

# National Trust quadrats: Heathland condition mapping report

Written by Charles King

This report has been written following two weeks of fieldwork on Godlingston Heath, Studland Peninsula and Slepe Heath. This was a Student Environmental Research Team (SERT) project that was conducted in collaboration with the National Trust. This SERT has been named 'Purbeck 2017 Heaths, Grassland & Mires Wildlife'. The data collected during this was collected by a team of eight Bournemouth University students of who are mentioned below:

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## **Introduction**

The over-exploitation of heathland habitat has subsequently led to a decrease in numbers of both flora and fauna species (Bakker & Berendse, 1999). Prevalent heathland species such as Gorse and Bracken has been used for fires, and the latter for bedding. The land has also been altered by cattle grazing and many areas have been built on; the sand and gravel composition of heathland soil meant these materials were once heavily utilised in construction. Non-native species have been planted on heathland and disrupted the acidity and fertility of the soil through decomposition. Ultimately, these processes have led to significant declines in heathland habitat and the areas that remain are rare and under threat.

The conservation of heathland habitats is critical for the continuation of the species' that rely so heavily on it. Lowland heathland habitat is home to a plethora of species including the six native reptiles in the UK. Similarly, it is important for birds such as the Nightjar and the rare Dartford Warbler; this species relies exclusively on dry heathland habitat. Furthermore, Ling heather (*Calluna vulgaris*) thrives on drier heaths whilst bog loving bryophytes such as sphagnum mosses thrive in mires/bogs that are wetter, therefore it is important that areas of dry and wet heathland are managed and maintained.

Grazing using sheep has been used in the past as a means of managing heathland habitats. Bakker *et al.*, (1983) found that grazing resulted in increased species diversity as well as greater variations in vegetation types and greater differences in height and cover of the canopy. Rotational fire and cutting by local farmers were also dominant features of past heathland management (Ascoli *et al.*, 2009).

The purpose of this study was to identify and map the compartments of; Godlingston Heath, Slepe Heath and Studland Peninsula, located on the Isle of Purbeck. The intended outcome of this study was to develop a database of the characteristics of each compartment so that the data collected could be used to determine adaptive management approaches which can be used in each particular compartment. This study allowed us to identify what species are present on the heath and where they are distributed, as the presence of certain species can depict whether the heathland is in a desirable or non-desirable state. Overall, the study investigated a large array of variables that constituted the condition of the heathland; this data will be compared with data collected in the future to assess the success of the management practices that are currently in place, and also to determine what changes have occurred on the heathland over time.

## **Method**

*Godlingston Heath, Slepe Heath and Studland Heath were the main sites that were investigated. Each site was divided into compartments; within each compartment 10 heathland condition monitoring surveys (also known as National Trust Transects) were conducted. The heathland condition monitoring surveys were conducted by laying a 4m<sup>2</sup> quadrat down, at random sites within each compartment.*

*Generally, the entire area was surveyed before each quadrat was placed, this was done in order to achieve sample sites that were representative of the compartment being surveyed, as well as to ensure an even distribution of the quadrats. Once a quadrat had been selected the coordinates for that site were taken from the centre of the quadrat using a Garmin GPSMAP 64s. A ten-digit coordinate was recorded onto the data sheet. The abundance of each species present in the quadrat was measured using the DAFOR scale.*

*Afterwards, the heath age class was recorded; this refers to whether the heather was pioneering, building, maturing or degraded, as well as the percentage of bare ground, percentage of dead heather, percentage of branched lichens, percentage of moss forming mats as well as other variables that were on the data sheet, including signs of grazing and no. of shoots grazed within the quadrat. This variable was measured by inspecting 30 shoots of heather within each quadrat to see if they have been grazed, results were tallied in the appropriate column on the data sheet. Estimated percentage cover and estimated height of heather were also recorded. Signs of grazing refer to the presence of animal dung, tracks and couch; their presence was measured as either None, Low, Medium or High on the data sheet.*

*Valley Mire condition surveys were conducted within a 2m<sup>2</sup> quadrat; the DAFOR scale was used to determine the abundance of species present within each quadrat. However, factors such as; the percentage of tussock forming grasses, percentage of sphagnum mosses, percentage of gorse/bog myrtle, percentage of open water and percentage of bare mud were measured instead. The data for valley mires was recorded onto a different data sheet.*

*All data was stored on a database called 'Living record'.*

## Results

### Grazing on Godlingston Heath

The data collected for number of shoots grazed, within the ten sites in each compartment, was used to calculate the mean number of shoots grazed.

