Pasture Utilization at Islands in Northern Norway

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Abstract

The Norwegian sheep industry is based on utilization of "free" rangeland pasture resources. Use of mountain pastures is dominating, with about two million sheep grazing these pastures during summer. Regional challenges related to e.g., loss of sheep to large carnivores make farmers think differently. The Norwegian coastline is among the longest globally and is scattered with islets and islands. Alone along the coast of Nordland county, it is estimated more than 14,000 islands. Use of islands for summer pasture is an alternative but there is a limited knowledge about such a management system. In this study, we examined lambs' average daily gain on island pastures at the coast of Norway. In total 230 lambs on three islands (Sandvær, Sjonøya, and Buøya), with varying pasture quality and stocking rate, for 3 years (2012, 2013, and 2014). At Sandvær as much as 92% of the island was characterized as high nutritional value while at Sjonøya and Buøya only 15%, was characterized high nutritional value. We found an average daily lamb growth rate of 0.320 kg d^{-1}. Lambs on Sandvær had a higher daily gain ($P < 0.05$) than those on Sjonøya and Buøya, and lambs' average daily gain was significantly lower ($P < 0.05$) in 2013 compared to 2012 and 2014. We conclude that with a dynamic and adaptive management strategy there is a potential to utilize islands for sheep grazing during summer.

Introduction

The Norwegian sheep industry is based on utilization of spatially diverse rangeland pasture resources as reflected in different management systems and local adaptations. Only 3% of Norway is used for crop production, but more than half of the land area has potential value as livestock pasture. Rekdal (2016) estimated that harvesting of rangeland vegetation by livestock could be doubled and in a White paper from the Norwegian Government from 2016 an increase in rangeland grazing is encouraged for all regions of the country. In Norway, about 2 million sheep are released onto extensive pastures for summer grazing mostly in mountainous areas. However, challenges due to high mortality to e.g., large carnivores have increased the interest in utilizing pastures on islands and islets along the coast. The coastal line of Norway is estimated to about 103,000 km including islands. Nordland county (stretching from 65 to 69◦N) is scattered with some 14,000 islands of all sizes, from small islets of ∼1 ha to inhabited islands up to 500 km^2. Many of the smaller islands were previous inhabited but are now abandoned and traditional farming with meadow harvesting and livestock grazing has ceased. In Nordland county, farmers are offered a diverse package of subsidies and incentives for restoring and maintaining the semi-natural coastal landscape. Most of the islands are flat (rising to 40–50m above sea level) and natural fresh water supply can be limited during summer. Vegetation types, their proportion, and distribution and thus pasture value varies substantially between islands (Rekdal 2001). A management of stocking rate customized to available pasture resources is therefore necessary to ensure animals' performance and welfare (Hatten et al. 2001). However, appropriate stocking rates are defined by decades-long experience by farmers, while little scientific knowledge exists about sheep performance on these coastal pastures. In a field study we investigated lamb performance during three consecutive summer grazing seasons (2012–2014) on three islands at the coast of Nordland county, with highly variable grazing values and stocking rates. The aim of the study was to describe lamb daily weight gain and to evaluate and discuss opportunities and challenges for future sustainable sheep grazing on island pastures.

Methods and Study Site

The study was performed at commercial farms and the only extra handling of animals was through weighing. The animals were collected by help of sheep dogs per normal practice at the farms. The islands are situated in Lurøy and Rødøy municipalities, at the coast of Nordland county in Norway (Figure 1). Sandvær (66◦20′35N, 12◦43′55 E) covers 39 ha and range up to 20 meters above sea level (m.a.s.l.). Sjonøya (66◦21′51N, 12◦52′42

E) covers ~208 ha and range up to 40m.a.s.l while Buøya (66◦37′31N, 12◦56′35 E) covers 36 ha and range up to 40m.a.s.l. The total livestock unit (LU) at Sandvær, Sjonøya, and Buøya were 1.26, 3.60, and 2.70, respectively, in all 3 years (2012, 2013, and 2014). At Sjonøya, an additional 40 sheep of the Old Norwegian breed (5.6 LU) grazed and was included when stocking rate was calculated.

