

# ST. KILDA SOAY SHEEP PROJECT: ANNUAL REPORT 2000

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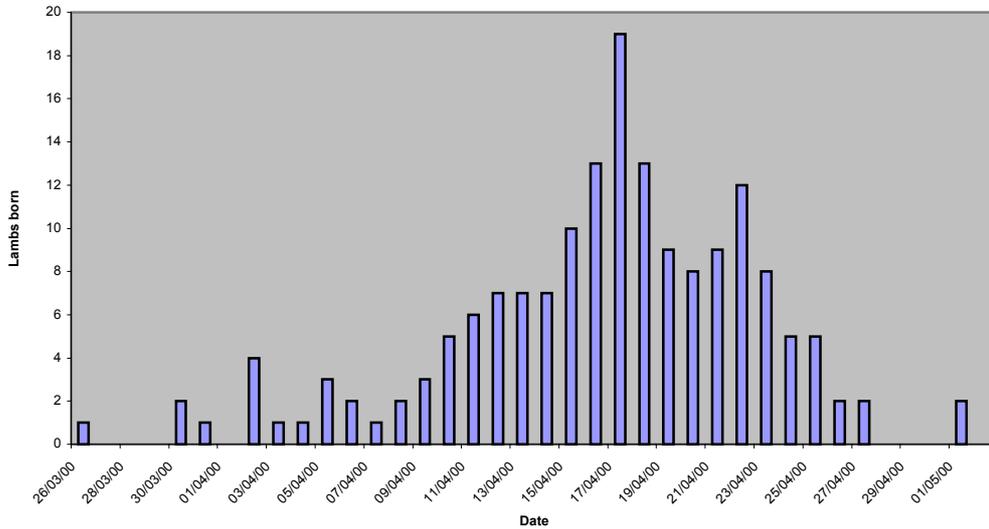
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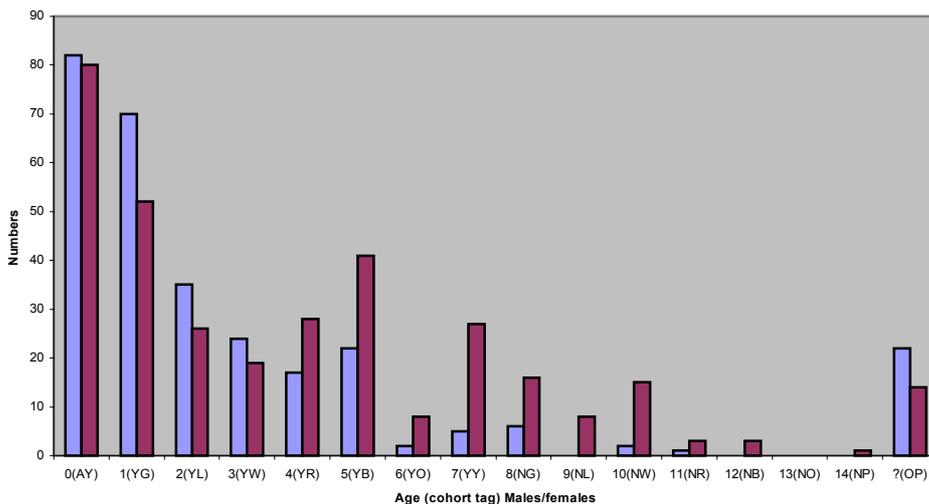
## POPULATION OVERVIEW

The sheep population on Hirta entered 2000 at a relatively low level and, as a result, there was little mortality through the year. Only 16 sheep were found dead within the study area between January and May of 2000, 7 between May and September and 1 between September and December. Lambing recruitment began on the 26<sup>th</sup> of March with 85% of lambs born surviving (Fig.1).

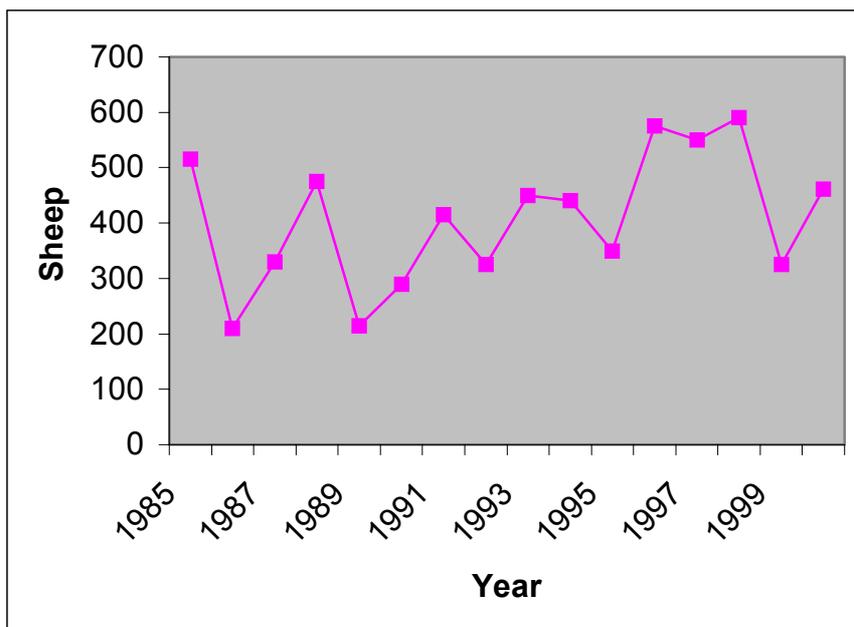


**Figure 1.** The temporal distribution of lamb births during 2000.

In December 2000, 629 tagged sheep were believed to be alive on Hirta, of which 461 regularly used the study area, an increase of nearly 42% on the previous year. The age distribution of the population is shown in Fig.2 and the changes in sheep numbers in the study area in Fig.3.



**Figure 2.** Age distribution of tagged Soay sheep presumed to be alive at the end of 2000.



**Figure 3.** The number of tagged sheep regularly using the study area since 1985.

One whole-island count yielded an estimate of 1,409 tagged and untagged sheep on the whole island with the details displayed in Table 1. The total population had increased by 51% since summer 1999.