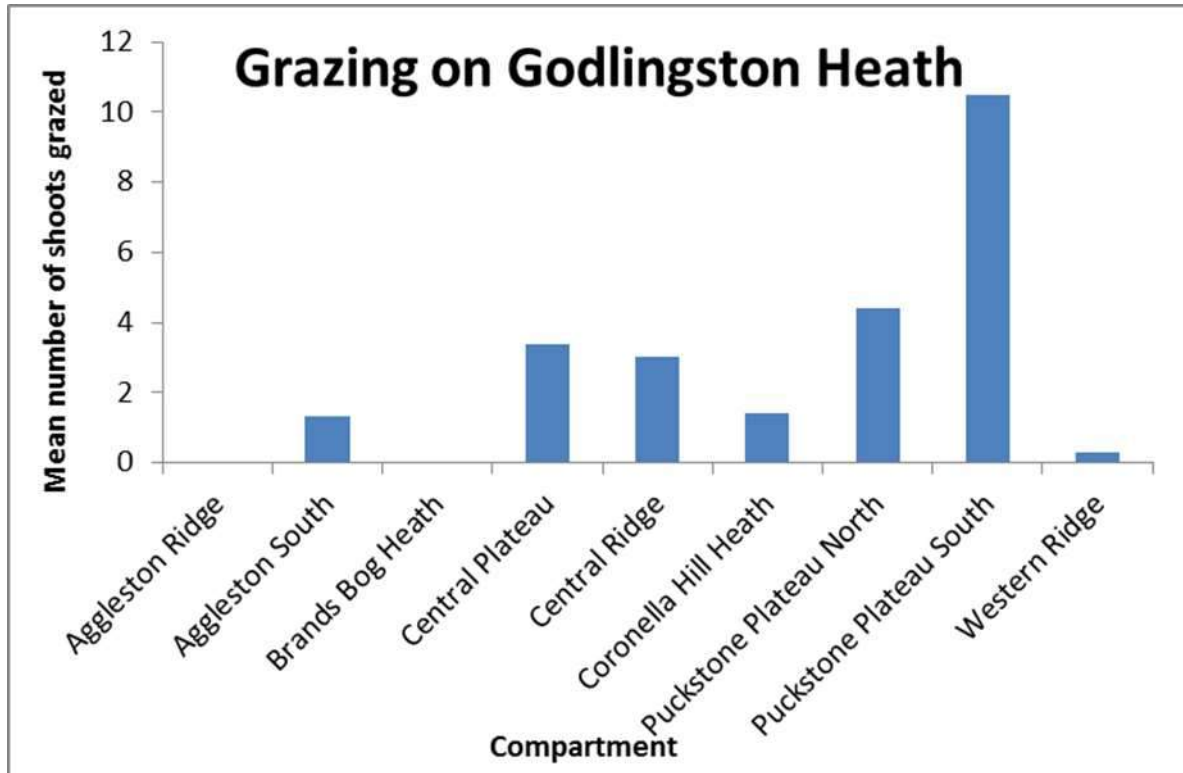


Figure 1: bar chart displaying the mean number of shoots grazed within each compartment on Godlingston Heath.

The results in figure 1 show that the compartment with the highest average number of shoots grazed was Puckstone Plateau North with an average of 4.4 shoots grazed per 4m<sup>2</sup> area. This was followed by Central Plateau with an average of 3.4 shoots grazed per 4m<sup>2</sup> areas. Compartments such as Aggleston Ridge and Brands Bog Heath showed no signs of grazing.

## Bare ground on Godlingston Heath

The data collected for the percentage bare ground, within the ten sites at each compartment, was used to calculate the mean percentage of bare ground.

