AranLIFE

Agricultural practices and the quality of calcareous grassland habitat on the Aran Islands

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Introduction

The Aran Islands are an extremely important site for a number of priority terrestrial habitats under the Habitats Directive (Annex 1) resulting in over 75% of the total land area of the Aran Islands (4,500 ha) being designated as Natura 2000 sites. The agricultural landscape is largely a mosaic of rare Annex I European farmland habitat types of high conservation value – limestone pavement, machair and orchid-rich calcareous grassland.

Calcareous grasslands are found on base-rich calcareous soils that are free draining and have a relatively low nutrient status. They are the predominant grassland habitat type found on the Aran Islands, where they overlie shallow or rocky limestone areas, and are also found in the coastal grassland habitat called machair. They are usually managed through grazing with livestock, although in some instances they may be cut for hay. Calcareous grasslands are among the most species-rich plant communities in Ireland.

The long history of farming on the Aran Islands has deeply influenced the nature of pastoral landscape as we know it today. Farm management activities, in particular grazing management with livestock, have created and maintained the calcareous grassland habitats that we value for their biodiversity.

Typical farm holdings on the Aran Islands are highly fragmented and relatively small-scale with lower than average stocking rates (<0.5 LU/ha), with most herds numbering less than ten animals. Poor economic return from such small holdings is leading to a reduction of farming on the islands. The Department of Agriculture Food and the Marine estimates that the number of farms on the islands has decreased by more than 30% in the last 15 years.

Traditional grazing regimes are likely to be the most effective and sustainable way to maintain, and in some instances restore, the biodiversity of semi-natural grasslands within priority farmland habitat on the Aran Islands (Smith et al. 2010). Grazing by livestock offers the reliable, cost-effective strategy for maintaining and enhancing the quality of species-rich grasslands on the Aran Islands. Maintenance of high quality calcareous grasslands depends on appropriate levels of forage being removed by grazing livestock. This ensures that a field has:

- Minimal scrub cover, with little or no new scrub encroaching onto grasslands.
- A high cover of plant species that indicate that the habitat is of high conservation value.

Achieving optimal grazing levels in grasslands on the Aran Islands depends on having easy access to fields, sufficient water supply, and the maintenance of boundary and internal stone walls. Additional important management factors controlled by the farmer that can also influence the quality of grassland habitats include:

- Grazing season
- Grazing pressure (time spent grazing a particular area)
- Livestock type used
- Supplementary feeding practices

Greater information is required in relation to the grassland community habitats and associated farming practices on a wide range of sites across the three Aran Islands

The primary aim of this research was to record and describe grassland community habitats and associated farming practices on a wide range of sites across the three Aran Islands. This aim was underpinned by the following objectives:

1. Describe the main vegetation types of found on Aran farms using community analysis techniques.
2. Document farm management practices, in particular grazing management, and investigate the relationship between vegetation types and management and environmental factors.

Knowledge on the ecology of grassland habitats can ensure that appropriate management plans can be developed to protect the natural and cultural heritage associated with calcareous grasslands of high conservation value on the Aran Islands.

This study is part of the larger EU LIFE-funded AranLIFE project (2014-2018). AranLIFE is working with farmers to demonstrate best management practices for the conservation of priority EU-protected habitats that are dependent on a continued farming system.

Methods

Site overview

The study was carried out on the three Aran Islands in the west of Ireland (Fig. 1). The Aran Islands are situated approximately 10 km off the west coast of Co. Clare (Latitude 53° 05'N, Longitude 09° 35'W, 0-90m above sea level). The islands are a geological extension of the karstic Carboniferous region of the Burren (Co. Clare). Upper Carboniferous limestone strata, interleaved with layers of shale and clay, form these exposed islands. The soil cover is thin, with pockets of rendzina between the bare limestone. The three main islands extend to approximately 46km^2.

The islands have a temperate, mild climate. Average air temperatures range from 7 °C (44.6 °F) in January to 16°C (60.8 °F) in July. Rainfall is high, the yearly average (1995-2017) being 1208 mm (www.met.ie). The wettest months are between October and January with approximately 134 mm of rainfall per month during these months. The driest months are April and May with mean rainfall levels of approximately 70 mm per month (1995-2017).

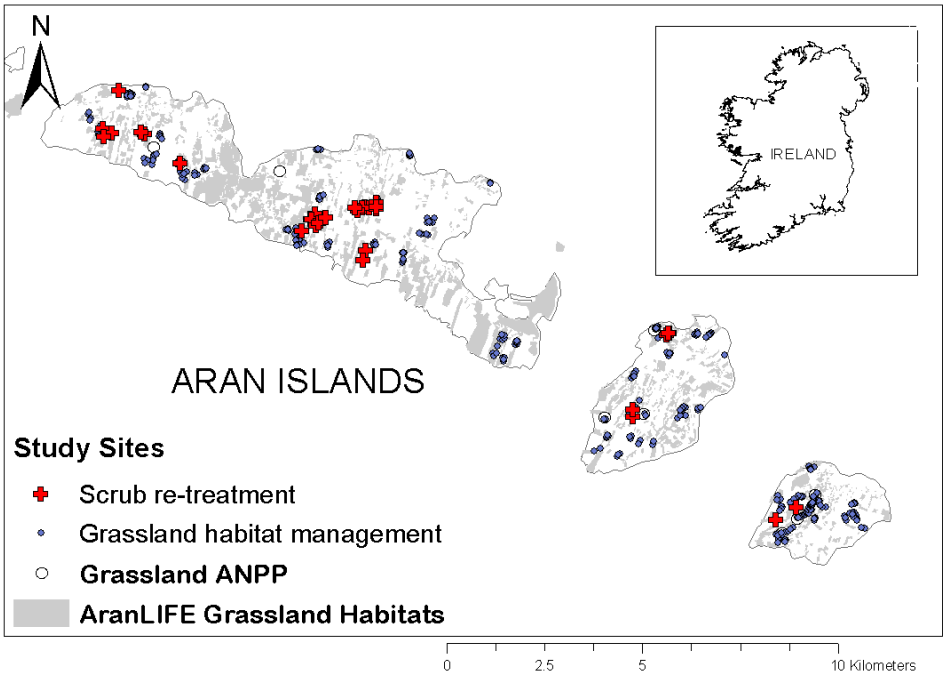

Figure 1: Location of study plots on the Aran Islands.

Grazing system at the farm level- site management

Grazing with spring-calving suckler cow/drystock herd is now the predominant farm enterprise on the Aran Islands (Figure 5). The overall farm structure is quite fragmented and consists of numerous land parcels scattered across the across the Island. The whole farm grazing system is comprised of an annual rotation of livestock between each land parcel. In general, livestock graze the relatively more exposed pastures on the south side of islands from late-October to March/April. Once spring-calving commences, herds are moved to relatively sheltered fields to the north of the Islands from March/April to October.

