# Fertility in female reindeer: the effects of nutrition and growth.

Fruktbarhet hos simler: effekter av ernæring og vekst.

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*Abstract:* Pregnancy rates in juvenile reindeer (*Rangifer tarandus*) vary considerably both within and between flocks. This potentially has considerable economic significance for reindeer husbandry. This paper discusses the influence of nutrition and growth on fertility in female reindeer using examples taken from the literature. Fertility in reindeer is related to body weight, like in many other mammals, but the relationship is not invariant. Weight-specific pregnancy rates appear to be density dependent in juvenile reindeer although not in adults. This strongly suggests that nutrition has an important influence on fertility in juveniles.

**Key words:** Fertility, nutrition, reindeer, reproduction.

**Rangifer,** 7(2): 37–41

**N. J. C. Tyler.** 1987. Fruktbarhet hos simler: effekter av ernæring og vekst.

*Sammendrag:* Drektighetsprosenten i ungrein varierer sterkt fra individ til individ og fra flokk til flokk. En høy fruktbarhet i reinflokken er selve grunnlaget for en vellykket reindrift.

Overraskende er det derfor at man vet lite om hvilke faktorer som bestemmer om rein skal bli drektig eller ikke. I denne artikkelen blir effekten av ernæring på reinsimlenes fruktbarhet diskutert. Undersøkelser indikerer at rein er som andre pattedyr, der fruktbarheten er relatert til kroppsvekten. Forholdet mellom reinens kroppsvekt og fruktbarhet varierer likevel sterkt. Mye tyder på at drektighetsprosenten i ungrein er avhengig av reintettheten. Dette indikerer at ernæringen er en viktig faktor når det gjelder fruktbarhet i ungrein. Vektspesifikk fruktbarhet kan derfor være en brukbar indikator for reinflokkens fôrtilgang. I prinsippet vil slike fruktbarhetsundersøkelser gi et tidlig varsel om reintallet er for høyt i forhold til beitegrunnlaget før en markert nedgang i slaktevekten observeres.

*Artikkelen oversatt til norsk er tilgjengelig fra forfatteren.*

**Rangifer,** 7(2): 37–41

**Tyler, N. J. C.** 1987. Ravitsemustilan ja kasvun vaikutus vaatimien hedelmällisyyteen.

*Yhteenveto:* Nuorten porojen hedelmällisyys vaihtelee suuresti yksilöstä yksilöön ja porotokasta toiseen. Tokan korkea hedelmällisyys on menestyksellisen poronhoidon perusedellytys. Poron kantavaksi tulemiseen vaikuttavista tekijöistä tiedetään kuitenkin yllättävän vähän. Kirjoituksessa käsitellään ravitsemustilan vaikutusta porovaatimen hedelmällisyyteen. Tutkimukset osoittavat että poron kuten muidenkin imettäväisten hedelmällisyydellä on yhteys ruumiinpainoon. Poron hedelmällisyyden ja ruumiinpainon suhteessa esiintyy kuitenkin suurta vaihtelevuutta. Paljon viittaa siihen että nuorten porojen tiineysprosentti riippuu porotiheydestä. Tämä puolestaan viittaa sihen, että ravinto on tärkeä tekijä nuoren poron hedelmällisyyttä ajatellen. Tästä johtuen painoon suhteutettu hedelmällisyys voisi toimia porotokan rehutaseen osoittajana. Sellaiset hedelmällisyystutkimukset antaisivat periaatteessa varhaisen varoituksen jos poroluku on ylittämässä laidunkapasiteetin, ennen kuin teuraspainojen selvä aleneminen huomataan.

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## Introduction

Adult reindeer and caribou (*Rangifer tarandus*) are usually highly fertile. In wild populations pregnancy rates normally exceed 60%, while in domestic flocks the adult pregnancy rate may approach 100%. Pregnancy rates in juveniles, by contrast, vary between 0 and 90%. This potentially has considerable economic significance for reindeer husbandry because many flocks consist predominantly of sub-adult and juvenile animals owing to selective slaughter of females aged 6 years and older. This paper discusses the influence of nutrition and growth on fertility in female reindeer. The principal question is: To what extent is fertility in females influenced by nutrition and growth? This can be divided into four separate questions: (1) Is fertility related to body weight in reindeer? (2) If so, is the relationship constant or variable? (3) How important is body weight alone in the control of fertility: is fertility also influenced by, for example, an animal's age or body composition at a given body weight? (5) What factors influence these relationships?

## Fertility and body weight

In many mammals fertility is closely related to body weight. Puberty is associated with the attainment of a critical weight above which individual females have an increasing probability of ovulation and conception (Joubert 1963, Mitchell and Brown 1974, Sadlier 1969). Reimers (1983) demonstrated this in wild reindeer using data from five different populations in southern Norway. He showed that adult (?) females with an estimated dressed weight of 22 kg in autumn were unlikely to conceive but, once over this threshold, the probability of pregnancy increased exponentially with increasing weight, reaching approximately 0.98 in animals with an estimated dressed weight of 46 kg.