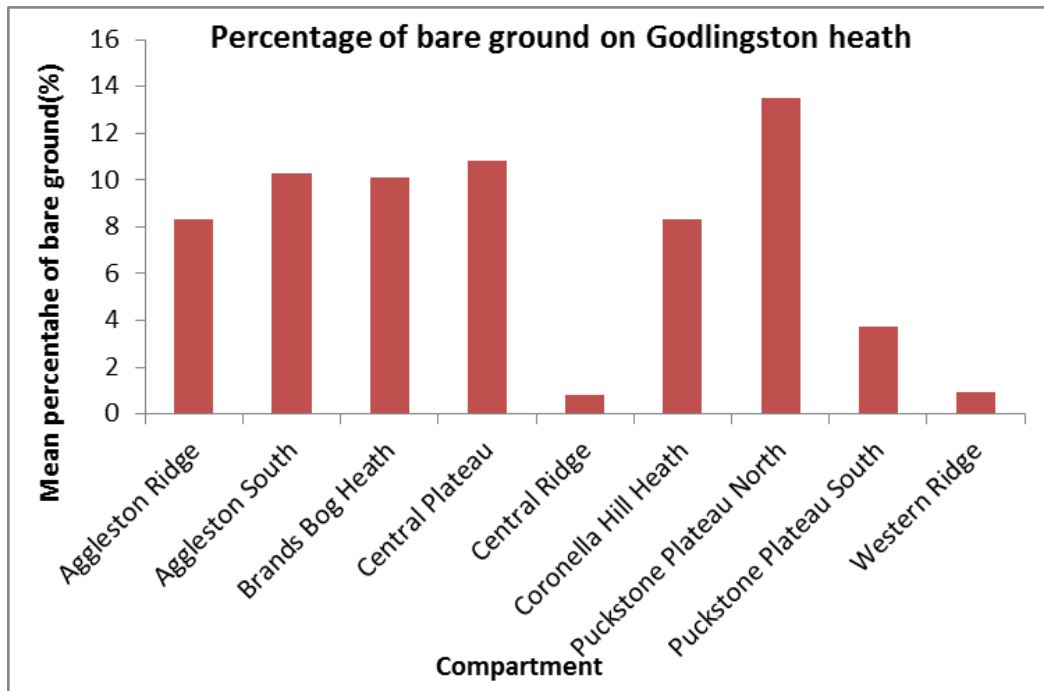


Figure 2: bar chart displaying the mean percentage of bare ground for each compartment on Godlingston Heath.

The data in figure 2 shows that Puckstone Plateau North has the highest percentage of bare ground with 13.5% bare ground per 4m<sup>2</sup> area. Central Plateau, Brands Bog Heath, Aggleston South, Aggleston Ridge and Coronella Hill Heath have a range of 2.5%; all of these compartments possess a relatively high percentage of bare ground. Whereas, Puckstone Plateau South, Western Ridge and Central Ridge have very low percentages of bare ground.

## Dead heather on Godlingston Heath

The data collected for the percentage of dead heather, within the ten sites at each compartment, was used to calculate the mean percentage of dead heather.

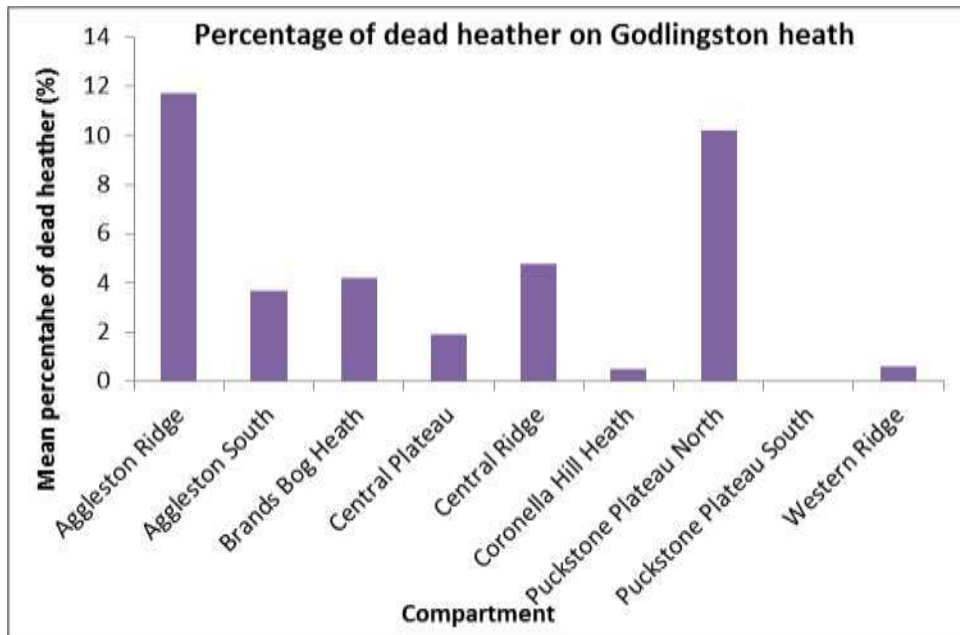


Figure 3: bar chart displaying the mean percentage of dead heather for each compartment on Godlingston Heath.