Figure 2: Aerial view of winter grazed pasture on Inis Meáin

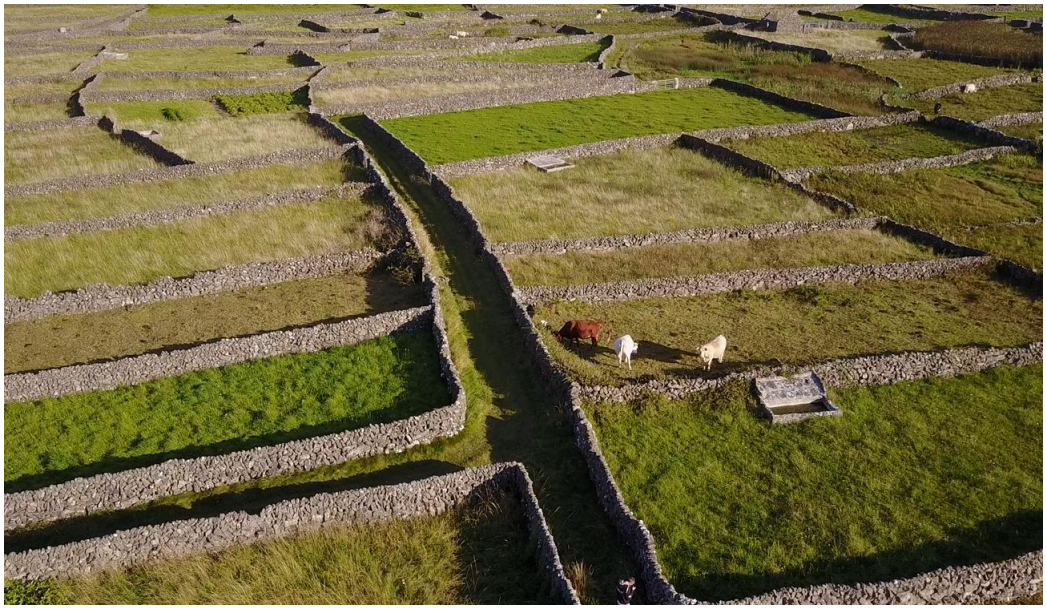

Figure 3: Aerial view of summer grazed pasture on Inis Meáin

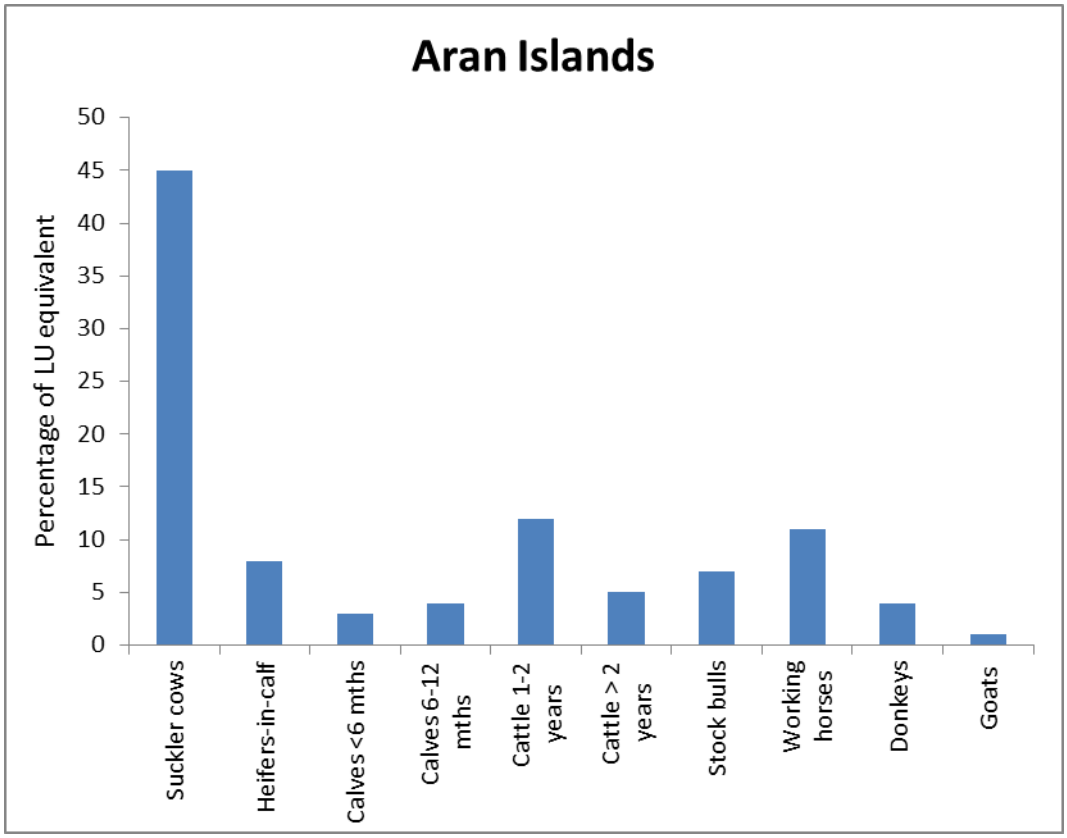

Figure 4: Relative proportion of livestock unit equivalents across the Aran Islands (from a sample of farms)

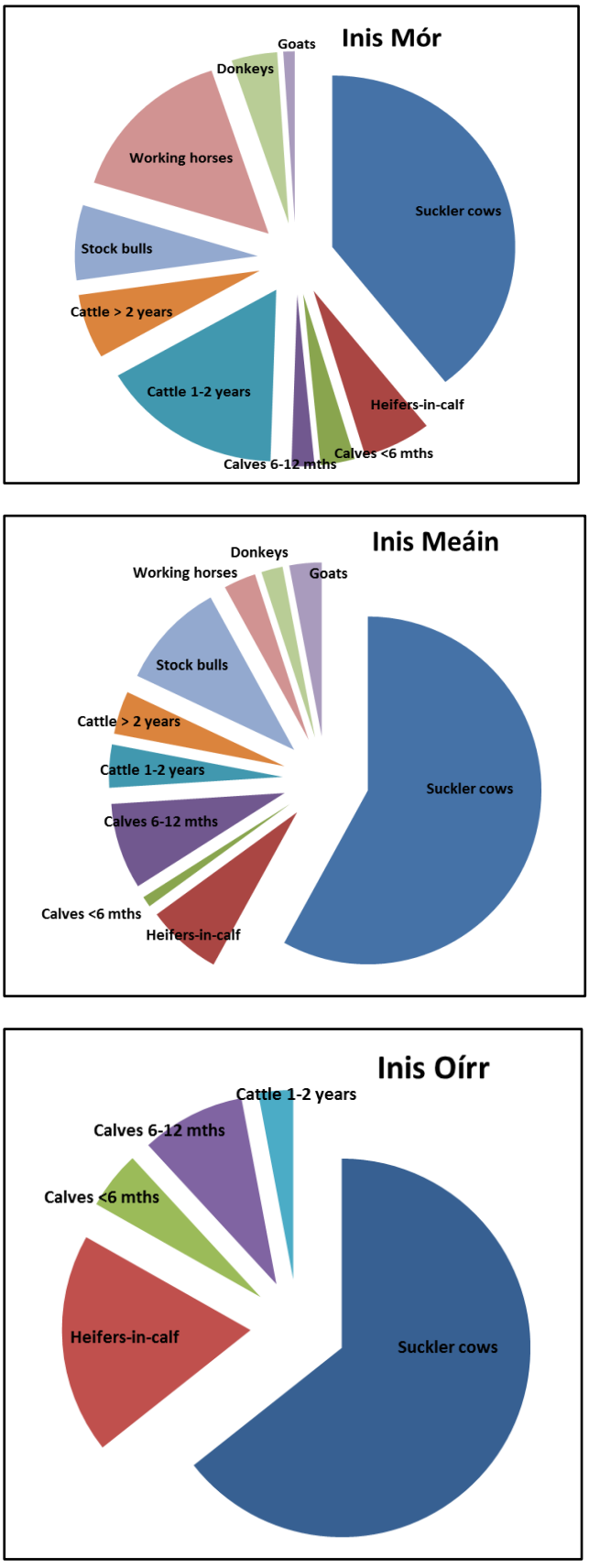

Figure 5: Relative proportion of livestock unit equivalents across a) Inis Mór, b) Inis Meáin and c) Inis Oírr, (n=25)