In some species, the relationship between body weight and fertility appears to be constant. This is not the case in reindeer. Reimers' (1983) conclusion that fertility increases with increasing body weight in reindeer is indisputable; what he did not emphasize, however, perhaps because it is plain from his data, is that in some cases fertility at a given body weight deviated by as much as 50% from the expected value. Lenvik *et al.'s* (1982) data from semi-domesticated flocks in Sør-Trøndelag/Hedmark provide further evidence of variation in weight-specific fertility in reindeer (Figure 1). In Trollheimen, for example, yearlings with a dressed weight of 25 kg had a probability of pregnancy of 0.95. In Riast/Hylling, by contrast, the probability of pregnancy in yearlings with the same weight was only 0.35. Clearly, body weight alone does not predict fertility accurately in reindeer.

## What other variables influence fertility in reindeer?

Dauphiné (1974) showed that barren-ground caribou which had not raised a calf during summer were significantly fatter in autumn than those which had. He suggested that low fat reserves might be an important ultimate cause of infertility in adult caribou. This raises the interesting question of bow important is body weight, *per se,* in the control of fertility in reindeer. In humans, for example, a minimum level of stored fat appears necessary for the onset and maintenance of menstrual cycles (Frisch and McArthur 1974). Similar results have been found in ungulates. In red deer *Cervus elaphus* and sheep, for example, body condition (fat-

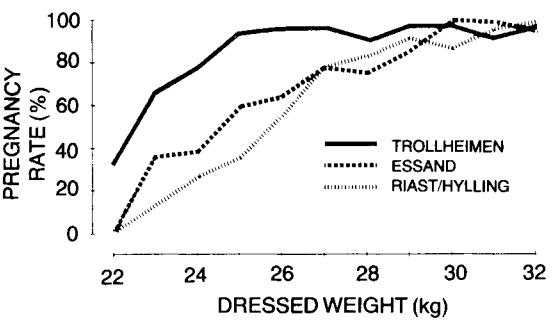


Figure 1. Weight-specific pregnancy rates in female reindeer aged 1.5 years in three semi-domesticated flocks (Trollheimen, Essand and Riast/Hylling) in Sør-Trøndelag/Hedmark. The animals were slaughtered in December-January and their reproductive status was determined by inspection of the uterus for the presence of a foetus. After Lenvik *et al.* (1982).

*Figur 1. Vekt-spesifikke drektighetsrater i 1,5 år gamle simlerein i tre tamreinflokker (Trollheimen, Essand og Riast/Hylling) i Sør-Trøndelag/Hedmark. Dyrene ble slaktet i desember-januar og deres drektighets-tilstand ble bestemt ved inspeksjon av uterus for foster. Etter Lenvik et al.* (1982).

ness) has an important influence on fertility independent of the effect of body weight (Adalsteinsson 1979, Albon *et al.* 1986). Albon *et al.* (ibid.), moreover, showed that five variables (body weight, fatness, skeletal size, reproductive status and age) each have independent effects on fertility in red deer. Unfortunately, there is no information on the independent effects of body weight, body condition, age or any other variable, on fertility in reindeer. It should be relatively straightforward to collect the appropriate data to investigate these effects, given that thousands of animals of known age are butchered annually in State controlled slaughter houses.

## Differences between populations

What factor(s) might account for differences in age and weight specific fertility between different flocks or populations of reindeer? Two possibilities are genetic differences and differences in the animals' nutritional status.

Genetically determined differences in reproductive performance are well known in fully-domesticated species: the livestock industry depends on them! By careful selective breeding, man has been able to manipulate his animals until their reproductive biology is better adapted to the constraints of the commercial rather than the natural environment. Røed (1985 a, b) has shown that there are significant genetic differences between flocks of semidomesticated reindeer in Norway. However, it is not known what, if anything, these differences contribute to variation in patterns of reproduction.

Dauphiné's (1974) results from barren-ground caribou (see above), on the other hand, raise the interesting possibility that an individual's physiological condition in autumn, measured in terms of fat reserves, can exert an important influence on its fertility. Albon *et al.'s* (1986) results from their study of fertility in red deer hinds are completely consistent with this. Furthermore, Albon *et al.* (1983) showed that the relationship between body weight and fertility in red deer hinds was strongly density-dependent both between and *within* populations. The latter result, in particular, strongly implicates an effect of nutrition.

There are two observations of density-dependent variation in fertility in reindeer. Each can be explained in terms of density-dependent food limitation. In neither case is the evidence conclusive, but no alternative explanations have yet been proposed.

