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Rangifer population ecology: a Scandinavian perspective

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Abstract: Population ecology is concerned with measuring changes in population size and composition, and identifying the causes of these fluctuations. Important driving variables include animal body size and growth rate, and their relationship to reproduction and mortality. Among wild and domestic reindeer (*Rangifer tarandus tarandus*), reproductive performance, calving time, calf birth weight and neonatal mortality are strongly correlated to maternal weight. Heavy females enjoy higher pregnancy rates, calve earlier, and give birth to heavier calves which have a higher neonatal survival rate than light females. Most studies indicate that both weaning weight of a calf and mature body weight correlate to its birth weight. Calf body weight and composition influence the rate of attainment of sexual maturity. Females which breed as calves suffer reduced growth and give birth to smaller calves, which suffer higher neonatal mortality and lower rates of postnatal growth. A yet unresolved question is whether reindeer body weight, and hence reproductive performance and neonatal mortality, are more strongly influenced by winter than by summer grazing conditions. This paper reviews population ecology studies on wild and domestic reindeer and promotes the view that body size in *Rangifer* is determined primarily by grazing conditions during the summer.

Key words: *Rangifer,* reproduction, mortality, growth.

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Introduction

Although regulated in number primarily through hunting or herding practices, most populations of wild and domestic reindeer (*Rangifer tarandus tarandus*) are also influenced by predation, climatic extremes, insects, and food limitation. These factors may act directly or indirectly through increased mortality or through reduced reproduction. In a comprehensive literature review, Eriksson *et al.* (1981) demonstrated that lichens, when available, constitute a significant portion of the winter diet of *Rangifer.* Constraints on winter food availability, particularly lichens, has generally been accepted as the main factor responsible for poorer condition, increased mortality of young and reduced reproduction among reindeer (e.g. Skogland, 1983; 1984; 1985; 1988). Consequently, management of wild reindeer populations in Norway is based primarily on lichen biomass in the various areas (Gaare & Skogland, 1980). This principle also applies to management of domestic herds in most places. Nonetheless, reindeer also thrive in environments without lichens or with low lichen biomass provided there is access to alternative food, *e.g.* Russia (Syroechkovskii, 1984), Svalbard, (Reimers, 1982; Tyler, 1987) East Greenland (Reimers, 1980a) and South Georgia (Leader-Williams, 1988).

The body weight cycle in *Rangifer* with rapid growth in summer and slow growth or weight loss in winter appears to be endogenous and independent of the seasonal variation in the food supply (McEwan 1968; Skjenneberg & Slagsvold, 1968; Dauphiné, 1976; Reimers *et al* , 1983; Suttie & Webster, 1995). The adaptive significance of this cyclic pattern of growth is that it allows weight reduction in winters when food is scarce and of low quality and compensatory growth and a rapid restoration of body condition during the lush summer. Different populations of teindeer are characterized by different body sizes (Movinkel & Prestbakmo, 1969; Reimers *et al.*, 1983). Body weight influences pregnancy rates (Reimers, 1983a; Lenvik, 1988), calving time (Reimers, 1983b), birth weights (Skogland, 1984) and calf survival (Skogland, 1984; 1985). This paper reviews population ecology studies on wild and domestic reindeer and promotes the view that body size in *Rangifer* is determined primarily by grazing conditions during the summer.

Material and methods

Body condition and growth rates are based upon measurements of total body weight (TBW) and dressed or carcass weight (DW = TBW minus viscera, head, skin and lower legs). As the fetus and its associated tissues and rumen fill vary substantially with season (*e.g.* Adamczewski *et al* , 1987), DW is a better index of condition than TBW. For comparative purposes, the TBW was estimated from dressed weight according to the equation: $TBW = 5.9 + 1.66 * DW$; $N = 189$; $r^2 = 0.958$ (Reimers, unpubl. data).

Growth rates were estimated from linear regression analysis. Summer growth rates of calves were calculated from birth weights estimated from fetal growth rates (Reimers, unpubl. data) and known calving dates (Table 2), and calf body weights sampled through the hunting season from 20 August to 25 September. Summer growth rate of adults was estimated on basis of animals sampled in June/July and during the hunting or the slaughter season. Weights obtained during the hunting season were assumed to reflect the weight of the animals 1 September.

Winter weight loss was assumed to occur from 1 December to 1 May, after which males and barren females start regaining weight. Pregnant females, however, continue to loose weight until calving.