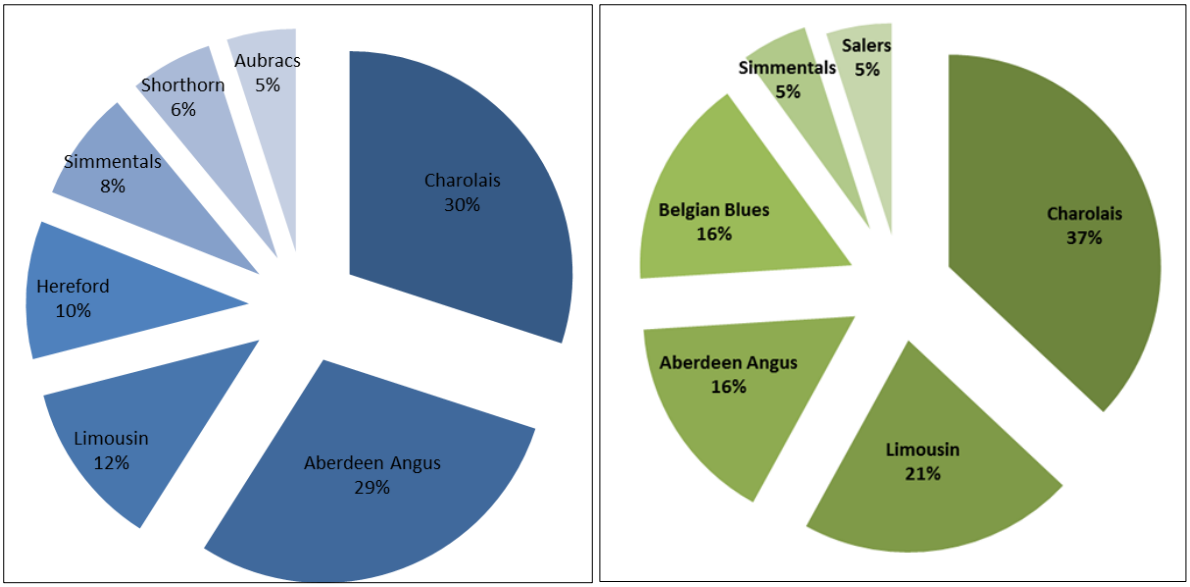

Figure 6: a) Suckler cow breeds and b) stock bull breeds their proportional abundance across a selection of Aran farms (n=25)

Site selection

Vegetation composition associated within farmed habitats was sampled across all three Islands using stratified random sampling approach. Island, grazing management type, proximity to southern coastline and scrub cover were all available criteria used to stratify samples and capture the range of factors potentially associated environment and disturbance. Efforts were made to match the proportion of sample sizes to Island area.

Commonages were not included in this study due to the low number of farmers in the sample with grazed commonage.

Field survey methodology

Botanical surveys were carried out between May and September 2016 and 2017 using national methodologies (O'Neill et al. 2013). The vascular plant species in 2m x 2m quadrats at each sampling site (Fig. 7) were recorded and their cover estimated using percent cover (% Cover recorded instead of DOMIN– as recommended by Irish Semi-natural grasslands survey final report for benefits associated with numerical analysis of metastudies).

Homogenous stands of vegetation were sampled. Obvious variations in sward community composition were surveyed separately using 2m × 2m quadrats and sub samples within enclosed fields were aggregated by averaging. Since the main aim was to describe the grassland habitats, releves with >50% cover of woody scrub species were avoided as this was classified as scrub habitat under Fossitt; in this situation, grassland area would be dramatically reduced and comparisons of biodiversity indices between these releves would be misleading. A suite of environmental data and variables associated with disturbance were recorded *in situ*.

Forage production and utilization

Forage production

Annual above-ground net primary production (ANPP) was quantified using the moveable cage (1m x 1m x 0.4m) method (Mc Naughton et al. 1996), across eight representative sites (Figure 7). Forages were cut to ground level within a 0.5m x 0.5m quadrat and oven-dried to constant weight (60°C for 48 hours) to determine percentage dry matter.

Figure 7: Sampling for forage yield on the Aran Islands. Red arrows indicate the associated sampling (lower panel) of the vegetation in the exclusion cage (upper panel).

In addition to directly measuring forage productivity using moveable exclosures, three additional methods were used to describe utilization of the forage resource on the Island. From this, inference can be drawn in relation to productivity and comparisons can be made using indicative results collected using movable exclosures.

- A review of historical stocking rates
- A farm-level review of current farm structure using GIS and farmer questionnaire data.
- And extensive and detailed grazing management dataset was collected directly from the farmers themselves (Figure 8) and combined with detailed site surveys to determine grassland area and vegetation type.

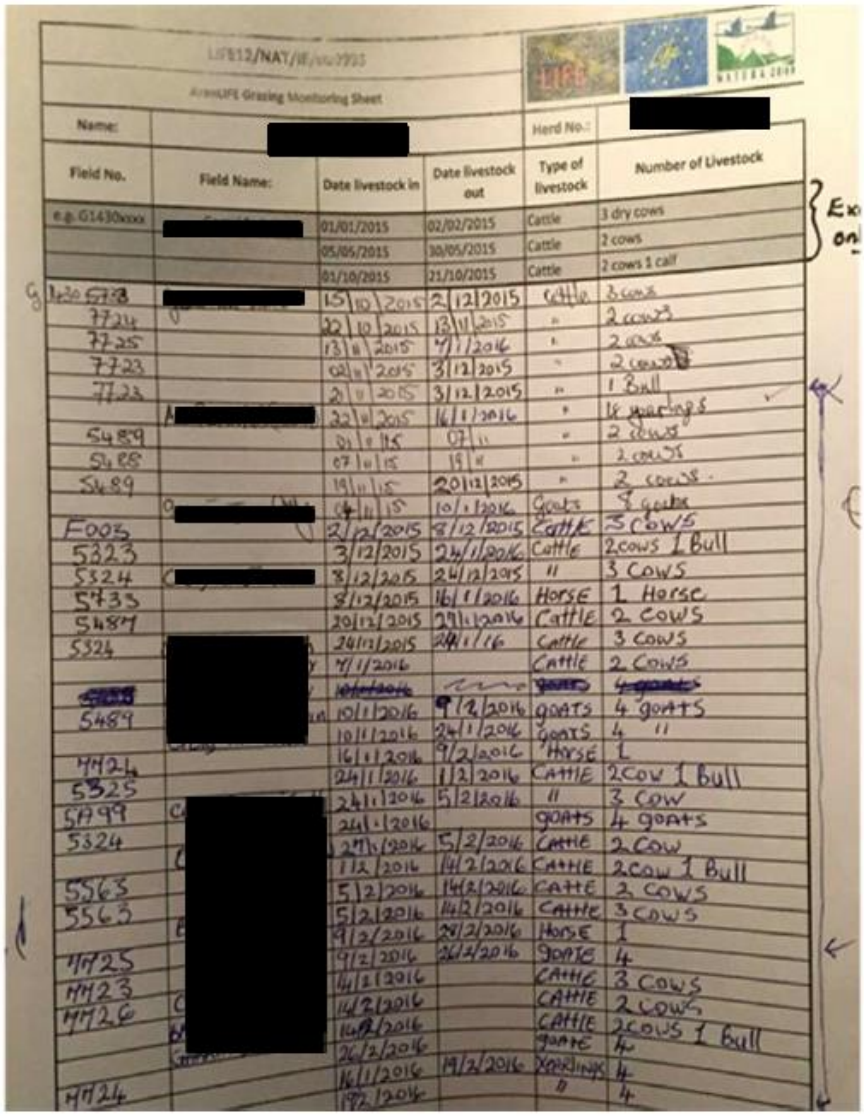

Figure 8: Example of grazing record sheet completed by farmer on the Aran Islands.

Results & Discussion

Vegetation types

A total of 363 releves were carried out as part of this study (Table 1), and this yielded a total of 210 vascular plant and bryophyte species (Table 2) (see Duignan et al., 2018 for further information).

Table 1: Number of releves carried out as part of the study

Island	Number of relevés
Inis Mór	194
Inis Oírr	97
Inis Meáin	72

Vegetation communities

Two predominant pasture types were identified on the Aran Islands; 'winter-grazed pastures' (WP), and 'summer-grazed pastures' (SP) (Fig. 9). There are clear differences in species richness among different grassland groupings (Table 2, Fig. 10a), but also in the number of species that indicate calcareous grasslands with high ecological quality (Fig. 10b). The absence of grazing was associated with the lowest species richness and lowest ecological quality (Table 2).