First, Skogland (1985) showed that juvenile fecundity was inversely density-dependent across four populations of wild reindeer. In Knutshø-Forelhogna (density = 1 animal per km$^2$) yearling fecundity was close to 100%. At the other extreme, in Snøhetta (density = 3.5 animals per km$^2$) yearling fecundity was 20%. There was a corresponding density-dependent decrease in body size across the same four populations which Skogland (1983) attributed to food limitation.

Lenvik *et al.'s* (1982) data, second, provide a most interesting case because these authors were able to control for the effect of body weight. In Trollheimen, where weight-specific pregnancy rates in yearlings were consistently high (Figure 1), the population density was 1.4 animals per km$^2$. In Riast/Hylling, where weight-specific fertility was consistently low, the population density was 2.3 animals per km$^2$. In Essand, where pregnancy rates were intermediate at all weights, population density was also intermediate between the other two flocks (Table 1). These data are important for two reasons. First, they confirm density-dependent variation in fertility in juvenile reindeer. Second, they show that density-dependent differences in fertility between flocks may not necessarily be due simply to slowed growth and delayed matu-

Table 1. Population size and density of three flocks of semi-domesticated reindeer in Sør-Trøndelag/Hedmark in 1981*.

*Tabell 1. Populasjonsstørrelse og tetthet i tre tamreinflokker i Sør-Trøndelag/Hedmark i 1981*.*

| Flock | Number of animals | Population density n/km$^2$** |
|---|---|---|
| Trollheimen | 2500 | 1.4 |
| Essand | 4061 | 1.8 |
| Riast/Hylling | 4495 | 2.3 |

* Data supplied by Reindriftsadministrasjonen, Alta.

** Calculated on the basis of the animals' annual range.

** Data fra Reindriftsadministrasjonen.*

*** Beregnet på grunnlag av dyrenes årsbeite.*

rity: *weight-specific* rates of fertility in juveniles themselves appear to be density-dependent. We know nothing about the physiological basis of this.

Differences in population density are, of course, not in themselves evidence of differences in *per capita* food availability. However, they can provide a useful indication of relative levels of nutrition in different populations and are widely used for this purpose. Ideally population density should be expressed in terms of the number of animals per unit of available food. The appropriate units, regarding reindeers' nutrition, would be kilojoules of available digestible energy or grams of available digestible protein. This information is not available for any population of reindeer, wild or semi-domesticated, in Norway so we express density in terms of animals per unit area, instead.

Hence, the causal significance of differences in population density becomes clear only if density correlates with some parameter which clearly is influenced directly by nutrition. Skogland (1983) used body size. Unfortunately, no size or weight data are available from the three Sør-Trøndelag/Hedmark flocks. Summer grazing in Trollheimen, however, is considerably better than in Essand and Riast/Hylling owing to the effects of heterogenous, mountain topography and a more oceanic climate on the floral composition and phenology of the pastures (E. Gaare, personal communication). This confuses direct comparison of the three flocks with respect to population density alone: at the same time, however, it provides very strong support for the suggestion that differences in fertility between the flocks, measured in terms of weight-specific rates of pregnancy two months after the rut, may be attributed to differences in the animals' nutrition.

## Discussion

The principal consequence of density-dependence in the relationship between body weight and fertility in red deer is that, as population density increases, hinds have to become heavier before they achieve the same fertility as hinds in low density populations. Albon *et al.* (1983) concluded that density-dependent differences in the fertility of red deer hinds may not simply be an effect of depressed early growth and late maturation at high densities. They interpreted their results in terms of an adaptation whereby individuals in high density populations probably minimize the risk of dying from starvation in late winter, given that the relative energy costs of pregnancy and lactation are lower in large hinds in good condition.

Density-, or nutrition- dependent variation in weight-specific fecundity in juvenile reindeer might also be adaptive. Early breeding results in delayed growth: reindeer in Sør-Trøndelag/-Hedmark which conceive as calves, and successfully rear a calf in their second summer, weigh, on average, 12.6 kg (19.9%) less at 16 months' of age than peers which did not breed (Lenvik and Fjellheim, in prep). This is important for husbandry because calves' weight at birth is strongly influenced by their dams' body weight and also strongly influences their chances of survival (Eloranta and Nieminen 1986; Rognmo *et al.* 1983; Skogland 1984). Hence, in resource limited populations, individuals which first conceive as calves might subsequently enjoy lower reproductive success than animals which conceived first at 1.5 or 2.5 years, owing to the consequences of lost early growth.

In conclusion, in reindeer, like other mammals, fertility is related to body weight; however, the relationship between body weight and fertility is not invariant in reindeer. Variation in (weight-specific) pregnancy rates in juveniles is density-dependent. This strongly suggests that nutrition has an important influence on fertility in young reindeer.

**Acknowledgement**

S. Skjenneberg and T. Skogland kindly read an earlier version of this paper.

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Manuscript received 30. September 1987