Winter pastute quality was assessed on the basis of lichen availability according to Gaare and Skogland (1980) and Skogland (1985). Plant growth was assumed to start on 1 June.

The animals were aged on basis of tooth development and wear or from cementum annuli (Reimers & Nordby, 1968).

Results

Pregnancy rates

Pregnancy rates are reported to range from 75–100% among 2 1/2 year or older wild or domestic reindeer (Table 1; see appendix for all tables). There is a significant positive relationship between catcass weight (DW) at the onset of rutting and pregnancy rate (Reimers, 1983a; Lenvik *et al.*, 1988). Pregnancy has not been recorded in animals weighing less than 21 kg at breeding. All wild reindeer females with an estimated pre-rut TBW 69 kg were pregnant. In the Kaamanen experimental herd in Finland average pregnancy rate was only 79% even though the mean TBW was above 70 kg. Pregnancy rate in Svalbard reindeer (*Rangifer tarandus platyrhynchus*) in Nordenskiøld Land, based upon the proportion of females ≥1 year old with antlers two to three weeks before calving, was annually highly variable and ranged from 26 to 82% in 1980–82 (Tyler, 1987).

Calving time

Plant phenology (Skogland, 1989a), predation and insect harassment (Bergerud, 1975) are suggested as the main factors explaining birth synchrony and calving time in *Rangifer*. Most calves are born within 14 days (*e. g.* Nowosad, 1975; Eloranta & Nieminen, 1986) in spring. Calving midpoint date (the day when 50% of the pregnant females have given birth) is highly variable within and between subspecies. Extreme midpoint values in reindeer vary from 15 April in the Mackenzie Delta herd (Godkin, 1986) to the first week of June in Svalbatd reindeer (Kastnes, 1979; Tyler 1987). In southern Norway the calving midpoint varies from 6 to 27 May (Table 2) and is strongly correlated to pre-rut dressed weights in females (Fig. 1).

Birth weight

Birth weight varies among various herds (Table 3). Birth weight is positively correlated with maternal weight immediately prior to calving (Espmark, 1980; Rognmo *et al.*, 1983; Eloranta & Nieminen, 1986) and at mating (Eloranta & Nieminen, 1986).

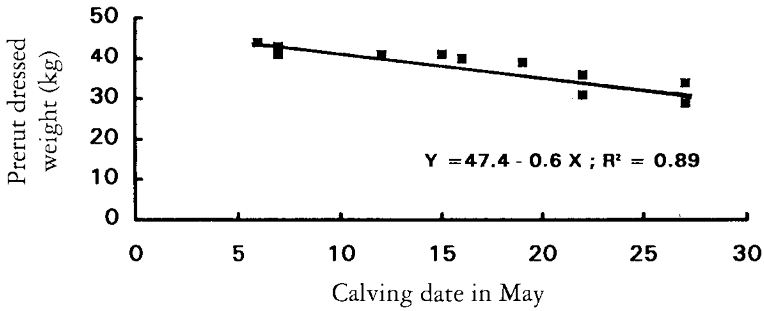

Fig. 1. The relationship between pre-rut dressed weights of adult (> 2 yr) reindeer females and calving dates (the date when 50% of the pregnant females have given birth) in 11 wild reindeer areas in southern Norway. (See Table 2 for references).

Calf mortality
Calf mortality during the first 5 months following birth varies from almost zero in Knutshø in 1984 (Skogland, 1985) to 44% in a semi domesticated herd (Rognmo *et al.*, 1983) (Table 4). A calf's chance of survival appears to be strongly influenced by its mother's body weight at the time she gives birth (Skogland, 1984; 1985). Females with small body weights give birth to small calves which suffer higher mortality than calves born from well fed and heavy females. Tyler (1987) recorded mortality of Svalbard calves aged 0–4 months during 1980–82 and found that it was negligible all three years.

Weight loss during winter
Average dressed weight loss among wild reindeer from January to April ranged from 11 to 21 g/day among calves and from 18 to 70 g/day in females aged ≥ 1 yr (Table 5). Applying these values to the entire weight loss period 1 December to 1 May, the estimated weight loss ranged from 1.7–3.2 kg among calves to 2.7–10.6 kg among 1 1/2 year or older females.