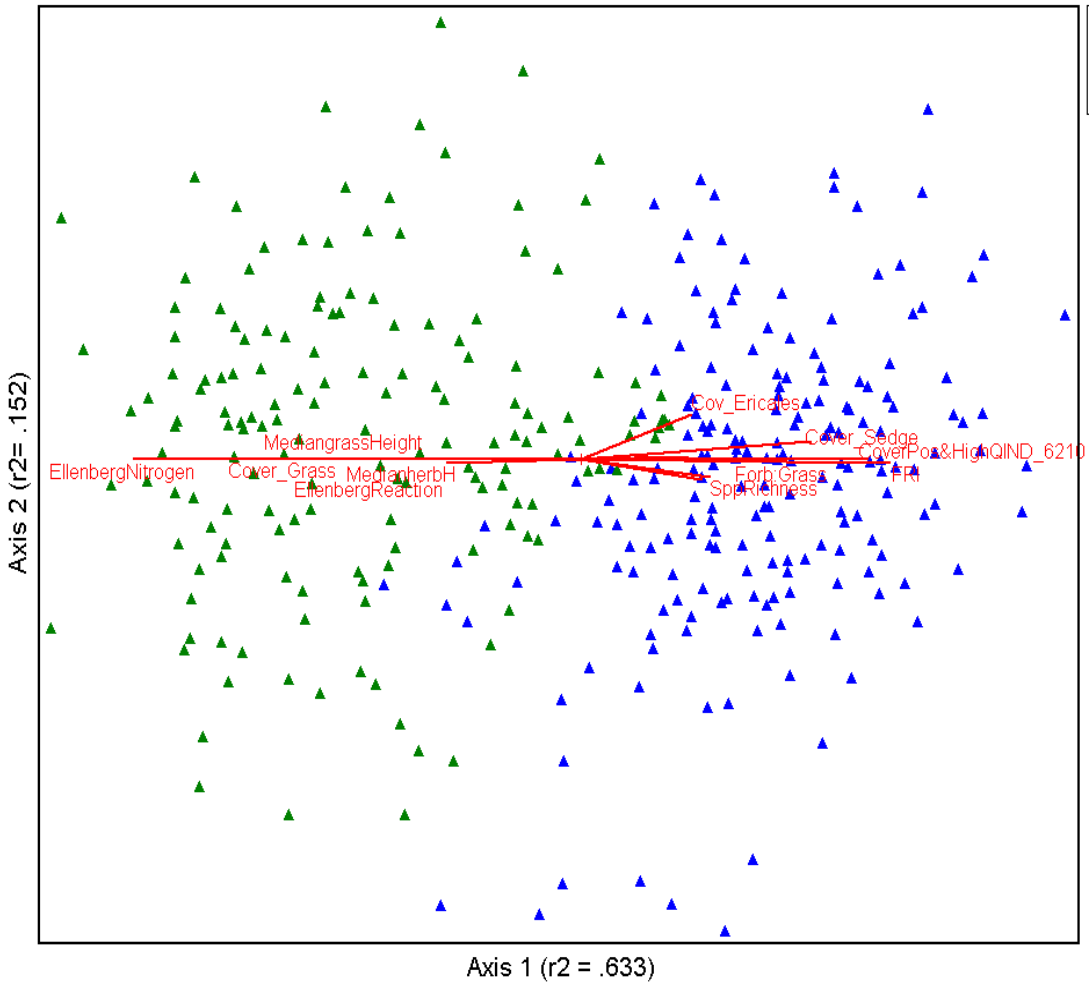

Figure 9. Non-metric Multidimensional Scaling ordination plot of 351 relevés. Each triangle is a relevé. The radiating line direction represents Pearson correlation to variables relating to vegetation structure, biodiversity and Ellenberg Indicator Values. The length of the line indicates the strength of the correlation to the species ordination. The colour of each triangle represents the group membership to vegetation types that resulted from Cluster Analysis and Indicator Species Analysis.

Table 2: Summary table of grassland groupings based on broad management types.

	Winter pasture	Flash-grazed	Summer pasture	No grazing
	(108)	(24)	(106)	(15)
Functional Group percent cover				
Grasses	38.1 (2)	41.3 (4.7)	53.6 (2.2)	46.5 (6.5)
Sedges	9.4 (0.7)	7.8 (2.5)	3.6 (0.6)	6.6 (2.1)
Rushes	0.1 (0)	1.7 (1)	0.8 (0.4)	0 (0)
Broadleaf herbs	75 (2.1)	76.9 (4.1)	65.4 (2)	33.8 (6.9)
N-fixing herbs	16.4 (0.8)	22 (2.4)	21.3 (1.3)	10 (2.6)
Low Woody	7.6 (1.2)	0.3 (0.2)	0.6 (0.4)	14.7 (6.1)
Shrubs	2.7 (0.5)	2.2 (0.8)	3 (0.6)	7.8 (2.1)
Ferns	2.5 (0.6)	0.8 (0.5)	3.8 (0.8)	9.9 (3.6)
Bryophytes	4.6 (0.5)	6.4 (1.3)	6.5 (1)	4.7 (1.3)
Litter	7.7 (1.2)	3.7 (1.1)	5.7 (0.8)	23 (4.6)
Structure & Environment				
Median Soil Depth (cm)	8.2 (0.5)	9.1 (1.1)	11.2 (0.5)	9.4 (1.7)
Grass Height (cm)	15 (1)	17.4 (1.7)	23.8 (1.6)	28.6 (4.1)
Herb Height (cm)	10.7 (0.5)	12.5 (1.5)	14 (0.9)	13.2 (2)
Heather Max Height (cm)	4.5 (0.6)	0.6 (0.5)	0.6 (0.3)	9.9 (3.4)
Altitude	62.1 (2.9)	40.1 (4.2)	31.4 (1.8)	25.4 (3.8)
Forb:Grass	2.5 (0.1)	3.1 (0.9)	1.6 (0.2)	1.4 (0.5)
Ellenberg Nitrogen	3.2 (0.1)	3.9 (0.2)	4.5 (0.1)	3.5 (0.2)
Ellenberg Reaction	5.7 (0.1)	6.2 (0.1)	6.1 (0)	5.5 (0.2)
Ellenberg Salinity	0.4 (0)	0.4 (0)	0.4 (0)	0.6 (0.2)
Biodiversity				
Species Richness	24.3 (0.6)	22.7 (1.3)	20.4 (0.7)	13.6 (1.2)
Simpson's Diversity	11.8 (0.4)	10.9 (0.7)	10.1 (0.4)	6 (0.8)
Abundance-weighted Floristic Rarity Index	10.8 (0.3)	9.4 (0.8)	6.5 (0.3)	7.6 (0.9)