The weather is typical coastal climate with mild winters and wet summers, with mean temperature during winter around 0◦C and during summer around 12◦C. Annual precipitation is around 2,000 mm. The vegetation was mapped using the system of Rekdal and Larsson (2005) and a total of 19 different vegetation types, both natural and semi-cultivated, were identified on the islands. We classified the vegetation types into four main classes based on value for sheep grazing: “Not Suitable” (no grazing value or inaccessible), “low”, “medium” or “high” (for details, Lind et al. 2020).

Figure 1. Map of Norway and the islands (insert) Sandvær (south), Sjonøya and Buøya (north).

The study animals were of the dominating sheep breed in Norway, the Norwegian White Sheep. Ewes and lambs were recruited from two commercial sheep farms that had used the islands for summer grazing during several years prior to the study. We asked the farmers to randomly select adult ewes (>2 years of age) with two lambs at foot. The farmers selected the animals post-lambing to ensure that all ewes and lambs were healthy and distributed the animals randomly to the islands. The animals had access to all vegetation types within each island. Lambs were born in May and were between 1 and 4 weeks old when released to the island pastures. All ewes and lambs were individually ear-tagged for identification. The ewes were weighed before released to and when collected from the islands. The lambs (n = 230) were weighted at birth (average 4.90 kg, Standard deviation, SD = 0.86 kg), when released to the island (average 9.98 kg, SD = 3.51 kg), and when collected (average 38.1 kg, SD = 7.90 kg) as normal routine done by the farmers. The animals were on average released to the islands in week 21 (end of May) and collected in week 37 (beginning of September).

Data on a total of 230 twin lambs were analyzed by fitting a general mixed linear model in Proc Mixed of SAS statistical software (12), using the Satterthwaite option for estimation of denominator degrees of freedom. The model used was

$$y = Xb + Zu + e,$$

where y is the observation of individual lamb body growth (kg d^{-1}) on island pasture; b is a vector containing fixed demographic and environmental effects (lamb age, early growth, sex, ewe age, ewe weight, island, year, year*island), and X is the incidence matrix relating the observations to the effects in b. The random effect of ewe by year is u, related to observations by incidence matrix Z. Finally, e is the residual variance.

Results

As much as 92% of the area of Sandvær is characterized as high nutritional value which here includes the vegetation types of low herb meadow, high forb meadow, moist meadow and pasture. At Sjonøya, about 80% of the area is characterized as low nutritional value with the island dominated by coastal heath (31%) and damp heath (41%). Most of the remaining area is classified as medium to high nutritional value (low herb meadow, meadow birch forest and pasture). At Buøya 86% was characterized as low nutritional value and only 14% of high value.

Lambs' average daily gain on the island pastures was 0.320 kg d^{-1} (SD = 0.067 kg d^{-1}), and they spend on average 89 days on the islands (SD = 13 days). From the mixed model (Table 1) all variables in the model were significantly affecting lamb growth at $P < 0.05$, except for lamb age (days) at release on the islands ($P = 0.66$).

Table 1. Effect of lamb age (d) at release, lambs average daily gain (g d^{-1}) from birth to release, lamb sex (male or female), age of ewe (year), ewe weight (kg) at release, islands (Sandvær, Sjonøya, Buøya), year (2012, 2013, 2014) and the interaction between year and island, their nominator Degrees of Freedom (NDF), denominator Degrees of Freedom (DDF), F and P values.