Weight increase during summer
Growth rates of wild reindeer calves in Hardangervidda and in Rondane were 70 and 82% respectively of the growth rates of calves in North Ottadalen decreasing to 29 and 72% respectively in yearling males (Table 6). The growth rate differences are reflected in the increasing carcass weight differences between male calves and yearlings (Table 7). Summer growth rates among semi domesticated reindeer were comparable to those in Hardangervidda, which were 80–90% of the growth rates in Rondane and 50–70% of those in North Ottadalen. Based upon the recorded growth rates, the estimated increase in total body weight from 1 June to 1 September varies between 25 and 36 kg among calves and between 13 and 38 kg among older animals. This corresponds to a dressed weight increase of 12–25 kg among calves, 10–22 kg among yearling males and 13–23 kg among lactating females ≥ 2 year.

Discussion

Pregnancy rates, calving time, birth weight and calf mortality
Pregnancy rates in reindeer are strongly related to autumn body weight (Table 1). Pregnancy rates in yearling semi domesticated reindeer increased from close to zero to about 90% as body weight increased from 40–50 kg (Lenvik *et al.*, 1988). In some semi domesticated and wild herds, calves reach 40 to 50 kg in autumn and conceive in their first year of life (Reimers, 1972; 1983a; Ropstad *et al.*, 1991). In semi domesticated herds the consequences of early breeding has been high mortality among calves born from calves and reduced maternal gain in weight (Ropstad *et al.*, 1991; Lenvik & Aune, 1988). We have been unable to record corresponding data in wild populations. It appears maladaptive to breed, loose the calf and suffer a growth set back, and so presumably management conditions, under which a yearling looses its calf, are unfavorable.

Although female weight has a strong predictive power, number, age and body weight of the breeding males also affect the pregnancy rate (Lenvik *et al.*, 1988). Males present after the hunting season were few, young and in poor condition during the sampling years (Reimers, 1975), and may well be the reason for lower pregnancy rates in Snøhetta than predicted from the TBWs (Reimers, 1983a).

Caribou are reported to mature later and reach lower pregnancy rates than reindeer (Dauphiné, 1976; Miller, 1976; Parker, 1983; Skogland, 1989b). However, nutrition and body weight are evidently also key factors among these subspecies.

For example, Quellet *et al.* (1991) found that 68 out of 69 caribou (*Rangifer tarandus groenlandicus*) including 15 yearlings, were pregnant on Southampton Island. This introduced herd of caribou were in prime physical condition judging from back fat thickness and kidney fat index.

Timing of births reflects both nutritional and genetic influences (Tables 2–3; Fig. 1). The timing of rut (Lenvik, 1988) and calving time (Reimers, 1983b) are related to the pre-rut body weights of females. Heavy females presumably ovulate earlier and so give birth earlier than light females. Calving time may change with changing environmental conditions (Nowosad, 1975; Skogland, 1990b). The midpoint of calving in the Knutshø area is 16 May (Fig. 1). These reindeer originated in the neighbouring Snøhetta and possibly Rondane North areas, from where they migrared in the 1950-60s and where midpoint of calving occurs on 27 and 22 May, respectively. Calving in Snøhetta presently appears to occur 5 days earlier, following reduction in population size and increase in body weight, while calving in North Ottadalen occurs 5 days later following a population increase and a decrease in body size (Flydal & Reimers, unpubl. data). According to Skogland (1990b), calving in Hardangervidda has advanced 10 days from 1983 to 1989, parallel to improvement in the animals' physical condition.

The birth weight of calves is related to the weight of females just prior to calving (*e.g.*, Varo, 1972; Skogland, 1984; Eloranta & Nieminen, 1986). Calves born from mothers weighing more than 90 kg total body weight, weighed 40-70% more than calves born to females weighing less than 60 kg (Rognmo *et al.*, 1983; Eloranta & Nieminen, 1986). However, as emphasized by Eloranta & Nieminen (1986), the birth weights of the calves in their study related equally significantly to female body weights in autumn. Consequently, the birth weight of a calf may be determined by the body weight of the female in autumn.

Early mortality of calves is clearly related to birth weight which is itself influenced by maternal body weight (*e.g.* Varo, 1972; Rognmo *et al.*, 1983; Eloranta & Nieminen, 1986). Lenvik & Aune (1988) were able to reduce calf mortality from 19-24% to 5-6% by selecting for high maternal body weight. In one of the experimental herds the calf mortality rate up to 2 months of age was 48% among calves born from females with 55 kg body weight and 2% among females of 70 kg or more.