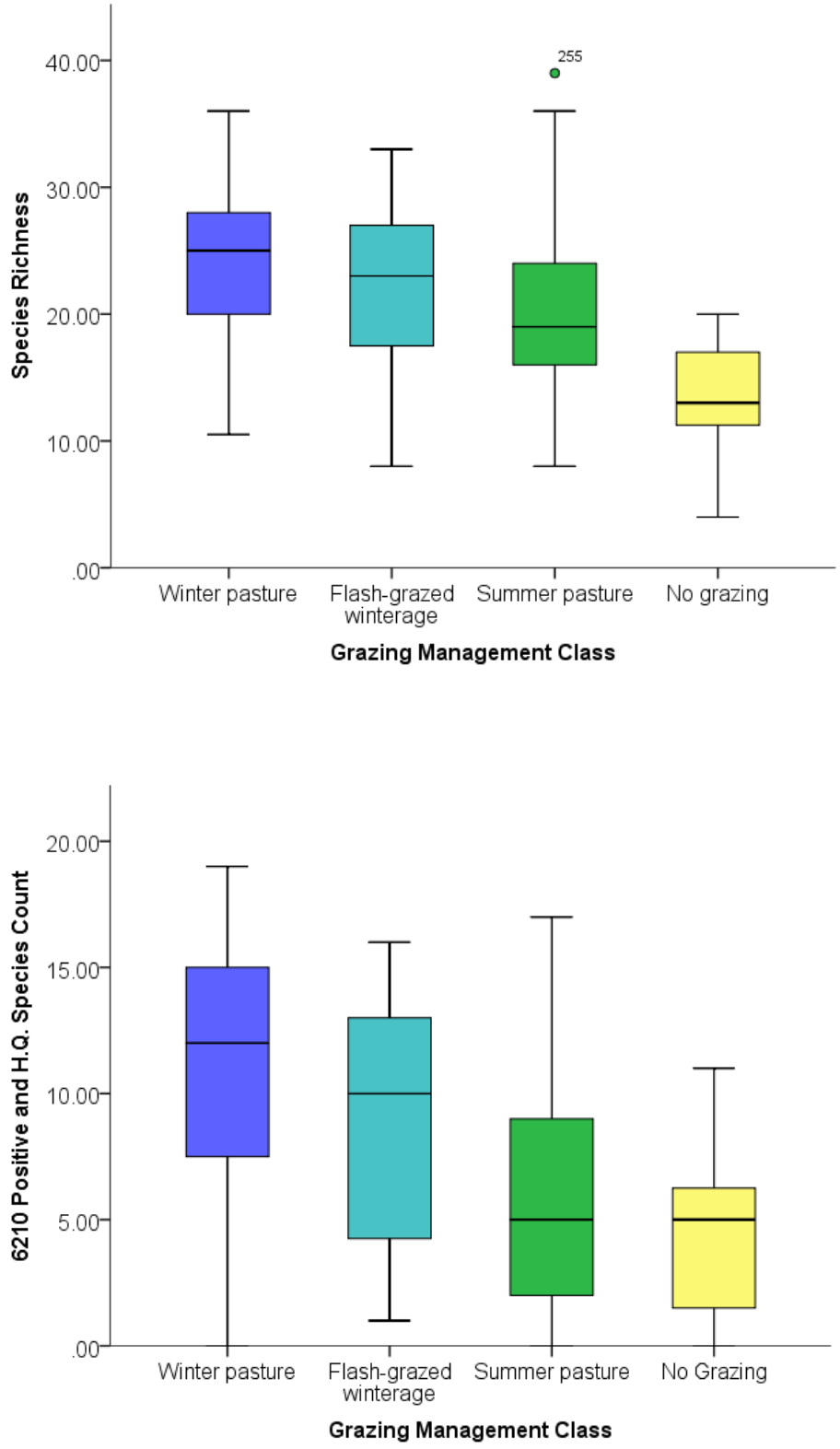

Figure 10: Grazing management and a) species richness and b) positive and high quality indicator species

Agricultural potential and grazing management

A primary objective for conservation management of biodiversity semi-natural grasslands is achieving an optimal annual stocking rate which promotes biodiversity. The aim for sustainable grazing levels on low-input semi-natural pastures is to get a good balance between forage production and utilisation. Under-utilisation results in a build-up of senesced forage of low feeding value for the animal, as well as loss of grassland habitat to woody species encroachment, both result in a loss of important species associated with calcareous grasslands. On the other hand, high utilization can favour the spread of competitive grass species and a build-up of soil nutrient status over time.

This study utilised two complimentary methods to determine annual stocking rates (LU/ha/yr) on a typical Aran farm.

1. *Annual net primary production*: Direct measurement of herbage yield within grassland habitats is an important aspect of determining annual stocking rates for habitat conservation and livestock production. Resulting dry matter yields can be used to determine indicative annual stocking rates (LU/ha/yr) within broad pasture types.

2. *Grazing management records*: Annual stocking rates can also be determined through annual farmer grazing management records. These calculations are based on the amount of forage a livestock unit will theoretically consume in a day, and the number of days spent grazing a known grassland area.

Annual net primary production

The herbage yield within grassland habitats is an important aspect of sustainable grazing management for habitat conservation and livestock production. Above-ground net primary productivity (ANPP) was used as a measure of annual dry matter yield on semi-natural pastures on Aran. Average ANPP in SP was 5654.7 kg DM ha-1 yr-1 (Table 3), and the overall range of ANPP was between 4466.08 to 6704.1 kg DM ha-1 yr-1 in this pasture type. Average ANPP in WP was approximately 50% of the production potential recorded in SP (2156.7 kg DM ha-1 yr-1). The range in ANPP across WPs was over three times greater than SP; the highest recorded ANPP in WP was 4466.08 kg DM ha-1 yr-1 on a moderately sheltered WP and the lowest was 926 kg DM ha-1 yr-1 on a comparatively exposed pasture.

Differences within and between pasture types are associated with factors which impact on a plants ability to mobilise reserves for new leaf material production. For example, soil depth, water and nutrient supply, variability in plant community composition, exposure to shear wind stress, positive and negative feedbacks associated with differential grazing pressures (i.e. plant complimentary regrowth potential) and season grazed. The steeper environmental gradients and higher variation in plant community composition associated with WPs is likely responsible for the higher variability within this pasture type.

These results are comparable to previous studies which quantified dry matter yields on northern European dry calcareous grasslands of highly calcareous and shallow soils overlaying limestone bedrock (Table 4). The average DM yields in WP are in line with these previous studies and lower extremes recorded on the most exposed WPs are likely due to shallow soil depths in combination with exposure to shear stress exerted by prevailing south-westerlies. Average and maximum annual dry matter yields in SP were found to be higher than those previously recorded for dry grasslands, and are more in line with measures of harvestable yield in species–rich semi-natural un-fertilized lowland hay meadows in the UK when first cut in late-June or July (Tallowen and Jefferson, 1999). Aran SPs are relatively sheltered (have smaller field sizes enclosed by relatively tall stone walls), and frequently have a history of rotational cropping. In addition, Ireland experiences a relatively milder oceanic climate. These factors may account for higher ANPP recorded within this pasture type.

The seasonal availability of forage accessible to livestock will have a large impact on annual grazing management, livestock carrying capacities, supplementary feeding requirements and farm profitability. Farmers on the Aran Islands, through experience, have a very keen awareness of the growth potential of each and every land parcel on their own farms and locally-specific unwritten rules exist in relation to the livestock carrying capacities of Aran pastures. This study, for the first time, provides a quantitative indication of the potential forage yields across Aran pasture types, but does not take into account inter-annual variability in forage yields over the longer-term. However, in the context of the Aran farming system, these results can shed light on the motives behind annual grazing management strategies employed by Aran farmers and can enable the development optimal grazing management models which depend on information about forage supply and utilization.

Table 3: Annual stocking rates calculated from measurements of forage dry matter productivity on the Aran Islands and from a range of comparable dry grasslands

	Forage Dry Matter kg DM ha^{-1}	Annual harvest	Cutting height	Annual stocking rate if grazed in Winter at 70% utilization and 10kg daily dry matter intake	Annual stocking rate if grazed in Summer at 60% utilization and 12kg daily dry matter intake
Summer-grazed pasture	4467-6704	Annual production	4 cm	0.86 - 1.29	**0.51 - 0.77**
Winter-grazed pasture	926-4343	Annual production	4 cm	**0.18 - 0.83**	0.11 - 0.5

Seasonal stocking rates of pasture types on Aran based on forage quality and annual grass production data.

Table 4: Annual stocking rates calculated from measurements of forage dry matter productivity on the Aran Islands and from a range of comparable dry grasslands

Geographic location	Forage Dry Matter kg DM ha^{-1}	Date of annual harvest	Cutting height	Annual stocking rate if grazed in Winter at 70% utilization and 10kg daily dry matter intake	Annual stocking rate if grazed in Summer at 60% utilization and 12kg daily dry matter intake
Summer-grazed pasture, The Aran Islands, Galway	4467-6704	Annual production	4 cm	0.86 - 1.29	**0.51 - 0.77**
Winter-grazed pasture, The Aran Islands, Galway	926-4343	Annual production	4 cm	**0.18 - 0.83**	0.11 - 0.5
The United Kingdom (Wells and Cox 1993)	1940.5 (long-term average)	May	<1 cm	0.37	0.22
Sweden (Sjögren, 1988)	2080- 5310	October	-	0.4 - 1.02	0.24 - 0.61
The Netherlands (Willems *et al.* 1993 and Willems, 1983)	1600-4500	July; Early-august	2-4 cm	0.31 - 0.86	0.18 - 0.51
North-west Switzerland (Braschler *et al.* 2003)	1500 – 3660	October	5 cm	0.29 - 0.7	0.17 - 0.42

*Seasonal stocking rates of pasture types on Aran based on forage quality and annual grass production data.