**Table 1.** Demographic and geographic distribution of sheep observed during the count of Hirta on August 15<sup>th</sup> 2000. Coat colours are DW = dark wild, DS = dark self, LW = light wild, and LS = light self.

Location	Females				Males				Lambs	Total
	DW	DS	LW	LS	DW	DS	LW	LS		
<b>Conachair/Oiseval</b>	182	2	55	0	55	0	20	0	161	<b>475</b>
<b>Mullach Bi/Cambir</b>	175	16	80	2	28	2	7	0	172	<b>482</b>
<b>Ruaival/Village</b>	145	9	73	2	40	3	12	0	168	<b>452</b>
<b>Total</b>	<b>502</b>	<b>27</b>	<b>208</b>	<b>4</b>	<b>123</b>	<b>5</b>	<b>39</b>	<b>0</b>	<b>501</b>	<b>1,409</b>

## REPORTS ON COMPONENT STUDIES

### **Reproductive energetics of rams, and the maintenance of horn diversity.**

Ian Stevenson, David Bryant & Ken Wilson

The contrast between rams with large, powerful horns, and those with small, deformed 'scurs' is one of the most obvious differences between individual Soay sheep, and also one of the hardest to explain. Around 10% of males have these scurred horns, which are largely useless for fighting, and this greatly reduces their breeding success in any given year. Scurring has a genetic component, so why is this apparently highly undesirable character maintained at a constant level on Hirta?

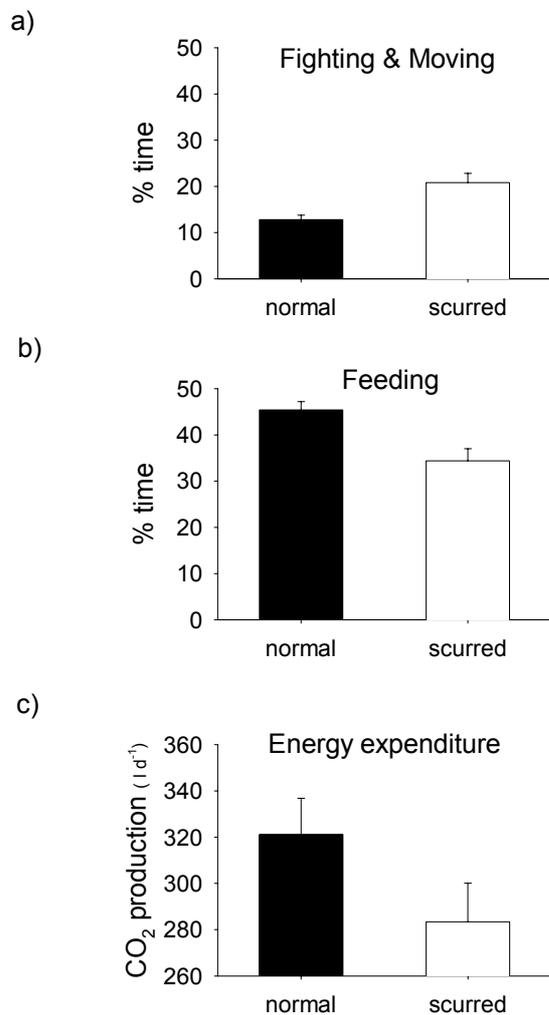
Perhaps the continued existence of scurring is due to a better ability to survive harsh winters. Previous work suggests that scurred sheep tend to live longer, and so may compensate for a lower annual breeding success by surviving to compete in more ruts. The superior survival of scurred males is surprising, however, since observations during the rut reveal behaviours that appear likely to *increase*, rather than reduce, their mortality risk. Scurred males cannot defend females against normal-horned males, and so they follow a highly opportunistic strategy, searching widely for oestrous ewes with which they mate hurriedly before returning to the search. As a result, scurred males spend more time in behaviours that appear to be energetically expensive, such as walking, running and fighting (Fig.4a). Not only do they appear to expend more energy, but they also have less time available for grazing and so their energy intake is lower than that of normal-horned males (Fig.4b).

In order to understand the continued existence of scurring in this population, we are investigating the mismatch between their superior survival and the apparently very energetically expensive rutting behaviour of scurred males. To do this, we are making direct measurements of energy expenditure of scurred and normal-horned males during the rut using the 'doubly labelled water' technique. This method measures how much carbon dioxide a sheep breathes out over 7-10 days and, from this, the energy expenditure can be estimated. The appeal of the method is that it requires the individual to be caught only at the beginning of the measurement period, and again at the end, yet it can yield daily energy expenditures during the intervening period with no disturbance to the sheep.

We undertook a small pilot study in the rut of 1999, and, with that information, conducted a major comparison of the rutting energetics of scurred and normal-horned males in November 2000. Four scurred males and four normal-horned males were studied in 1999, and a further 7 scurs and 14 normal-horned in 2000. Unfortunately, the analysis of samples is very time consuming and, as yet, we only have provisional results from seven of the animals studied in 1999.

The initial results from 1999 suggest that the assumption that scurred rutting behaviour is very expensive may be wrong (Fig.4c). Energy expenditure of scurred males is, on average, lower than for normal-horned males, and this could contribute to their superior survival rate. Obviously, no rigorous comparison can be made at this stage, due to small sample size. It seems possible, however, that behavioural observations may underrate the energetic costs of normal-horned males defending oestrous ewes in comparison with the apparently exhausting

search for undefended females undertaken by scurs. This issue will be settled when we obtain the results from the larger study, later in 2001.



**Figure 4.** - *a)* proportion of time spent moving or involved in aggressive interactions with other males during the rut of 1999 by males with scurs or normal horns. *b)* Proportion of time spent feeding and ruminating. *c)* Energy expenditure by four normal-horned and three scurred males in rut 1999.