Weight loss during winter

The average winter weight loss (DW) among 1 1/2 year and older females in the poor areas (Table 5) was 53±10 g/day, with a range from 16 g/day in Hardangervidda in 1983 to 72 g/day in Snøhetta around 1960. In Snøhetta, the reindeer population reached a maximum of some 15,000 animals (4 animals/km^2) in the summer 1963 (Reimers, 1968), at which time the winter pastures were heavily overgrazed (Gaare, 1968). A reduction harvest brought the population down to about 2,000 animals towards the end of the 1960s. In Hardangervidda, the reindeer population reached a maximum of about 32,000 animals (4 animals/km^2) in summer 1965, with pasture detoriation comparable to that in Snøhetta (Skogland, 1990a). Increased harvest reduced the population to about 7,000 animals in 1971. Concerned with this rapid reduction in numbers, the game administration (Direktoratet for vilt og ferskvannsfisk) protected the herd from hunting the following 2 years. Hunting was reopened in 1973, and in 1983 when the reindeer population was approaching a second maximum (24,000 animals summer 1984), the loss in dressed weight during winter (16 g/day) was the lowest on record. The winter pastures were at this time still heavily overgrazed (Skogland 1990a), calves were born small in 1983 (Skogland, 1984) and female body weights were all time low (Table 8). We have no indications of favorable snow conditions in winter 1982-83. Consequently, the high population size and the heavily overgrazed lichen pastures, should, according to the accepted management hypothesis, have resulted in rapidly decreasing body weights through the winter 1982–83. However, weight loss was relatively small (mean 16 g/day; Table 5) and female body weights were maintained reasonably well throughout that winter. In two of the areas (Forelhogna and North Ottadalen), body weight loss during winter was remarkably high. This occurred in spite of high quality winter pastures (Skogland, 1983). These results support the earlier view (Reimers, 1983) that winter range quality or lichen biomass does not explain reindeer body weight development through winter and the McEwan (1968) winter dormancy hypothesis.

Summer growth rates

The summer growth rates (TBW) among calves and yearling males in North Ottadalen were close to 400 g/day (Table 6). This is the maximum growth rate recorded among free-grazing reindeer, but higher rates of growth have been recorded among penned reindeer fed on a high plane of nutrition (Luick *et al.*, 1980; Ryg & Jacobsen, 1982; see Reimers 1983b). In Hardangervidda, the average summer growth rate in calves was 277 g/day, which is in the lower end of the scale for calf growth rate among free-ranging reindeer (*e.g.* Krebs & Cowan, 1962; Haukioja & Salovara, 1978; Nieminen & Petterson, 1990).

The differences between the ateas in calf growth rates may relate to birth weights and lactational conditions during the first month. Both are strongly related to the female's body weight. Calves in Hardangervidda are born small from small mothers. Small mothers may produce less milk of poorer quality and hence raise calves of smaller body size by 1 Septembet than better fed mothets. Female body condition has not been reported to influence milk composition (Luick *et al.*, 1974; Jacobsen *et al.*, 1981; Rognmo *et al.*, 1983). Restricted feed during late pregnancy may reduce milk volume (Jacobsen *et al.*, 1981). With the method used (milking after a 4-hour separation of mother and calf) they found a significantly higher milk production 2 weeks postpartum in the group fed supplements during pregnancy. Judging from calf growth rates, Rognmo *et al.* (1983), nonetheless concluded that milk yield, within certain limits (undefined by the authors), is independent of female nutrition during pregnancy. This apparent contradiction may relate to differences in feed quality during lactation. Rognmo *et al.* (1983) fed the lactating females a high quality diet during the first three weeks of lactation, while Jacobsen et al. (1981) added lichens to whatever the reindeer could find on a fenced-in natural pasture.

As shown by White (1983) and White & Luick (1984) milk production and calf growth rate appear to be strongly influenced by food quality in summer. Calves botn from reindeer kept on a high plane of nutririon in winter and spring and then given a low plane of nutrition (dwarf birch and sedges) following peak lactation in early summer had a 24% lower growth rate than the calves given a high plane of nutrition (willows and sedges). The poorer summer range condition reduced milk production and therefore the calf growth rate. Although the reindeer calves in Jacobsen *et al.* (1981) and White (1983) were unable to compensate fot lower milk intake by greater intake of forage, Hudson & Adamczewski (1990) noted that elk calves (*Cervus elaphus*) receiving less milk may compensate by eating more solid food and attain the same growth rate as those consuming more milk. In a study of captive woodland caribou (*Rangifer tarandus caribou*), Lavigueur & Barette (1992) found that growth rates of calves from birth to 45 days of age were positively correlated with suckling rate (suckles/hour) during the first 35 days. From 46 to 100 days, growth rates were positively correlated with time spent feeding on pelleted ration and on hay. They suggest that metabolic weaning (the time when the offspring should be able to satisfy all its nutritional requirements by itself) could begin at around 15–20 days and end at about 40–45 days.