Figure 3 Shows Aggleston Ridge and Puckstone Plateau North possess the highest percentages of dead heather per 4m<sup>2</sup> area, with 11.7% and 10.2%. All other compartments have a relatively low percentage of dead heather with Puckstone Plateau South being the lowest followed by Western Ridge and Coronella Hill Heath.

### Godlingston Heath compartment heather stages

The maturity of the heather at each site within each compartment was recorded and the below figures display the results of each of the ten sites within the compartment on Godlingston Heath. To determine the overall stage of heather within the compartment the mode is calculated; the most occurring result is displayed by the largest segment in each chart.

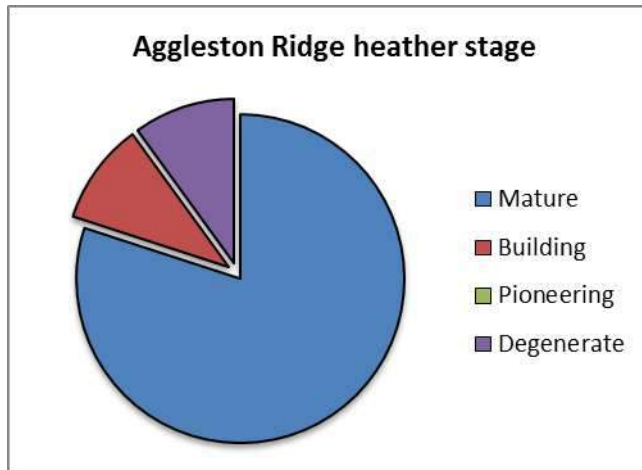


Figure 4a: Pie chart displaying the stages of maturity within compartment: Aggleston Ridge

Figure 4a shows that Aggleston Ridge is dominated by heather in a mature stage. Small areas of this compartment are building and some areas are degenerate also.

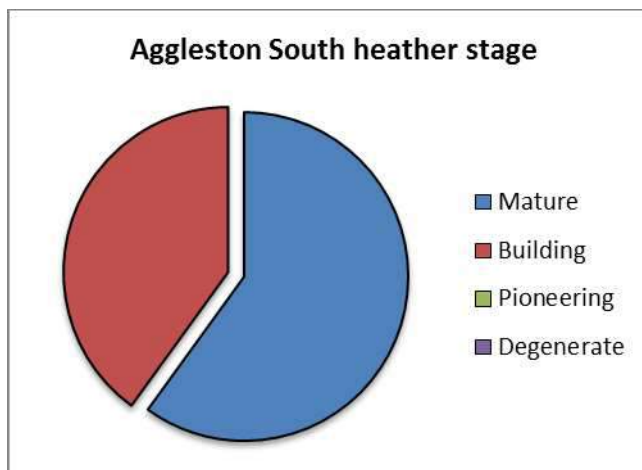
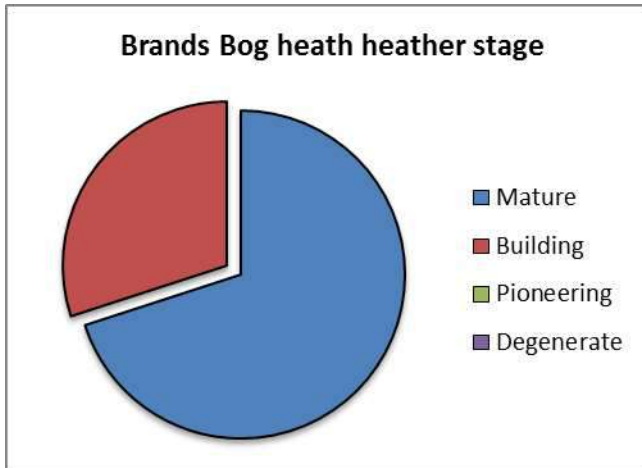


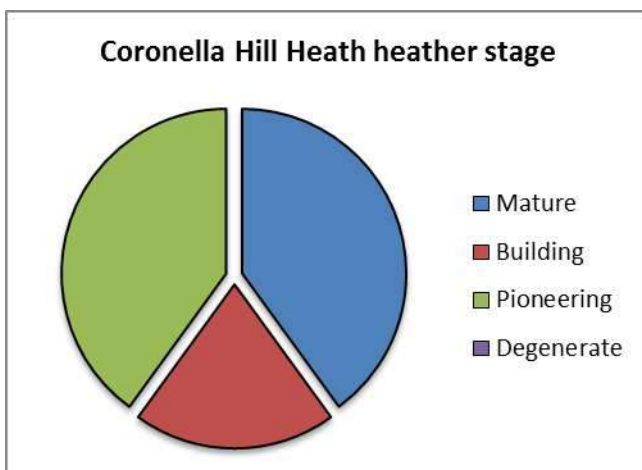
Figure 4b: Pie chart displaying the stages of maturity within compartment: Aggleston South

Figure 4b shows Aggleston South comprises mostly of mature heather; however almost half of the compartment is in a building stage of maturity.