### Ram behaviour with respect to 'favoured' insemination times.

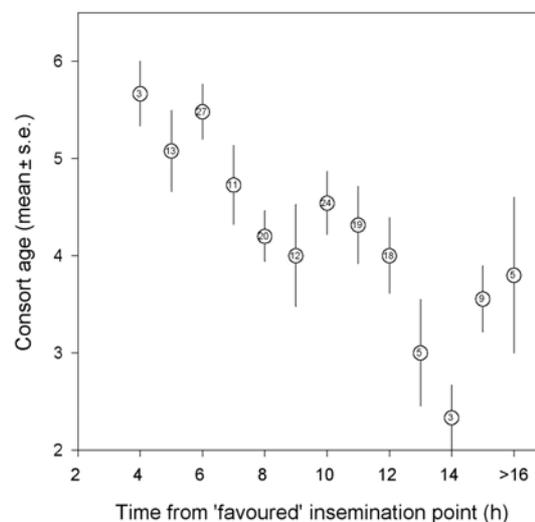
B. T. Preston, I. R. Stevenson & K. Wilson

In mammals that experience sperm competition (the competition between the ejaculates of two or more males for the fertilisation of ova), the outcome can be thought of as a lottery- the more tickets bought (in this case, the more sperm inseminated), the greater the chances of winning (i.e. of siring a lamb). However, males can bias the ensuing 'lottery' by inseminating females at a favourable time during their oestrus. Studies on domestic sheep have demonstrated that rams mating with ewes 9-15 hours after the onset of oestrus, have a greater chance of siring lambs than males mating either earlier or later. This is thought to be partly

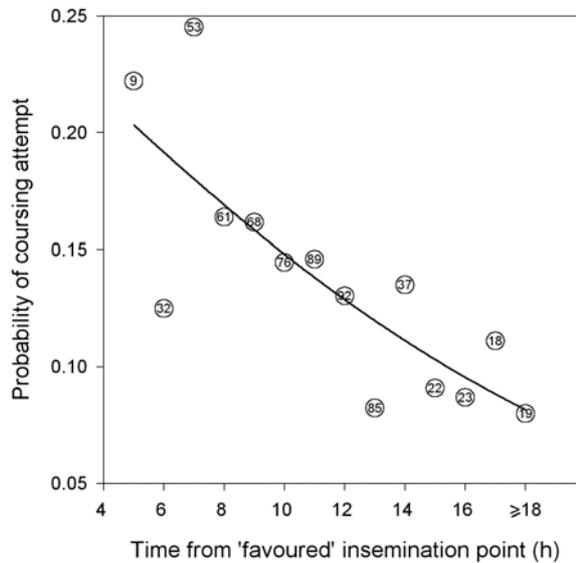
due to the time it takes sperm to finish ‘maturing’ inside the female’s reproductive tract, and to be transported to the site of fertilization. This leads us to the prediction that males should prefer to associate and copulate with females during these favoured periods.

The Soay sheep mating system is characterised by male combat for access to receptive females and female promiscuity (see annual report 1998-99), and we find that dominant rams do appear to time their mate guarding (and hence copulations) to occur closer to this ‘favoured’ insemination time (Fig.5). Furthermore, males guard females for shorter durations and are less likely to attempt copulations once the ‘favoured’ time of insemination has passed.

Subordinate males excluded from access to females during this time, practice an alternate mating tactic (coursing), where they attempt to break the integrity of the consort pair and force copulations on oestrous ewes. The timing of these coursing attempts also appears targeted towards this ‘favoured’ period of oestrus (Fig.6).



**Figure 5.** Age of consorting rams relative to ‘favoured’ insemination time. Age of consort male is plotted against estimated time from ‘favoured’ insemination point. The data are grouped by hour and are expressed as mean age of consort male  $\pm$  s.e. Numbers within each data point indicate the numbers of consorts grouped. Age is used as an estimate of a ram’s dominance rank.



**Figure 6.** Probability of subordinate rams attempting forced copulations and estimated female fertility. Probability of observing a courting attempt is plotted against estimated time from female's favoured insemination point. Data are grouped by hour and numbers within data points indicate the number of observations in that hour.

### Sperm depletion in Soay sheep.

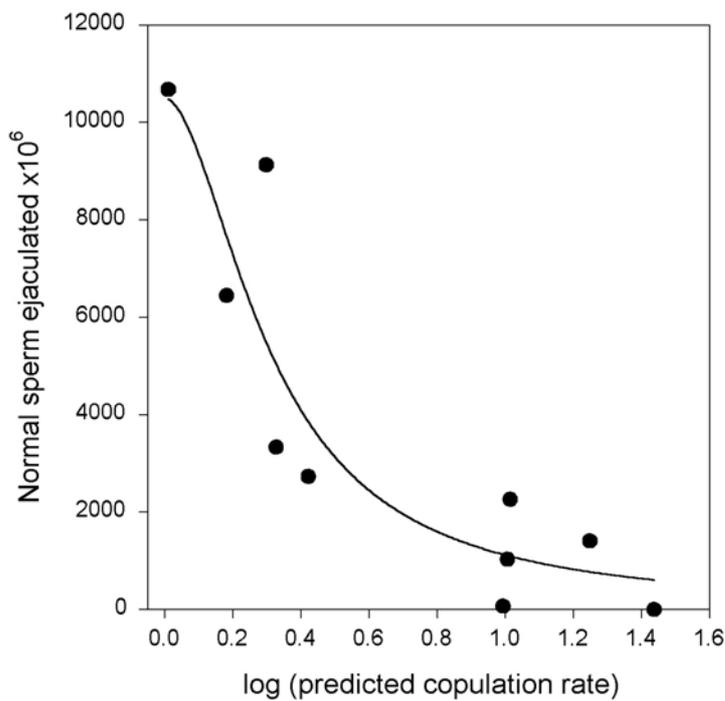
Brian Preston, Ian Stevenson, Josephine Pemberton & Kenneth Wilson.

Statistical analyses of the behaviour and reproductive success of Soay rams during the rut, indicate that 'large' males (ie. those of large body and horn size) tend to gain greater access to oestrus ewes, copulate more and gain most paternities (see Annual report 1999). However, the high copulation rates of large males appears to result in a gradual depletion of their sperm reserves. As a result, large males appear to lose paternities towards the end of the rut when their ejaculates become swamped in competition with those of 'smaller' males with relatively intact sperm reserves.