The low growth rate in summer recorded among Hardangervidda calves suggests food limitation in summer. At the start of their second growing season, the initial effects of later calving time and possible milk quantity shortages should be absent. Furthermore, the ability for compensatoty growth (Wilson & Osbourne, 1960; Allden, 1970) should be present. Apparently, it is not. Yearling males in Hardangervidda grow during their second summer at a lower rate than they did as calves. The difference in dressed weights towards the end of the growing season (1 September) increased 8 kg, from 14 kg as calves to 22 kg as yearlings in Hardangervidda compared with North Ottadalen (Table 7). The corresponding difference between North Ottadalen and Rondane increased 3 kg, from 9 kg as calves to 12 kg as yearlings.

The reason why Reindeer in Snøhetta, Hardangervidda and Rondane do not attain the body size of the animals in North Ottadalen, Forelhogna and Knutshø is not explained by poor winter nutrition. The winter pastures in Rondane are excellent (Skogland, 1983) and weight loss in winter is small but the animals are apparently unable to grow at a maximum rate during the summer. Nevertheless, weight loss is moderate even on the heavily overgrazed winter pastures in Snøhetta and Hardangervidda. There are two possible explanations: (1) pre- and postnatal food limitation have reduced the skeletal frame and thus the animals will grow to smaller overall size; and (2) summer conditions in terms of range quality or grazing conditions prohibit growth at a maximum rate. Allden (1970) in his review on food deprivation on cattle and sheep, found no evidence to show that a calf subjected to nutritional deprivation from an early age of suckling will eventually become a cow of smaller stature. There were indications that restricted nutrition in late prenatal or early postnatal life may affect the ultimate size in sheep (Allden, 1970). The evidence is by no means conclusive, however, because the experiments that have shown persistent residual effects have been of too limited duration. In field experiments with sheep, differences at maturity have been small (Allden, 1970). Profound nutritional stress applied to breeding ewes during early or late pregnancy have resulted in reduced birth weights. With a normal diet restored at birth, however, the weight difference was small or no longer evident.

Compensatory growth

Compensatory growth in summer following food restriction in winter is well documented in cervids. Suttie (1980); Suttie *et al.* (1983); Suttie *et al.* (1984) and Milne *et al.* (1987) reported that red deer (*Cervus elaphus*) subjected to nutritional deprivation during winter showed a remarkable compensatory growth during summer. but failed to compensate fully for the previous under nutrition. In a comparable study on yearling elk stags (*Cervus canadensis*), Wairimu *et al.* (1992) reported that the group of elk wintered on medium-quality hay attained similar weights and frame measurements in July as the group wintered on a high-quality diet.

Although no long term controlled feeding experiments comparable to the red deer and elk studies have been carried out, compensatory growth following food restriction apparently also occurs in reindeer. Kumpula & Nieminen (1992) noted that calves were capable of compensating for a low birth weight if summer conditions (temperatures, rainfall and insects) were favorable. In yearling males fed a submaintenance diet through winter, Jacobsen *et al.* (1977) reported compensatory summer growth tates (TBW) upon realimentation of 114-180 *vs.* 96–114 g/day, and Ryg & Jacobsen (1982) 352 *vs.* 209 g/day. Espmark (1980) measured a summer growth of 194 g/day among lactating females food restricted during the month before calving, compared to 134 g/day in the unrestricted group. Calves born from mothers given restricted feed during late pregnancy, however, had a lower growth rate than calves born from supplementary fed females (Espmark, 1980; Jacobsen *et al*, 1981). Rognmo *et al.* (1983) reported the opposite result; calves born from food restricted females grew at a faster rate than calves born from supplementary fed females. It is important in this context to note that male calves have a mote rapid growth rate than female calves (*e.g.* Petersson & Danell, 1993). There were 7 male vs. 2 female calves in the fast growing group, and 2 male *vs.* 7 female calves in the slower growing group in the growth study of Espmark (1980) and therefore the nutritional effect may be confounded. The same may apply to Jacobsen *et al.* (1981) and Rognmo *et al.* (1983); neither of them stated the sex composition for the two groups of calves.