Effect	NDF	DDF	F value	P
Lamb age	1	101	0.19	0.663
Early growth	1	209	6.64	0.011
Sex	1	206	27.81	< 0.001
Ewe age	5	104	2.69	0.025
Ewe weight	1	104	13.37	< 0.001
Island	2	101	20.88	< 0.001
Year	2	106	10.79	< 0.001
Year*Island	4	102	32.07	< 0.001

T-tests between LS means showed that lamb daily gain (data not shown, see Lind et al. 2020 for details) differed between islands ($P < 0.01$) and that lambs at Sandvær had the highest daily gain (0.372 kg d^{-1}) mainly caused by a high growth rate in 2012. Across islands, lamb daily gain was higher in 2012 and 2014 compared to 2013 ($P < 0.01$). The interaction between year and island show that the lambs' growth on Sandvær in 2012 was higher than that of all other year * island classes ($P < 0.01$); no other significant differences were found. Male lambs had a higher average daily gain than female lambs ($P < 0.01$).

Discussion

The proportion of vegetation types of high nutritional value differed between the islands. The vegetation type pasture is mainly former managed permanent grassland for forage production, now abandoned, and has a high nutritional value with an estimated grazing capacity of 0.75 LU per ha per year (Rekdal 2001).

At Sandvær around 92% of the total area was classified as high value according to Rekdal (2001) and included pasture (covering 12 ha), low herb meadow (covering 38%) and tall forb meadow (covering 21%). Twenty-one sheep (1.26 LU) grazed the island every summer while the capacity was more than 5 LU. When vegetation is grazed at an optimum stocking rate the forage quality maintains. However, when the number of animals is too low, non-grazed areas will degrade and in the case of Sandvær this was shown by encroachment of meadowsweet *(Filipendula ulmaria)*. Meadowsweet has little grazing value for sheep and is often seen dominating areas with zero or low grazing pressure (French 2017). A higher stocking rate combined with an earlier release would help improve the now low nutritional value of the vegetation type tall forb meadows and lead to an even higher weight gain of the lambs.

The stocking rate at Sjonøya was estimated to 9.2 LU. About 15% of the island was pasture, low herb meadow, meadow birch forest, pasture land forest and moist meadows which in total could carry 12 LU. Lamb daily gain on Sjonøya was significantly lower than that of both Sandvær and Buøya. Sjonøya consists of 4 smaller islands connected only at low tide. Most of the cultivated pasture type is located on one of them and sheep could be temporary stranded at an area with mostly low nutritional value vegetation types. This could be one explanation for the lower average daily gain.

The number of sheep at Buøya was estimated to 2.7 LU. Fourteen percent of the island (5 ha) was pasture and could carry around 2.5 LU (Rekdal 2001). Livestock density may be a limiting factor for lambs' growth, since the rest of Buøya is dominated by heath vegetation types and classified as having low nutritional value. Lambs' growth rate was significantly lower on this island compared to Sandvær, but higher than on Sjonøya. As discussed, parts of the high nutritional areas of Sandvær was not grazed due to the low stocking rate. We suspect that the total area was reduced in forage quality during the summer. On the other hand, the smaller area of high nutritional vegetation types at Buøya could be more intensively grazed and thus maintain a higher quality throughout the grazing period. The investigated islands all had a high degree of plant species diversity. Over a three-month period, the nutritional value-change would be species-specific and influenced by general phenological development as well as the within-year impact of grazing.

A dynamic management plan when using island pastures is important. As the islands are flat, phenological development is uniform across the pastures and the stocking rate should ideally be higher in the spring and early summer than later. During the summer, the lambs' need for high-quality forage increase while at the same time the pasture quality declines, decreased digestibility and crude protein content. However, the pasture quality can to some extent be maintained if the stocking rate is adjusted during the grazing season. To release and collect the animals at the right time are therefore critical for the production output.

Conclusion

In the present study we evaluated lamb performance on three islands with different grazing value and stocking rates. These lambs had a daily weight gain similar to the average weight gain for the Norwegian White breed on a national level. The homogenous topography and low altitude variation on the islands result in a uniform vegetation development and render the vegetation more sensitive to between and within summer climate variation. Adjustment of stocking rate, date of release and collection of animals must be fine-tuned. With a dynamic and adaptive management strategy, there are high potential benefits for increasing the use of island pastures.

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