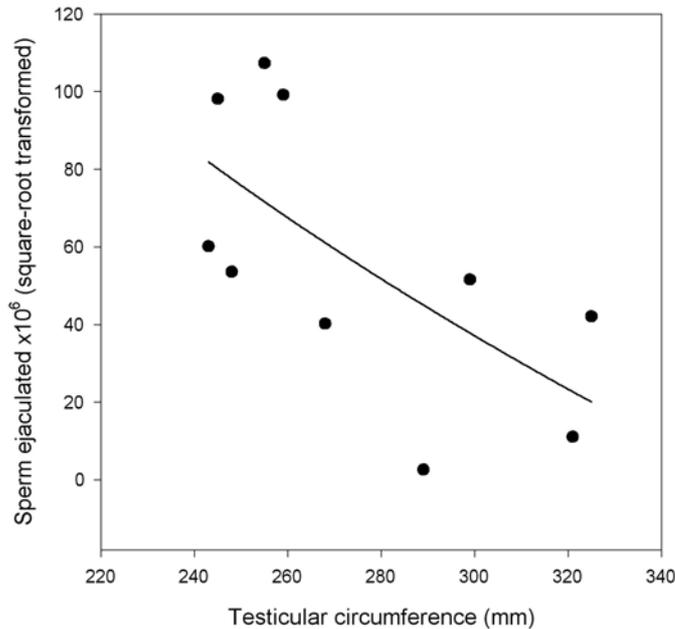
During rut 2000, we collected ejaculates from males in the latter half of the rut, with a view to examining ejaculate quality. Analysis of semen collected confirms sperm depletion as the most parsimonious explanation for an observed decline in success of larger males as the rut progresses (Preston et al. 2001). Not only did large, behaviourally-successful males produce smaller ejaculates (Fig.7a;  $P < 0.005$ ), but those ejaculates comprised fewer morphologically-normal sperm ( $P < 0.05$ ). The extent of sperm depletion is indicated by the observation that one male in our sample had a sperm count below the threshold of  $10^8$ , at which conception rates have been shown to be seriously affected in domestic sheep. Interestingly, the highest

numbers of sperm ejaculated (in excess of  $10^{10}$  from the smallest male) are significantly higher than the  $4-6 \times 10^9$  per ml expected from 'good quality' domestic rams.

It could be argued that the lower siring success of large males towards the end of the rut is due to differential investment in sperm production, with larger males always producing less sperm, rather than to a depletion of their sperm reserves. However, we think this is highly unlikely. In mammals, there is widespread evidence for testicular size determining sperm production rate, yet we find a *negative* correlation between testicular circumference and number of sperm ejaculated (Fig.7b) ( $P < 0.05$ ). This suggests that males producing ejaculates of limited size towards the end of the rut had greater capacity for ejaculate production at the start of it.



7(a)



7(b)

**Figure 7.** Evidence for sperm depletion in Soay sheep. **a)** Numbers of sperm ejaculated in relation to the logged predicted copulation rate (predictions are from the results of a statistical analysis (using GLMM) examining copulation rates and is based on horn length and hind leg length of the individual). **b)** Total sperm ejaculated in relation to testicular circumference of male.

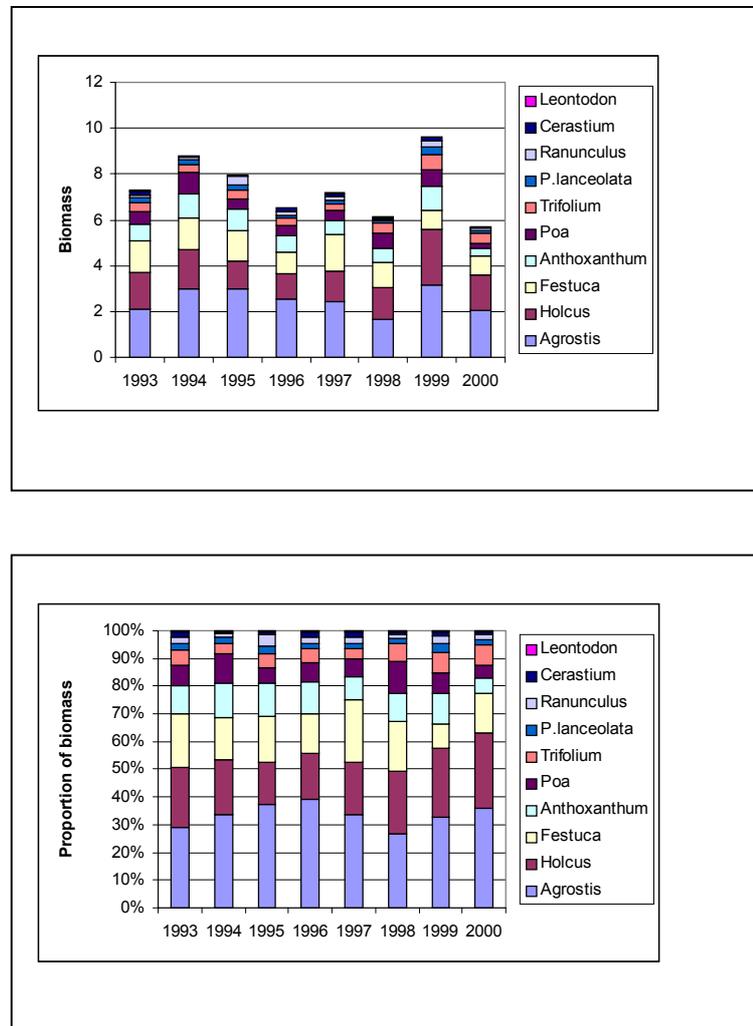
## Vegetation.

Mick Crawley

After eight years of sorting vegetation samples it is worth looking to see if any patterns are beginning to emerge that show the impact of fluctuations in sheep numbers on the botanical composition of the sward. The textbook story is that unpalatable species should do relatively well in years of moderate grazing intensity, and palatable species do well in years of low grazing intensity. In the absence of grazing, the palatable species would outcompete the unpalatable species (this is borne out by the dominance of *Festuca rubra*, the most palatable species, on the roofs of the ungrazed cleits). There is no decent theory about what should happen in years of very high grazing intensity, when the sheep are forced to eat most species, palatable and unpalatable alike.