Summer grazing conditions - pasture quality and insect harassment

Since Klein (1968) suggested summer range quality as the main factor effecting growth rate and body size in reindeer, several workers have published reports in support of this. (*e.g.* Movinkel & Prestbakmo, 1969; Reimers, 1980b, 1983b; Huot, 1989; Kojola & Helle, 1993; Crete & Huot, 1993). As the reindeer in Snøhetta, Hardangervidda and Rondane fail to grow as rapidly as the reindeer in North Ottadalen, Forelhogna and Knutshø, focus needs to be on the summer grazing conditions. All of these areas except Rondane are rated as good summer ranges (Reimers *et al*, 1983; Skogland, 1983). Although ranges are rated as good, the quality of them as reindeer habitat most certainly vary. Insect harassment is an additional and frequently overlooked component of summer habitat quality. It is conceivable that the harassment effects will vary between years and between areas due to variations in summer climate, population size and topography and insect relief areas (high mountains and snowbeds). Insects keep animals moving about and hence increase energy expenditure and reduce grazing time (*e.g.* Kelsall, 1968; White *et al*, 1975; Thomson, 1977; Reimers, 1980b; Helle & Tarvainen, 1984; Russell & Nixon, 1990; Kojola, 1991; Helle & Kojola, 1994). Fancy's (1986) simulation of the energy budget of a lactating caribou, showed the animal in negative energy balance for 12 days in July, implying a carcass weight loss of 4 kg, resulting from insect harassment. Observations of reindeer and caribou during summer in a variety of locations indicated that the harassment effects arises from attacks from warble (*Hypoderma tarandi*) and nose bot flies (*Cephenemyia trompe*) rather than from mosquitoes (Culicidae) (Reimers, unpubl. data). The flying activity of these two species increases with increasing air temperature and the number of flies present (Folstad *et al*, 1991; Nilssen & Haugerud, 1994). The number of flies present is also a function of *Rangifer* population size.

In conclusion: a large amount of data indicate that pregnancy rate, calving time, calf birth weight and early calf survival among reindeer are strongly related to the maternal body weight. As the winter weight loss in reindeer is moderate even on severely overgrazed winter pastures, it appears that growth rates and ultimate body size in reindeer are primarily a function of summer grazing conditions. Maximum growth rate in summer of about 400 g/day (TBW) is recorded in feeding experiments with semi domesticated reindeer and in a few wild reindeer areas. In most other situations, wild as well as domestic reindeer show summer growth rates far below the maximum. This suggests a closer look at the summer grazing conditions, including pasture diversity and quality and insect harassment from primarily warble and nose bot flies. High quality summer pastures are of limited value to the reindeer if harassing insects (or extensive human activity) prevent them from feeding effectively.

Winter pastures are important in providing energy and small amounts of protein, but they will generally be incapable of meeting maintenance requirements and should be viewed as holding areas for the animals until summer ranges become available (Torbit *et al.,* 1985). It is probably of adaptive significance to allow loss of body weight in times of scarcity and a rapid build up in times of plenty. The Svalbard reindeer convincingly exemplify this strategy (Reimers, 1982).

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Appendix: Tables 1–8

Table 1. Estimared pre-rut body weights (TBW) and mean rates of pregnancy in domestic and wild reindeer herds. The TBW of wild reindeer was estimated from rhe regression TBW = 5.9 + 1.66*DW.

Area/herd	Period	Pre-rut TBW (kg)	Mean pregnancy rate (%)				Reference
Age at breeding		2+ yr	0–1 yr	1–2 yr	3+ yr	*n*	
Domestic reindeer							
Lødingen, Norway	1960–63		6	61	77		Skjenneberg & Slagsvold (1968)
Kaamanen, Finland	1970–84	71	0	38	79		Eloranta & Nieminen (1986)
Arvidsjaur, Sweden	1981–82		27	60	93	210	Mossing & Rydberg (1982)
Riast/Hylling, Norway	1976–79	57		63	91	1114	Lenvik *et al.* (1988)
Essand, Norway	1976–79	59		67	94	581	Lenvik *et al.* (1988)
Trollheimen, Norway	1976–79	59		94	92	1038	Lenvik *et al.* (1988)
Mackenzie Delta Herd, Canada[1]	1976–81				99		Godkin (1986)
Wild reindeer, Norway							
Forelhogna	1983	77		100	100	22	Skogland (1984)
North Ottadalen	1967–72	79		50	100	10	Reimers (1983a)
South Ottadalen	1967–72	69	75	75	100	21	Reimers (1983a)
Norefjell-Reinsjøfjell	1992–94	74			97	240	Reimers (unpubl.)
Knutshø	1983	75			100	23	Skogland (1984)
Rondane North	1970–72	66	0	63	94	53	Reimers (1983a)
Snøhetta	1951–59	64	0	23	75	132	Reimers (1983a)
Snøhetta	1963–65	62	0	0	80	19	Reimers (1983a)
Hardangervidda	1948–58	57	0	50	79	48	Reimers (1983a)
Hardangervidda	1970	54	0	33	84	46	Reimers (1983a)
Hardangervidda	1973	57	0		91	25	Reimers (1983a)
Hardangervidda	1983	54	0	80	88	69	Skogland (1984)