Grazing practices on the Aran Islands

Field surveys carried out by AranLIFE on summer and winterage pastures show that there is a relationship between species-richness and the type of plants in a pasture, and the long and unique tradition of seasonal grazing (Table 2).

- **Summer pasture** (Glas fhéar)- spring to autumn.
- **Winterage pasture** (Sean fhéar)- autumn to spring.

Summer pastures

Plant species-richness is high in this pasture type. The diversity however can vary greatly between summer pastures generally as a result of how frequently and heavily they are grazed during the plant flowering season, or how much intensification (chemical fertiliser additions, over-seeding with agricultural seed mixtures) has been undertaken in the past.

When summer pastures are grazed in summer to maximise their agricultural output, frequent heavy grazing (3-4 times) during the plant growing season will reduce the cover of certain plant species because it prevents them from flowering and setting seed. On the other hand, summer pastures that are grazed too lightly can become so ‘strong’ that they smother smaller and more delicate flowering plants.

Winterage pasture

Winterages have a feeding value similar to summer pastures during the active plant growing season. However, many winter pastures are not suitable for livestock in summer, due to the reduced availability of water. Therefore, winter forages are allowed to build up over the summer months, and subsequently grazed in winter. In what could be considered a relatively harsh landscape, these winterages provide livestock with all the basic requirements: a relatively warm dry-lie, dry fodder and sufficient water. The ecological significance of winter grazing is very high. Plant litter and potentially dominant grasses are removed. The removal of winter forage biomass acts to ‘reset’ the pastures before the next growing season and prevents nutrients from building up in the soil. During the growing season, herbaceous plant species flourish undisturbed in their low-nutrient environment. From a farmer’s point of view, winter pasture is a valuable resource, as it is a low-cost and healthy alternative to winter housing of livestock practiced on most of the mainland.

Grazing pressure/Annual stocking rates (ASR) for optimum species-richness

To maintain grasslands in good quality, farmers must achieve a balance between the amount of forage a field produces each year and the amount of forage consumed by grazing livestock (i.e. level of utilisation). Overuse or underuse of a field will influence forage quality and quantity. Too little grazing, especially on winterage pasture, results in the build-up of low-quality unpalatable forage that suppresses the growth of younger, and more succulent forage of a higher feeding value. Low levels of grazing may also lead to scrub encroachment. Over-grazing, or grazing too tightly can lead to poaching, especially on relatively deeper soils.

> ***The grazing pressure (annual stocking rate) describes the number of livestock in a field and the length of time they remain there and is measured in 'livestock units per hectare per year' (LU/ha/yr).***

A sub-sample of 22 farmers were surveyed across the three Aran Islands to determine stocking rates at the whole-farm level. Results are presented in Table 5.

Overall, the average stocking rate on the Aran farm was recorded as 0.4 LU/ha. The range of variation surrounding the average stocking rate likely reflects the large variation in farm physical structure that exists between farms. For example, the extent of limestone pavement habitat on farms; the relative proportion of winter-grazed to summer-grazed pastures; and differences in forage productivity within pastures type. For examples, a farmer with a higher proportion of highly exposed winter-grazed pasture will have less annual forage production compared to a farmer with relatively sheltered winter-grazed pasture.

Due to the range of variability in stocking rates (LU/ha) that can exist across farms, it is prudent to also calculate annual stocking rates (LU/ha/yr) within broad vegetation types that exist on the Aran Islands (see Table 6).

Table 5: Stocking rate of farms on the Aran Islands

Sub-sample of 22 Farms	<10 hectares (4)			10-20 ha (9)			20-30 Ha (4)			>30 hectares (5)			Overall (22)		
	Mean	Stdev	Range	Average	Stdev	Range	Average	Stdev	Range	Average	Stdev	Range	Average	Stdev	Range
Farm Size (hectares)	7.85	1.05	6.7 - 8.8	13.85	2.60	10.7 - 17.8	25.05	2.28	21.9 - 27.2	54.64	29.00	32.7 - 104.1	24.80	22.17	6.7 - 104.15
Cattle LU/ha	0.46	0.09	0.3 - 0.5	0.43	0.21	0.1 - 0.8	0.45	0.14	0.3 - 0.6	0.27	0.08	0.1 - 0.3	0.40	0.17	0.11 - 0.87

Table 6: Annual stocking rates recorded by farmers on summer and winter pastures, and over a range of vegetation types on the Aran Islands

Vegetation type and sub-types	**Average (LU/ha/yr)**	**Range (± 20%)**
Summer pasture	**0.71**	**0.57 - 0.86**
Semi-improved summer	0.76	0.61 - 0.92
Species-rich summer	0.56	0.45 - 0.67
Winterage	**0.43**	**0.34 - 0.52**
Winterage + summer flash-graze	0.54	0.43 - 0.64

Grazing duration/Grazing Days

The annual stocking rate (ASR) for summer pasture in Table 6 is 0.71 LU/ha/yr, compared with 0.43 LU/ha/yr on winter pasture. This means that the overall stocking rate of a summer pasture of average productivity is approximately double that of a winter pasture of average productivity. These figures can be used to calculate appropriate grazing days for a field (see examples 1 and 2) and a farm (example 3).

Example 1: A farmer has four suckler cows (= 0.9 livestock units per animal) available to graze one hectare of winterage of average productivity (annual stocking rate = 0.43 LU/ha/yr; from Table 6 above). Approximately 20% of the field is covered in exposed limestone pavement.

Step 1. Convert the guideline Annual Stocking Rate to 'grazing pressure'	0.43 x 365 days = 157 LU days/ha/yr
Step 2. Deduct 20% non-vegetation area	0.43 x 365 x 0.8 = 125.5 LU days/ha/yr
Step 3. Calculate the LU available to graze	4 x 0.9 = 3.6 LU
Step 4. Calculate the target average number of days to achieve appropriate grazing levels*	125.5 / 3.6 = 35 days
Step 5. Proposed range for days spent grazing with four cows**	28-42 days

*Based on average annual stocking rates for winter pastures recorded with farmers on the Aran Islands.

**The proposed range of grazing days is based on the values in Step 4 ± 20%. The ± 20% is to account for the within and between season variation in forage, due to factors such as climatic conditions.

Example 2: A farmer has one suckler cow (0.9 LU), one calf <6months (0.2 LU) and one calf 1-2 years old (0.7 LU) available to graze a 0.25 hectare parcel of summer pasture of average productivity (ASR = 0.71 LU/ha/yr; from Table 6 above). The farmer grazes this parcel 3 times per year.

Step 1. Convert the guideline Annual Stocking Rate to 'grazing pressure' per hectare.	0.71 x 365 = 259 LU days/ha/yr
Step 2. Convert 'grazing pressure' per hectare to grazing pressure per actual area, 0.25ha in this example.	259 * 0.25 = 65 LU days per year
Step 3. Calculate the LU available to graze.	0.9 + 0.2 + 0.7 = 1.8 LU
Step 4. Calculate the target average annual number of days to achieve appropriate grazing levels.	65 / 1.8 = 36 days
Step 5. Calculate number of days per grazing period to achieve appropriate grazing levels	36 / 3 = 12 days
Step 6. Proposed range for days spent grazing with one suckler cow, one calf <6months and one calf 1-2 years old per grazing period	9 – 14 days

Example 3: A farmer has a farm of 16 hectares, 4.8ha of summer pasture and 11.2ha of winter pasture, both with average ASR. 25% of the winter pasture covered in exposed limestone pavement. Using data from farmers on the Aran Islands we can calculate average annual stocking rate

	Farmer Surveys				**Measured productivity**		
Vegetation type	Average annual stocking rate (LU/ha/yr)[1]	Total Area (ha)	Pasture area (ha)	Livestock units per annum	Average annual productivity (kg DM)[2]	Average forage utilisation (kg DM)[3]	LU potential for grazing period[4]
Summer pasture	0.71	4.8	4.8	3.4	26400	15840	7.1
Winterage pasture	0.43	11.2	8.4	3.6	17850	12495	6.9
Total		16	13.2	7.02	44250	28335	6.8
Overall farm stocking rate (LU/ha)				**0.44**			**0.43**
Overall farm stocking rate pasture area (LU/ha)				**0.53**			**0.52**

[1] Figures are average values and indicative of overall carrying capacity. There is a large variation in annual stocking rates recorded during AranLIFE (related to variation in site factors) across fields and farms.