One of the first things we found out was that the vegetation was exceptionally resilient to high grazing pressure: the biomass in August is roughly the same in years when winter grazing was very heavy as in post-cash years when spring and summer grazing were light.

Here we look at botanical composition both in absolute terms as biomass (g dry matter per unit area) and in relative terms as percent of total green matter (excluding bryophytes, dead organic matter and heather stems) (Fig.8)



**Figure 8.** Biomass composition of Village Bay sward. **a)** Absolute values. **b)** Relative composition

The prediction about the most palatable species gains very little support: *Festuca* was least abundant in the post crash summer of 1999, not most! We still have much too little data to test for time lag effects. The most abundant species, *Agrostis* and *Holcus* were both at highest peak biomass in the post crash year, but their relative abundances were not unusually high. The flower stem densities continue to provide the most sensitive indicator of grazing intensity. It is clearly going to need 20 years or so of data before any robust (and hopefully generalisable) patterns about botanical composition emerge.

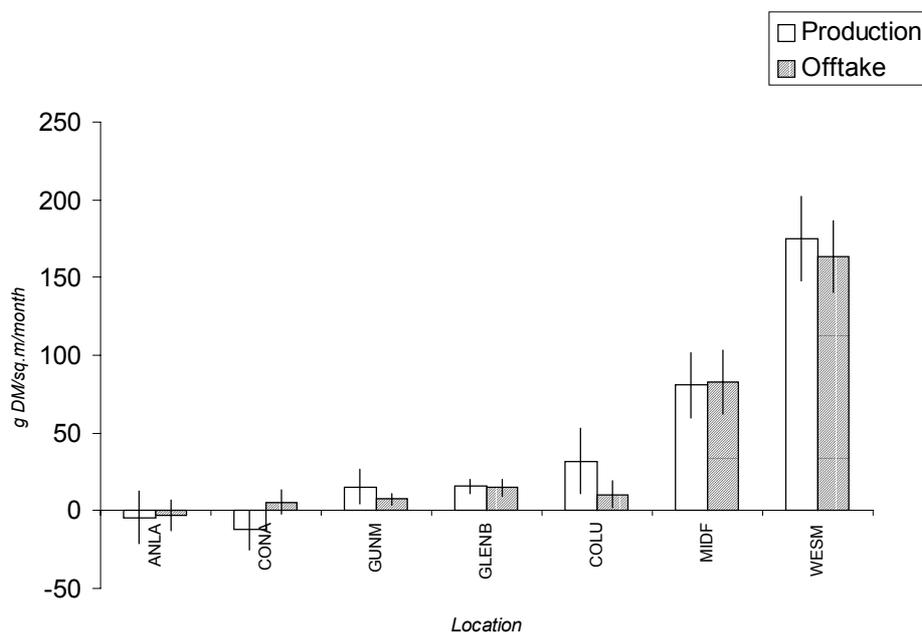
## Primary Production and Grazing on Hirta.

Owen Jones & Mick Crawley

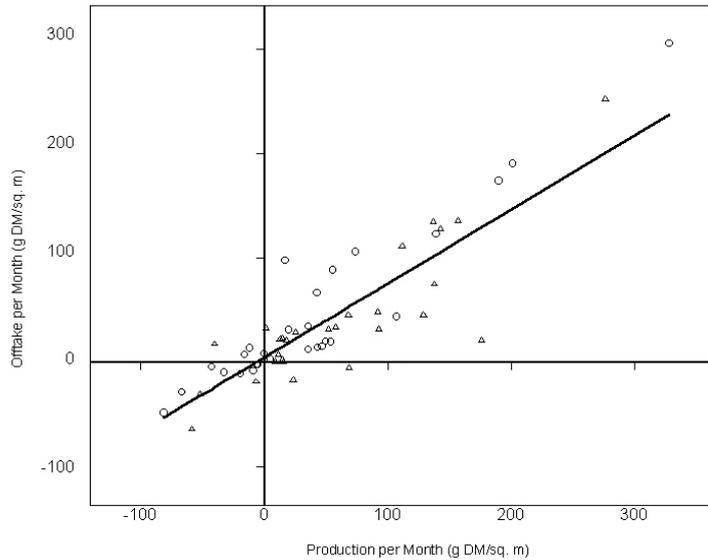
In order to investigate productivity and grazing from both tussocks and gaps within different vegetation community types, a total of 14 pyramid shaped grazing exclosures were erected at seven locations on Hirta in April 2000. Three of the locations were within the head-dyke: West Meadow, Mid Field (both *Holcus-Agrostis* grassland) and St. Columbus (*Agrostis-Festuca* grassland), and four were outside: at the foot of Oiseval/Gun Meadow (*Festuca-Plantago* sward), Conachair (*Calluna* heath), Anlag (*Sphagnum* mire), and Glen Bay (*Molinia* grassland).

Two full harvests have now been completed, providing data for the summer (beginning of April to mid-August) and autumn (mid-August to mid-October). Over-winter measurements (mid-October to beginning of February) have been made for three locations so far (Gun Meadow, West Meadow and Mid Field).

**Main Results** -The different areas differ markedly in their productivity and the amount of offtake, with the most productive areas being within the head-dyke (St. Columbus, Mid Field and West Meadow) (Fig.9). Anlag, and Conachair are both so unproductive that measurement errors can produce apparent negative productivity. It is clear that there is a strong positive correlation between productivity and the amount of grazing, demonstrating that the sheep prefer to graze on the more productive areas (Fig.10).