[1] Twin fetuses occurred in from 0.4 - 26.2% of the females.

Table 2. Midpoint calving date (the day when 50% of the pregnant females have given birth) in semi-domesticated and wild reindeer herds. Values are multi-year means.

Area	Midpoint calving date	Reference
Semi-domesticated reindeer		
Kautokeino, Norway	8 May	Skjenneberg & Slagsvold (1968)
Kaamanen, Finland	20 May	Eloranta & Nieminen (1986)
Mackenzie Delta Herd, Canada	15 April	Godkin (1986) Nowosad (1975)
Wild reindeer, Svalbard	1st week of June	Kastnes (1979), Tyler (1987)
Wild reindeer, Norway		
Forelhogna	7 May	Skogland (1984)
North Ottadalen	6 May	Holthe (1975)
South Ottadalen	12 May	Holthe (1975)
Norefjell-Reinsjøfjell	7 May	This work
Knutshø	16 May	Reimers (1983b)
Rondane North	22 May	Reimers (1983b)
Rondane South	15 May	Reimers (unpubl.)
Setesdal West	22 May	Reimers *et al.* (1980)
Setesdal East	19 May	Engen (1991)
Snøhetta	27 May	Holthe (1975)
Hardangervidda	27 May	Skogland (1984)

Table 3. Mean total body weights (kg) of females and newborn calves in semi-domesticated and wild reindeer.

Area/Herd	Maternal pre-calving (April) weights	Maternal autumn (Aug.-Sept.) weights	Calf birth weights Males	Females	M + F	Reference
Semi-domesticated reindeer						
Kaamanen, Finland		< 50			4.2	Eloranta & Nieminen (1986)
Kaamanen, Finland		51-90			4.5-6.1	Eloranta & Nieminen (1986)
Kaamanen, Finland		> 90			6.6	Eloranta & Nieminen (1986)
Finland, domestic reindeer					5-6	Timisjärvi *et al.* (1984)
Finland, domestic reindeer	62		6.0	5.7		Varo (1972)
Lødingen, Norway	62–75				4.7	Espmark (1980)
Lødingen, Norway	56				3.7	Rognmo *et al.* (1983)
Lødingen, Norway	68				4.5	Rognmo *et al.* (1983)
Lødingen, Norway	68				4.5	Rognmo *et al.* (1983)
Lødingen, Norway	82				5.8	Rognmo *et al.* (1983)
Mackenzie Delta Herd, Canada			7.3	6.9	7.1	Nowosad (1975)
Wild Reindeer, southern Norway						
Snøhetta/Hardangervidda 1950-73	50 (27)[1]	55 (30)[2]			4.3	Reimers (unpubl.)
Hardangervidda 1983	46 (23)	54 (29)			3.7	Skogland (1984)
Rondane North	56 (30)	65 (36)			5.3	Reimers (unpubl.)
Forelhogna/Knutshø/ N. Ottadalen	72 (39)	76 (42)			6.0-7.0	Skogland (1988), Reimers (unpubl.)

[1] Mean dressed weight in parenthesis.
[2] Mean dressed weight in parenrhesis.

Table 4. Rates of calf mortality (%) in semi-domesticated and wild reindeer herds during the first 5 months after calving.