**Figure 4c:** Pie chart displaying the stages of maturity within compartment: Brands Bog Heath

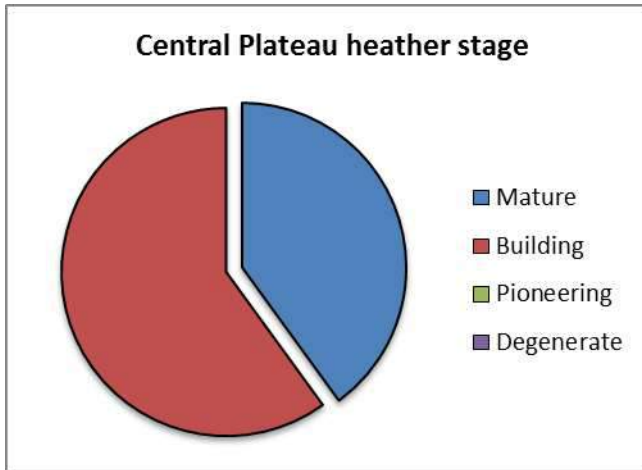
The results displayed in figure 4c for Brands Bog Heath show the compartment is dominated by mature heather with fewer areas of building heather.



**Figure 4d:** Pie chart displaying the stages of maturity within compartment: Coronella Hill Heath

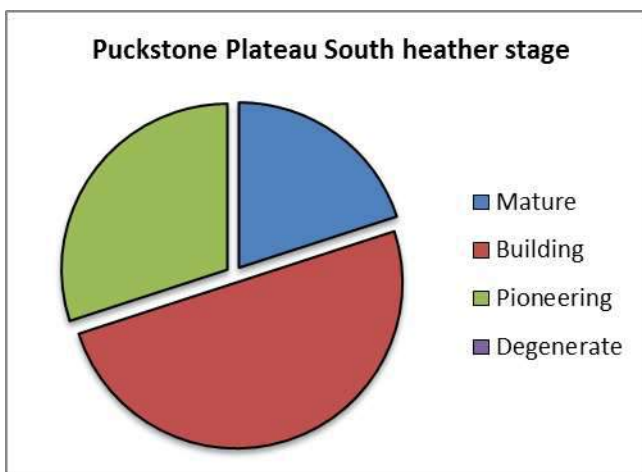
Coronella Hill Heath in figure 4d possesses equal areas of Pioneering and Building heather and a smaller proportion of building





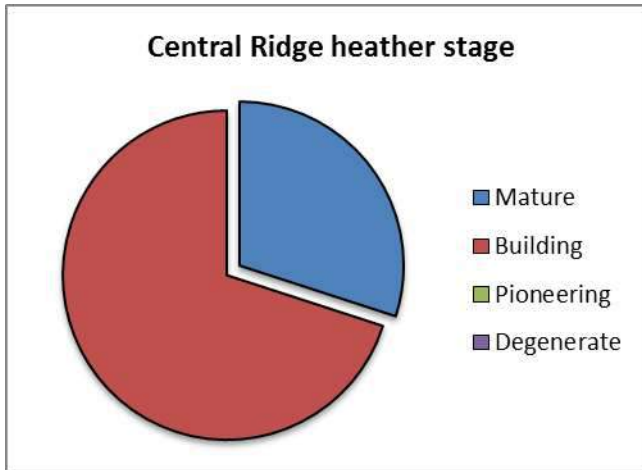
**Figure 4e:** Pie chart displaying the stages of maturity within compartment: Central Plateau

Heather in a building stage dominates Central Plateau in figure 4e. Mature heather makes up almost half of the compartment.