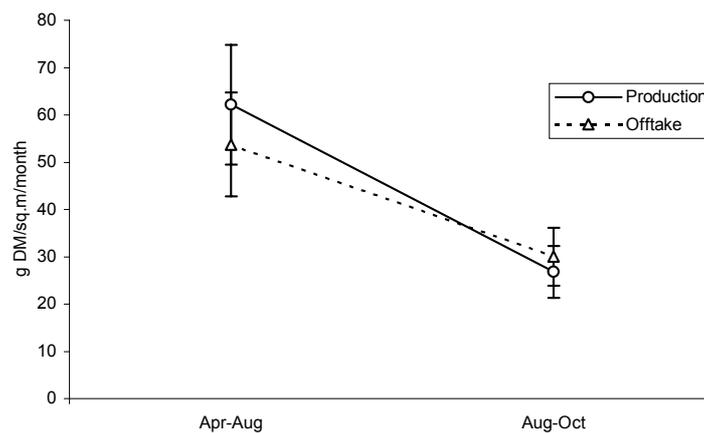


**Figure 9.** Productivity and offtake at the different areas studied. ANLA= An Lag, CONA= Conachair, GUNM= Gun Meadow, GLENB= Glen Bay, COLU= St.Columba's, MIDF= Mid Field, WESM= West Meadow. Error bars represent  $\pm 1$  SEM.



**Figure 10.** The Production-Offtake relationship on Hirta. Gaps are represented by circles and tussocks by triangles. A regression line has been fitted ( $y=0.754x+4.431$ ;  $R^2=0.799$ ).

*Temporal Changes* - Production and offtake both differ significantly between the two full harvests ( $p<0.05$ ). It is not surprising that both are higher in the summer than in autumn. Weather data indicates that although the mean grass temperatures were similar ( $13.91^{\circ}\text{C} \pm 0.28$  in summer compared with  $12.61^{\circ}\text{C} \pm 0.32$  in winter) the mean daily radiation levels were almost twice as high during the summer ( $13246\text{kJ}/\text{m}^2/\text{day} \pm 509$  compared with  $7175\text{kJ}/\text{m}^2/\text{day} \pm 603$ ). Production exceeded offtake in the summer, while in the autumn, offtake marginally exceeds production (although not significantly so) (Fig.11).



**Figure 11.** Temporal changes in production and offtake on Hirta between April and October 2000. Error bars represent  $\pm 1$  SEM

The three locations that have so far been harvested in February 2001 (Gun Meadow, West Meadow and Mid Field) show that production continues throughout the winter period. Interestingly, the level of production was not significantly lower than during the autumn ( $p > 0.05$ ) despite the lower mean grass temperatures ( $5.74^{\circ}\text{C} \pm 0.22$  compared with  $12.91^{\circ}\text{C} \pm 0.33$ ) and mean daily radiation ( $1424\text{kJ}/\text{m}^2/\text{day} \pm 111$  compared with  $7284\text{kJ}/\text{m}^2/\text{day} \pm 599$ ).

*Tussocks and Gaps* - It was recently reported (Jos Milner, Annual Report 1998 & PhD thesis) that the sheep show a strong preference for gaps over tussocks at the end of winter and a weak preference in the summer. This was explained by the fact that during the winter, tussocks are dominated by dead matter and are therefore of lower nutritional quality than the gaps whereas during summer the difference is less pronounced. The results from this enclosure study, however, show no such significant differences ( $p > 0.05$ ). This may be because although sheep take more bites from gaps than tussocks, their bite size is smaller on the shorter sward and thus less biomass is removed.

*Further research* - The enclosures will continue to be harvested on every visit to St. Kilda and will continue to provide offtake and productivity data. Furthermore, faecal samples from individual sheep are currently being analysed for diet composition and quality. Microscopic faecal cuticle analysis will provide botanical composition data while chemical analysis for nitrogen and fibre will provide general data on diet quality. It is hoped that these investigations will begin to elucidate the role of diet in the performance of Soay sheep.

### **Are grazing decisions of Soay sheep a consequence of parasite distribution?**

Mike Hutchings, Jos Milner, Iain Gordon and Ilias Kyriazakis

Over-winter mortality of Soay sheep on Hirta is thought to occur due to starvation exacerbated by parasitism (particularly gut worms). Nutrient and parasite distributions on the pasture may then determine Soay sheep grazing decisions during the spring and summer when the worm larvae are at their most abundant on the pasture and when the sheep face the nutritional demands of lactation and/or growth. We set out to determine (1) how parasites and nutrients are distributed in relation to the gap (short sward) and tussock (tall sward) vegetation types in the Village Bay area and (2) how the Soay sheep graze in relation to the distribution of nutrients and parasites.

Pasture samples (clipped down to soil surface) were taken in the spring and summer of 1998. In both seasons, pasture samples were taken from 25 tussocks and associated gap vegetation at 3 distance intervals from the tussock (contiguous i.e. 0cm, 15cm and 30 cm). The sheep grazing behaviour data were collected during 1996 and 1997 when individual sheep were watched and the numbers of bites taken from the gap and tussock vegetation in spring and summer were recorded.

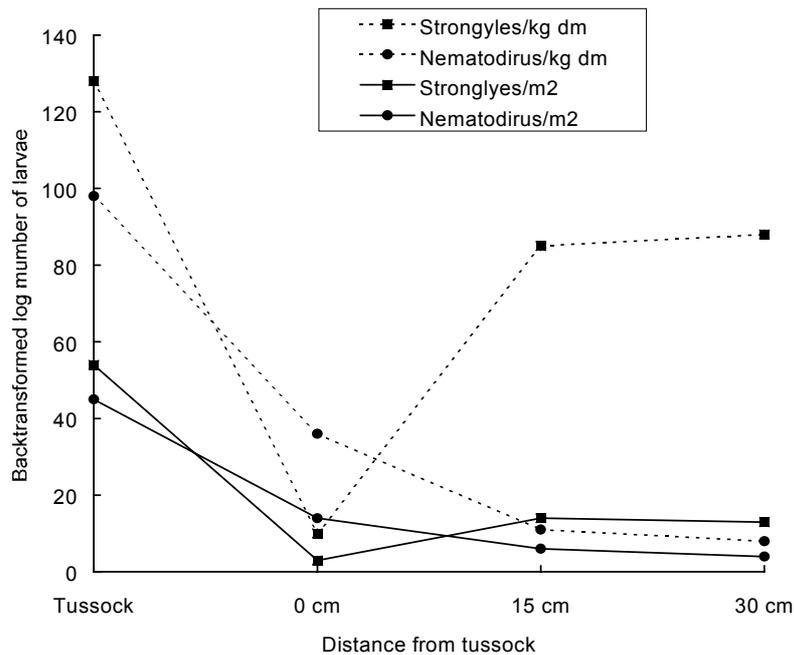
The nitrogen content of the gap was greater than that of the tussock vegetation in spring (Table 2). Pluck samples, taken by hand to mimic grazing, suggested that markedly higher

nitrogen intake could be achieved from grazing tussocks in spring but not summer (spring pluck samples: 27.5 g N/kg dry matter (DM); summer pluck samples: 18.2 g N/kg DM).