[2] AranLIFE research recorded average productivity of summer pastures and winter pasture as 5,500 kg DM/ha/annum and 2,100 kg DM/ha/annum, respectively.

[3] Utilisation figures recorded for AranLIFE were >70% for winterage and >60% for summer pasture. Conservative figures of 70% and 60% were used here.

[4] Dry matter intake, calculated using forage quality figures for grazing period (185 days for summer; 180 days for winter), is 12kg/day and 10 kg/day for summer and winterage pasture, respectively. Average annual intake was assumed to be 11.4 kg DM/day (LU body weight = 5,500kg).

Supplementary feeding within pasture types

Maintaining a high standard of animal health and welfare is an essential component of any conservation grazing management strategy. Matching the correct stocking rate to the natural carrying capacity of the land ensures that livestock have access to forage of sufficient quantity and quality for maintenance of body condition for most of the year. However, forages on winterage are unable to provide sufficient nutrition to maintain the in-calf suckler cow between February and March, thus almost all farmers supply some form of supplementary feeding during the winter grazing period (Nov-April). The most popular feed was imported hay as square bales. About 25% of farmers sampled gave concentrate feeds. In half of these cases, concentrate were solely provided, and for the remaining, concentrates were given in combination with hay. In the preceding year (2017), there was a sharp rise in supplementary feeding with mineral buckets observed and provided by the local vet. The mineral composition of this feed was informed by results of the health workshop.

Winter pasturage (WP): In almost all cases supplementation was given in the latter half of grazing a single field within a WP management unit and it is assumed the most unpalatable forage remained. Generally, farmers open up the next WP and supplementation would not occur again until the biomass remaining was limiting intake. One farmer explained that there was a need to manage your winter grass and "get the most out of it" or you would end up short of forage for the spring months. This would be problematic for a farmer as it would be difficult to sell an animal at this time of year and extra feed would be very expensive and difficult to import during winter months. Supplementary hay is provided to animals loose on the ground, with no dedicated feeding point or ring feeders present within the current sample of sites. Supplementary feeding on winterages has a dual purpose (in addition to keeping animals familiar and quiet). Firstly, to support the health of grazing livestock, around calving in particular, and to slow down the rate of body condition loss during winter months. Secondly, forage is a limited resource within WP and determines the stocking rate of the whole farm unit. In response, farmers are using supplementary feeding to extend the grazing period within winter pastures. This will equate to high grazing pressure within this pasture type. The main result being lower residual sward height (3-5cm), minimal litter cover, and low sward structural diversity immediately after grazing.

Summer pasturage (SP): There was a contrasting grazing management strategy recoded in SPs and differences were reflected in supplementary feeding practices. Farmers graze SP more frequently, the objective of which is to keep the summer pastures closer to a vegetative state and therefore "sweeter" for livestock. Achieving tight grazing (such as in WP) was not as strong an objective for farmers sampled. Numerous farmers pointed out that forcing livestock to eat unpalatable vegetation in SP wasn't good agricultural practice and it was more important to them that the animal put on as much weight as possible during this time in order to do as well as possible when they move to the WPs (cage trials show the differential rates of utilization between WP and SP). Supplementary feeding of the suckler cow is minimal or absent in SP. However, it was observed that some farmers had begun moving mineral buckets around with herds in SP in 2017. Weanlings do receive concentrates on SP in October when weaned and this practice can continue if needed into the winter period on WP. Concentrates (e.g. dairy nuts) are given to the suckler cow for a short period before and after calving. For the most part, this was carried out on SP, but one Inis Meáin farmer supplemented with dairy nuts on WP as the field was close to the road and accessible for monitoring calving.

Current supplementary feeding practices are typically kept to a minimum *i.e.* small amounts of supplementary hay, with minimal or no concentrate supplementation. Supplementation with concentrate is mainly given around calving time. This has the benefit of providing the suckler cow with protein, energy and mineral supplements at a time when forage quality and availability is lowest. The use of supplements in February or March maximises biomass removal of some of the least palatable winter forage.

Supplementary feeding appears to have minimal impact on indicators used to assess habitat condition (Fig. 11).

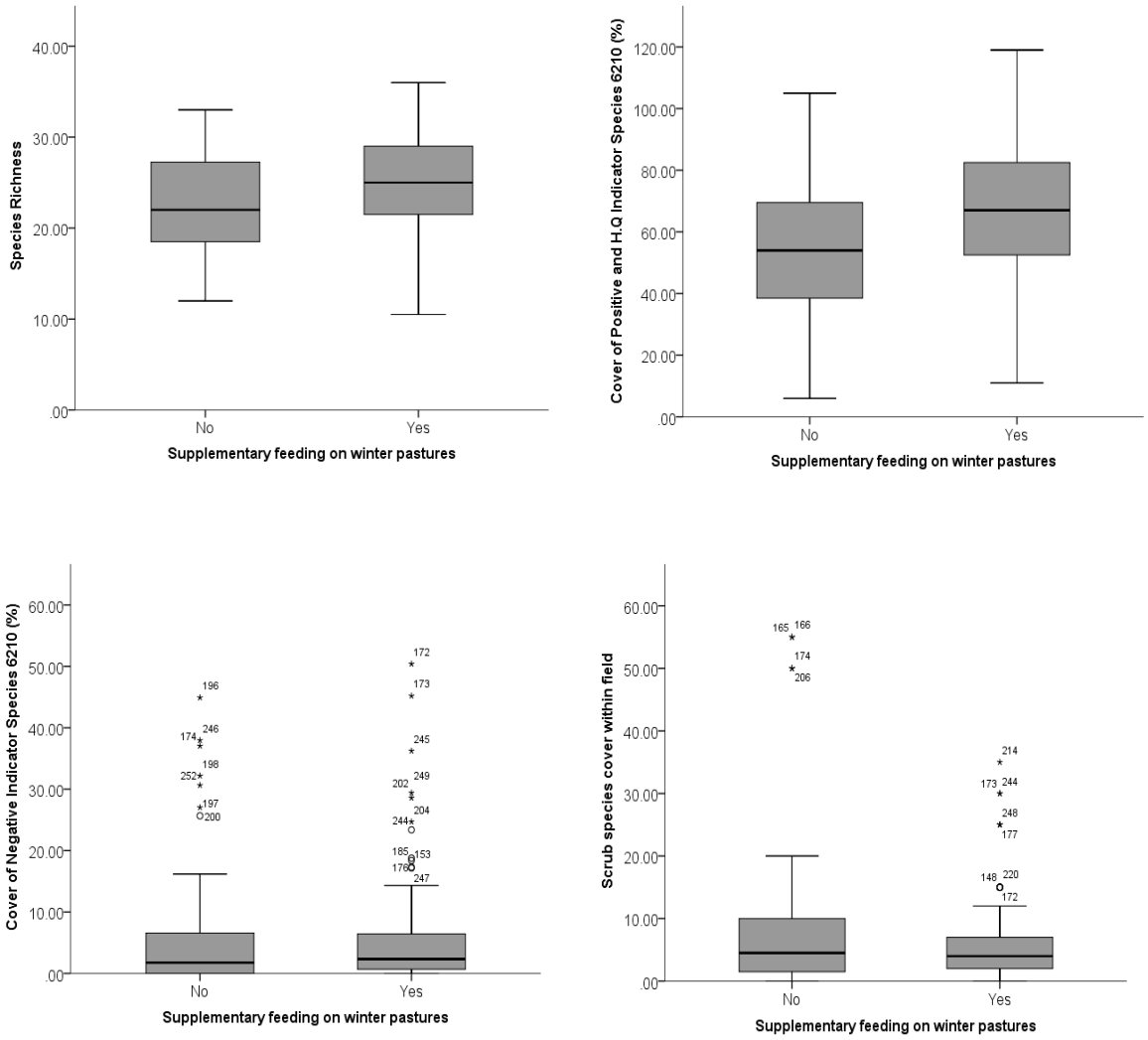

Figure 11: Impact of supplementary feeding within winter pasture on a) species richness, b) cover of positive indicator species, c) cover of negative indicator species and d) scrub species.