Area/Herd	Sampling years	% Mortality first 3-5 months	% Mortality first month	Reference
Semi-domesticated reindeer				
Kaamanen, Finland	1970–71	35	12	Eloranta & Nieminen (1986)
Riast/Hylling, Norway	Before 1977		19-24	Lenvik & Aune (1988)
Riast/Hylling, Norway	1981		7-8	Lenvik & Aune (1988)
Riast/Hylling, Norway	1984		5-6	Lenvik & Aune (1988)
Semi-domesticated reindeer, Norway			10-20	Skjenneberg & Slagsvold (1968)
Lødingen, Norway			33-44	Rognmo *et al.* (1983)
Mackenzie Delta Herd, Canada	1969–71	31-46	10	Nowosad (1975)
Wild reindeer, Norway				
Hardangervidda	1983	55	42	Skogland (1984)
Forelhogna/Knutshø	1984	0.3	0.3	Skogland (1984)
Hardangervidda	Average of 7 years	47	38	Skogland (1985)
Snøhetta	Average of 5 years	43	38	Skogland (1985)
Hallingskarvet	1982	72	23	Skogland (1985)
Brattefjell-Vindeggen			14	Skogland (1985)
Knutshø	Average of 6 years		5	Skogland (1985)

Table 5. Mean winter weight loss (gDW/day; DW = dressed weighr) in reindeer calves (males and females) and females 1 1/2 year or older. The error term (SD) in the wild reindeer calculated from regression analyses including animals weighed during February-April. Number of animals in parenthesis. Weight loss among semi-domesticated reindeer are means of estimates based upon three studies in which the end weight is subtracted from the start weight and the result divided with the number of days.

	Weight loss (gDW/day) in winter (January–April)		
Herd/Area	Calves	Females >1 yr old	
Semi-domesticated reindeer Norway[1]	21 ± 6		
Wild reindeer, Norway[2]			
North Ottadalen			
Forelhogna & Knutshø	13±24 (8)	70±27 (57)	32 -101[3]
Rondane North	11±11 (49)	18±31 (24)	
Hardangervidda & Snøhetta.	11±12 (77)	53±10 (213)	16 - 72[3]

[1] From Reimers (1983b).
[2] From Reimers (1983b), Skogland (1984), Reimers (unpubl. dara).
[3] Range of regression coefficienrs.

Table 6. Mean summer growth rates (gTBW/day ± SD; TBW = total body weight) in reindeer. Growth rates in wild reindeer are from the respective calving dates in May (male and female calves) and from June (male yearlings and 2 year or older lactating females) to September. Growth rates in semi-domesticated reindeer are mean estimates based upon several studies in which the end weight is subtracted from the start weight and the result divided with the number of days. Number of studies in paranthesis.

Herd/Area	Growth rates in summer (gTBW/day) Calves		Male yearlings		Females 1 1/2 yr+	
Semi-domesticated reindeer[1]						
Finland, Russia, Norway	274±42 (22)	206 - 350[4]	183± 34 (4)	151 - 231[4]	152±24 (5)	134 - 194[4]
Alaska[2]					136	
Wild reindeer, Norway[3]						
North Ottadalen	396		397		412	
Rondane North	326		285		234	
Hardangervidda	277		115		211	

[1] From Reimers (1983b).
[2] White (1983).
[3] From Reimers *et al.* (1983).
[4] Mean range.

Table 7. Male reindeer dressed weights (DW) (SD in three wild reindeer areas in southern Norway. Number of animals weighed in parenthesis.

Area	Sampling years	September dressed weights (kg) Calves	Yeatlings
Hardangervidda	1969–74	15.5 ± 2.3 (29)	26.9 ± 5.1 (58)
Rondane North	1970–74	19.8 ± 3.8 (9)	37.0 ± 6.1 (103)
North Ottadalen	1967–74	29.3 ± 3.8 (35)	49.1 ± 6.8 (175)

Table 8. Background information about the wild reindeer popularions under study in sourhern Norway. Number of animals weighed in paranthesis.

Area	Sampling years	Grazing quality[4] Summer	Winter	Female 1+ yr dressed weights (kg) in February
North Ottadalen	1966–74[1]	Good	Good	45.4±8.3 (3)
Forelhogna	1984[2]	"	"	46.8±5.0 (7)
Knutshø	1984[2]	"	"	41.4±2.6 (7)
Rondane North	1972–74[1]	Medium	Good	31.4±4.9 (14)
Snøhetta	1950–67[3]	Good	Poor	28.0±5.4 (19)
Hardangervidda	1955–58[3]	"	"	30.1±4.2 (30)
	1970[3]	"	"	28.1±3.2 (7)
	1973[3]	"	"	31.6±4.6 (8)
	1983[2]	"	"	25.7±5.8 (17)

1 From Reimers *et al.* (1983).
2 From Skogland (1984). Animals were sampled during February, March & April.
3 From Reimers (1983a). Dressed weights from January.
4 From Skogland (1985).