**Table 2.** Pasture characteristics measured in this study. Upper part: data; lower part: effects in data (N.S., not significant; \*\*\* significant at  $P < 0.001$ ).

	Season	Nitrogen (g N/kg DM)		Organic Matter Digestibility (g/kg DM)		Height (mm)	
		Spring	Summer	Spring	Summer	Spring	Summer
<b>Strata</b>	Tussock	22.38	19.12	399	543	16.83	20.13
	Contiguous	23.68	22.46	427	608	4.88	12.55
	15cm	23.54	25.24	410	595	3.66	9.92
	30cm	24.84	29.96	442	628	3.79	8.9
<b>Effects</b>	Season	N.S.		***		***	
	Strata	***		***		***	
	Interaction	***		N.S.		***	

In spring 1998 significantly more parasite larvae were present in tussocks compared to all gap strata (Fig.12). Only the gap vegetation contiguous to the tussock (0cm) contained lower numbers of larvae per kg DM than the tussocks. The 15cm and 30cm samples contained similar numbers of larvae when expressed per kg DM as the tussocks. In summer 1998 similar parasite burdens were present in both the gap and tussock vegetation.



**Figure 12.** The spring distribution of two kinds of parasite larvae in relation to the gap and tussock vegetation, expressed as density per m<sup>2</sup> and as per kg dry matter of herbage.

In late winter/early spring, Soay sheep may face trade-offs between the advantages of grazing tall and nutrient rich swards (increased nutrient and energy intake rate) and the costs of a greater probability of ingesting parasite larvae when grazing the tall tussocks. The distribution of nutrients and parasites in swards that created the trade-off in spring was not apparent in the summer.

Females with lambs and males had similar faecal egg counts (FECs) and consistently higher FECs than barren females (Table 3). Females with lambs undergo a reduction of immunity around the time of lambing, resulting in high FEC in late winter/early spring. In males, hormones such as testosterone make them more susceptible to parasitism explaining their higher FEC than barren females. In summer lambs in the process of acquiring and expressing immunity had greater FECs than all other groups.

**Table 3.** Faecal egg counts of animals of different status (eggs per gram with 95% confidence limits in brackets).

Animal status (S)	Month (M)					Effects		
	March	April	May	July	August	S	M	S* M
<b>Females + lambs</b>	248 (78-776)	98 (31-311)	156 (49-493)	123 (39-390)	32 (10-100)	***	N.S.	**
<b>Barren females</b>	4 (1-12)	37 (12-117)	3 (0-9)	67 (21-212)	3 (0-10)			
<b>Males</b>	141 (45-448)	120 (38-381)	58 (18-182)	40 (13-128)	225 (71-712)			
<b>Lambs</b>	-	-	-	731 (231-2313)	558 (176-1766)			

Overall, tussocks were avoided by grazing sheep. Older animals showed increased avoidance of tussocks and females avoided tussocks more than males. There was a positive correlation between FEC and tussock selectivity in males and a negative correlation for females. Tussock avoidance was greatest in late winter and spring with significantly less avoidance of tussocks in summer for all animals. When compared to barren females, the greater nutrient requirement of females with lambs was associated with a reduced avoidance of tussocks (Table 4). Males and barren females showed similar tussock avoidance in spring but males selected tussocks to a greater extent in summer. Lambs neither selected nor avoided grazing tussocks in summer.

**Table 4.** Tussock selectivity across the year.  $-1$  = total rejection and  $+1$  = total selection. Asterisks associated with means denote significant difference from random (ie 0; \* =  $p < 0.05$ ; \*\*\* =  $p < 0.001$ ).

Animal status (S)	Month (M)					Effects		
	Mar	April	May	July	Aug	S	M	S*M
Females + lambs	-0.53*	-0.52*	-0.60*	-0.12	-0.17	*	***	*
Barren females	-0.33*	-0.65*	-0.84*	-0.49*	-0.24*			
Males	-0.52*	-0.38*	-0.71*	+0.17	-0.11			
Lambs	-	-	-	+0.04	-0.06			

These data suggest that the grazing decisions of Soay sheep vary in relation to their nutrient requirements and ability to deal with parasitism. Increased FEC in females may cause increased avoidance of tussocks and hence parasites, whereas in males the increased FEC may be caused by their increased parasite intake through grazing tussocks. Without specific experiments to determine cause and effect in these correlations the hypotheses are only speculation. However, this research does highlight the fact that care must be taken when considering how faecal egg counts, and thus parasite burdens, relate to animal behaviour. It is likely that tussocks are beneficial for over-winter survival of parasite larvae, which create the trade-off between nutrient and parasite intake in spring. Random faecal deposition during spring/summer evens out the larval distribution and, therefore, alters the cost/benefit ratio of feeding on tussocks. Further research is needed to quantify the effects of faecal deposition on tussock creation and Soay sheep grazing behaviour.