Recommendations

Grazing -

Summer pastures

- Early summer: Where possible, summer pastures should be given time to regenerate and flower between periods of grazing. Avoid grazing too tightly during the plant flowering season (i.e. pastures where the vegetation is less than 5cm in height, on more than 75% of the grazeable area, is considered tightly grazed).
- Late summer: Most plants will have had a chance to flower and set seed by late summer. A final graze before closing your paddock for the winter should aim to remove as much forage as possible. This ensures that scrub is kept in check as much as possible.
- For sufficient grass in spring, you need to close summer fields as early as possible in autumn. As part of the overall grazing rotation, some fields that will be grazed first in spring should be closed in October. It may be prudent to close a summer pasture earlier than usual to keep as an option for early spring calvers. This is particularly important if spring growth is delayed and winter forage is running short.
- Where possible, soil nutrient levels should be kept low as this helps to maintain a variety of flowering plants. Application of chemical fertiliser to grasslands designated as a Special Area of Conservation is an activity requiring consent from the National Parks and Wildlife Service. Application of chemical fertilisers to grasslands should be avoided as it encourages the growth of competitive coarse grasses and lowers overall plant diversity.

Winterage pasture

- Winterage pastures should be grazed at least once a year, preferably during the winter months to reflect past management.
- Soils on the Aran Islands are well drained which provides cattle with a ‘dry lie’ in winter and allows tight grazing of winterages. However, avoid poaching (turning sod and blackening the land) at all costs. Extensive poaching in your field damages the native plants and takes the pasture longer to recover for the next grazing.
- Avoid bringing well-managed winterage into your long-term summer rotation. Aside from suppressing native plant species, it reduces your valuable winter grass bank and

may lead to higher winter feed costs. However, limited amounts of summer or year-round grazing of winterages can be a practical way to 'restore' pastures that have grown rank through lack of grazing.

- In some instances, 'flash-grazing' (a light summer graze) of winterage may be beneficial on more productive winterage grasslands.
- During the summer, consider ***targeted*** grazing of scrub re-growth on winterages. Consider the implications for flowering plants. Depending on conditions, the best practice may be to graze scrub re-growth every second year until it is under control.
- Following the removal of scrub, close off internal field boundaries to target grazing and suppress woody regrowth, and/or to remove any build-up of old low-quality vegetation - this 'resets' the pasture and increases forage quality later on.
- Areas dominated by *Molinia* are best grazed in early summer as this practice increases utilisation of this otherwise unpalatable species.

Stocking rate

- Calculate appropriate annual stocking rate to ensure appropriate grazing for livestock and plants. The figures included in this document can serve as a guide for exploring grazing management as a tool to increase the quality of a grassland habitat for nature conservation.
- Adjustments to recommended annual stocking rates (if necessary) should take into account specific grazing objectives, variability in winterage condition and productivity (e.g. between year variability).
- Take into consideration that the following factors influence forage productivity and resultant stocking rates: rock cover, forage quality, soil fertility, and climatic parameters including precipitation, and the level of exposure to wind.

Livestock type:

- If the stocking rate (regardless of livestock type) exceeds the natural carrying capacity of the grassland habitat, plant species-richness will decline within grasslands. The annual stocking rate must, therefore, be appropriate.
- Suckler cows are the predominant livestock on the Aran Islands and many breeding females are selected from the islands' herds. This has many advantages including learnt foraging behaviour on limestone, but also in disease control and in building a high quality breeding herd with desirable maternal attributes that produce good weanlings.
- Grazing with more than one livestock type, can benefit grassland habitats if livestock chosen have differing and complementary preference for particular plant species.
    - In fields where there may be a gradual increase in woody scrub cover, a mixture of cattle and goats could be advantageous to reduce scrub cover. Goats prefer to browse on woody scrub species such as bramble before targeting herbs, and they like grasses the least.
    - A mixture of cattle and horses can result in more efficient removal of forage from a field. Horses have 'patchy' grazing habits, and will create short lawns and avoid other areas altogether, whereas cattle are less selective and will graze an area more evenly.

Supplementary feeding:

- Match stocking rates to the natural carrying capacity of the land to ensure optimal utilisation and minimise supplementary feed costs.
- The introduction of mineral supplements can improve livestock health and reproductive capacity. One of the outputs of the AranLIFE project was a tailored mineral lick.
- Conduct body condition scoring of livestock. This is a valuable tool to monitor cow condition throughout the year and inform management decisions on supplementary feeding. This is especially important at sensitive periods such as the third trimester of gestation and in advance of breeding.
- Provide supplementary feeding from February up until the first flush of spring growth as required, depending on the body condition of in-calf cows. The daily energy demands of the suckler cow at this time are highest due to rapid foetal growth during the third trimester of gestation, or at the start of lactation.
- Always consult your vet if you are unsure about best feeding practices for herd health (including mineral supplementation amounts), and before implementing major changes to your current feeding strategy. Overfeeding and underfeeding of livestock is uneconomical and potentially harmful to livestock and habitats.
- Place mineral supplements strategically in undergrazed or scrub-encroached areas in order to alter grazing behaviour and increase vegetation use and trampling. This will have a greater effect in larger management units where grazing pressures may be less uniform.
- Place hay in the most undergrazed fields to increase the potential of forage utilisation.
- If feeding hay, scatter loose hay over any scrub margins to increase trampling of scrub.
- Move the feed location around a field to avoid localised trampling.
- Feed livestock at the same time each day to maintain livestock routines (this decreases stress and increases grazing activities).
- If practical, position new water tanks in the most scrub-affected (sheltered) areas of your field. Separating water source and supplementary feed sites may also encourage cattle to wander, increasing trampling of scrub. Trampling of scrub prevents it from encroaching onto unspoiled grassland habitat.

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Appendix

Overview and findings from the farmer questionnaire

Farming – recent changes

Livestock include cattle, horses and donkeys, goats and sheep. A large feral goat herd (14 at one count) were sighted at the cliffs on Inis Mór. Rabbits generally inhabit coastal grasslands to the north of the islands. Particularly dense on Inis Mór and to a lesser extend Inis Meáin.

Change in herd composition, cattle breeds and land uses:

1. Move away from mixed farming and an increasing specialization towards suckler cow farm system. Decline in sheep numbers was the largest change to herd composition. (Higher labour requirements, changes in labour availability, changes to EU and national legislation surrounding the slaughter and storage of animals all contributing to change – Suckler cows easier to handle/coupled with increasing age profile of farmer).
2. Simplification of the traditional management framework (land use for pasture dominates and loss of rotational cropping (rye, potatoes and hay). Less area devoted to kitchen gardens.
3. Increase in the number of bulls. Only two bull reported on Inis Mór approximately 100 yo (CDB reports). This has altered the system of grazing to a degree
4. Suckler calves are increasingly sold younger. This change is mainly market driven (there wasn't a large selling price difference between weanlings and yearlings). However, some farmers reported keeping calves as yearlings despite market incentives to sell, as they wanted to see the realized potential of their yearlings.
5. Older animals are no longer kept after two years of age, with the exception of livestock selected for breeding purposes (driven by policy).
6. Change in cattle breeds (62% of breeding herd from sampled farms were continental types). Traditional breeds (e.g. shorthorn) no longer desirable. Market-led. Also increasing accessibility to imported milk reduced dependency on traditional breeds for milking.
7. Move to continental breed types has likely increased supplementary feeding requirements of the Island herd. Continental animals have higher nutritional requirements.