками). Исследования проводились на землях имения Калё в Восточной Ютландии (Фиг. 1), где при помощи радиопеленгаторов следовали за деятельностью и передвижением по местности животных, помеченных радиопередатчиками. Кроме того, при наблюдениях косуль (их

численности, поведения и направления их передвижения) помогли участники в бегах, охотники и загонщики, а также расставленные по местности наблюдатели, одновременно с тем, как происходили беспокоящие события. При оценке материала кроме того использовались наблюдения за косулями при более крупных состязаниях в беге с ориентировкой в других местностях Дании.

В имении Калё не было охоты на косуль, ни в периоде наблюдений, ни за несколько десятилетий перед этим, но бывает охота на другую дичь. Косули в Калё не так пугливы, как косули, подверженные непосредственной охоте.

При крупных состязаниях в беге с ориентировкой с несколькими сотнями участников, длившихся 4-5 часов, типично что 75% всех наблюдений косуль произошли во время первой половины состязания, когда большинство косуль уходило в укрытие в чашу или убегали из леса. Крупные (с 700-1.000 участниками, и крупнейшие (более 2.000 бегунов) состязания в беге с ориентировкой в Дании оказывают более сильное беспокоящее влияние на косуль, чем небольшие состязания. При небольших состязаниях беспокоящий эффект не особенно силен, если эти состязания состоятся редко.

Во время небольших состязаний в беге с ориентировкой в Калё, происходивших по большей части леса (см. Фиг. 1), косули типично убегали в укрытие недалеко (в среднем 432 м, см. распределение в Фиг. 3), иногда несколько раз в течение одного и того-же состязания.

Во время охот, когда дичь выгоняли из укрытия, в которое она ушла, косули пробегали более далекие расстояния бегства - в среднем 847 м (Фиг. 3). Охота происходит только в части района, и каждый раз в одном четко ограниченном месте облавы. Раздраженность косуль проходила немедленно после их бегства, и затем они успокаивались в спокойном участке. При бегстве по лугам животные пробегали вдвое дальше, чем при бегстве внутри леса (1.141 м, по сравнению с 556 м).

Во время обоих видов беспокоящих событий были зарегистрированы косули, оставлявшие свое "собственное пастбище", или совсем оставлявшие лес. Независимо на вид нарушения их покоя, косули в Калё оставались на месте убежища от 0 до 7 часов. Типично они начинали идти обратно при наступлении темноты.

Довольно небольшие (до мин. прибл. 1/2 га) густые заросли, или болота, покры-

тые высокой растительностью, удовлетворяли требованиям косуль к убежищу во время небольших состязаний в беге с ориентировкой в Калё, длившихся до 2 1/2 часов. При более крупных состязаниях с более чем 500 участниками и длительностью в 4-5 часов, необходимо предоставить косулям более обширные спокойные густые заросли. Было зарегистрировано, что половина всей оцененной популяции косуль в лиственном лесу площадью в 200 га во время состязаний с более чем 500 участниками убегала из леса. В лесах с преобладающими хвойными деревьями и с хорошими возможностями укрытия в обширных пространствах, можно устраивать более крупные состязания без такого беспокоящего воздействия на поведение косуль, как в открытых лиственных лесах.

Беспокоящий эффект небольших состязаний в беге с ориентировкой в Калё был сильнее в марте, чем в июне. В марте лиственный лес "прозрачен", животные и люди могут видеть друг друга на далеком расстоянии. Косули встречаются небольшими табунками, и происходит много "очных ставок" бегунов с косулями. В июне видимость в лесу гораздо более ограничена, буки распустились, и подлесок вырос. Тогда косуль в общем видно только по одиночке, согласно их образу общественного поведения. В июне происходило гораздо меньше "очных ставок" бегунов с косулями. Однако, такие состязания не лучше организовать в июне, чем в марте, так как в периоде размножения новорожденные детеныши косуль подвержены опасности, особенно если матери мешают восстановить с ними контакт.

Считается, что наиболее внимательным к косулям было-бы организовать крупные состязания в беге с ориентировкой в июле-августе, до уборки урожая на нивах, пока многие косули еще не возвратились оттуда в лес.

Дается описание поведения косуль при нарушении их покоя (Табл. 1). Сценивается значение нарушений покоя в небольших биотопах, таких как живых изгородях и чащах. В заключении статьи дается ряд рекомендаций по организации состязаний в беге с ориентировкой.

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