### **Birth sex ratio variation in Soay sheep.**

Jan Lindström, Tim Coulson, Loeske Kruuk, Mads C. Forchhammer, Dave Coltman & Tim Clutton-Brock

In evolutionary biology, there is much current interest in the possibility that females may be able to control which sex of offspring they produce, and if they can, the decision rules that they may be following. This interest stretches back to 1973, when the evolutionary biologists Trivers and Willard suggested that females in relatively good physiological condition should produce offspring of the more expensive sex, if the increased allocation is likely to benefit this offspring more than it would the cheaper sex. Ungulates are commonly polygynous, with males competing for females, and this competition has led to the evolution of larger body size in males than females, and the evolution of weapons such as horns and antlers. A number of studies has shown that males are born at heavier weight and take more milk from their mothers, so they are generally the more expensive sex to rear, and size and condition is important in determining breeding success in males than females. Under the Trivers and

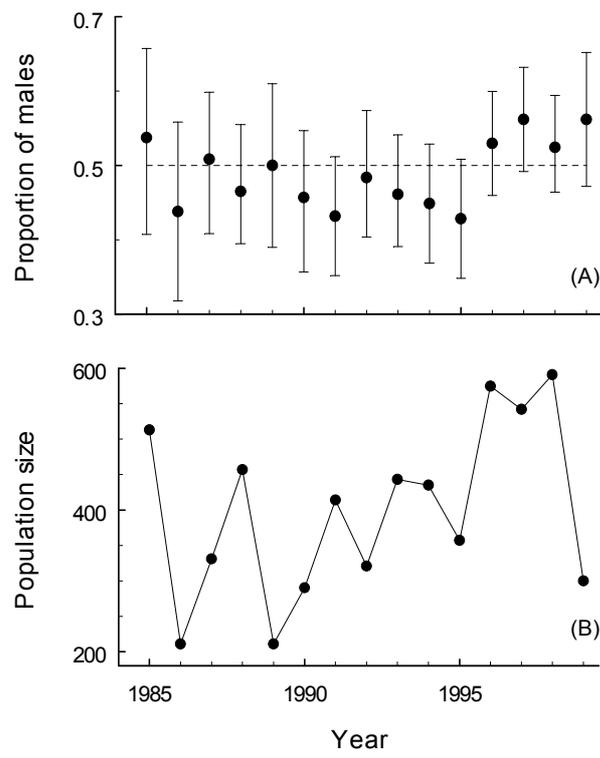
Willard hypothesis, females in good condition should therefore produce more sons than daughters, and *vice versa*.

Support for the Trivers and Willard hypothesis in ungulates has been patchy, at best. Perhaps the best positive example comes from the red deer study on Rum. When the red deer were at low density in the early years of that project, behaviourally dominant females (which are probably in the best condition) gave birth to more sons than daughters, whereas behaviourally subordinate females had more daughters. Other studies have given rather confusing results. In some cases they can be criticised for having rather small samples sizes, or not measuring sex ratio at birth, but one plausible reason for the contradictory results in sex ratio is that fluctuating environmental conditions may also have separate effects on offspring sex ratio. Such effects are exemplified in a recent re-analysis of Rum data by Loeske Kruuk and colleagues. While the dominant-subordinate effect was present at low density, at high density it was replaced by more an effect detected at the population level, in which more female calves are born following 'bad' winters (characterised by high density and high rainfall). Furthermore, whereas the dominant-subordinate effect previously noted appears to occur at conception, the population-level effect appears to occur through foetal loss during pregnancy.

The Soay sheep data set is an excellent data set within which to investigate this issue: samples sizes are large, lambs are sexed at birth and data are available over many years during which environmental conditions (mainly density and weather) fluctuated widely. Also, rams are larger than females, males compete for matings, and previous studies have shown that large-bodied males have great breeding success (see reports 1998, 1999).

The Soay sheep data set was subjected to statistical analysis at both the individual level and at the population level. Individual level analyses asked question like 'Do heavier females have more sons or daughters?', while population-level analyses asked questions like 'Does the population produced more sons after a high density winter? The summary data for the population across years is shown in Fig.13. Overall, we found no significant effects in any analyses at either the individual or the population level. There is a weak trend for more males to be born after high density winters, but this is not statistically significantly.

It would appear that individual Soay sheep do not manipulate their offspring sex ratio as predicted by the Trivers-Willard hypothesis, nor is population sex ratio affected by environmental conditions. The challenge now is to explain why the Rum deer should display such effects while the Soay sheep do not. The explanation seems likely to lie in the details of the biology and population dynamics: since male lambs often get matings at an early age, especially after a population crash, and crashes are unpredictable (well we can't predict them easily!) perhaps there is no advantage to females in trying to anticipate which sex of offspring will yield the most grandchildren.



**Figure 13.** (A) Proportion of males born in years ( $\pm 95\%$  confidence limits) and (B) population fluctuations in the Village Bay area 1985 – 1999.

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## **APPENDIX A: PERSONNEL CHANGES & SCHEDULE OF WORK**

### ***Personnel Changes***

In October 2000 Dr Loeske Kruuk took up a Royal Society University Research Fellowship that will involve analysis of St Kilda data.

### ***Schedule of work on St Kilda***

#### **Winter - Spring**

From March 17<sup>th</sup> until May 2<sup>nd</sup>, Jill Pilkington, Owen Jones and three volunteers carried out ten population censuses, conducted mortality searches (yielding 16 tagged dead animals) and tagged and sampled lambs for ongoing genetic studies. 187 lambs were born to 166 ewes; these figures include 21 sets of twins (18 ewes held both lambs, 3 lost one twin). 143 lambs (67 male and 76 female) were caught and tagged; a further 27 lambs died before any tagging attempt. 17 lambs were left untagged or were born after the lambing team left.

#### **Summer**

Jill Pilkington and two volunteers returned to Hirta on July 11<sup>th</sup> to carry out ten population censuses, conduct mortality searches (yielding 7 tagged dead animals) and prepare for the main catch-up of study area sheep. The catch-up took place from August 5<sup>th</sup>-17<sup>th</sup>, was led by Josephine Pemberton, and conducted by a team of 11 other project members and volunteers. 188 sheep were caught and processed, of which 69 were lambs (34 males and 35 females), 42 were yearlings (21 male and 21 females), 15 were adult males, and 62 were adult females. All animals were weighed and measured to monitor growth, and sampled for parasite and genetic analyses. 38 sheep were retagged because of damaged or missing tags. 19 previously untagged sheep (17 lambs and 7 adults) were caught and processed. Jill Pilkington, Vicky Parker and Leigh Stephen remained on Hirta until 1<sup>st</sup> September to complete parasite counts.

#### **Autumn**

From October 13<sup>th</sup> to December 8<sup>th</sup> Jill Pilkington, Ian Stevenson, Owen Jones and six volunteers monitored the mating period, carrying out focal watches, capturing and processing 38 incoming tups and carrying out eight population censuses. Only one dead sheep was found. Faecal samples were also collected for hormonal analysis.

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