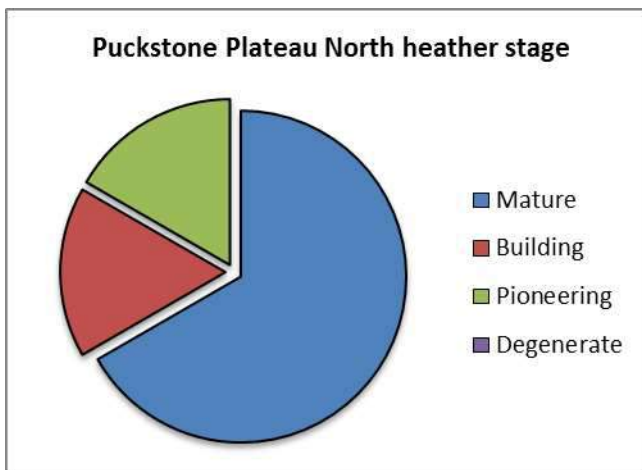
**Figure 4f:** Pie chart displaying the stages of maturity within compartment: Puckstone Plateau South

Figure 4f shows half of the heather on Puckstone Plateau South is building. Heather in a pioneering stage is the next most abundant and the smallest proportion is mature.



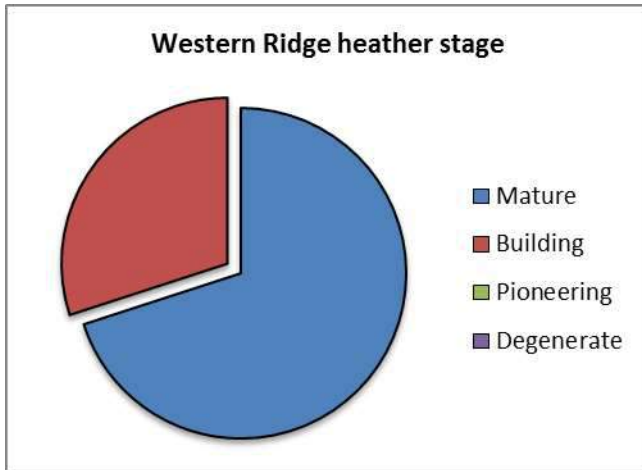
**Figure 4g:** Pie chart displaying the stages of maturity within compartment: Central Ridge

The heather is mainly building on Central Ridge. Figure 4g shows fewer areas of mature heather.



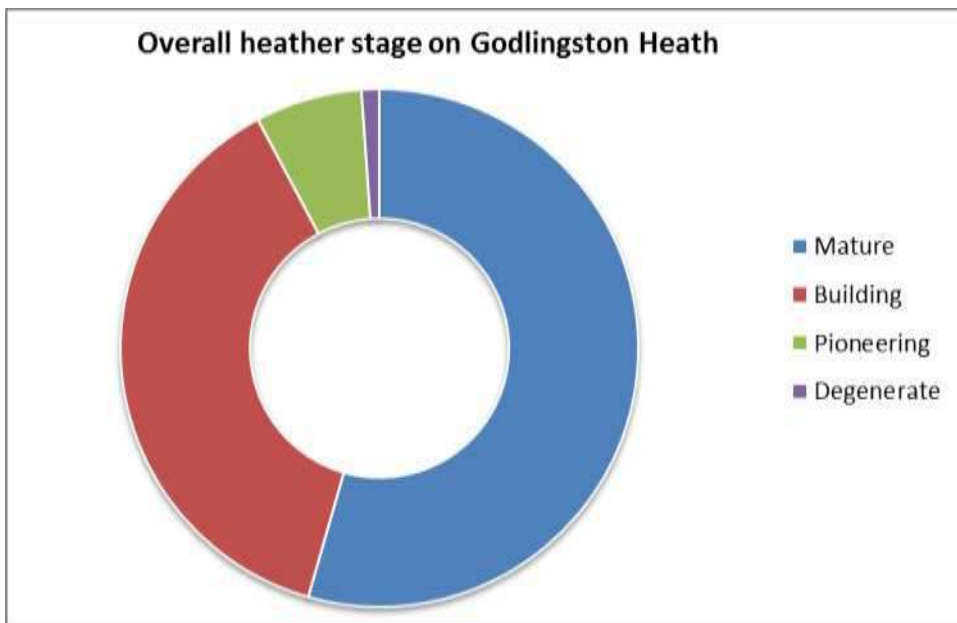
**Figure 4h:** Pie chart displaying the stages of maturity within compartment: Puckstone Plateau North

Mature heather dominates Puckstone Plateau North. Less than half of the heather in figure 4h consists of equal proportions of pioneering and building heather.



**Figure 4i:** Pie chart displaying the stages of maturity within compartment: Western Ridge

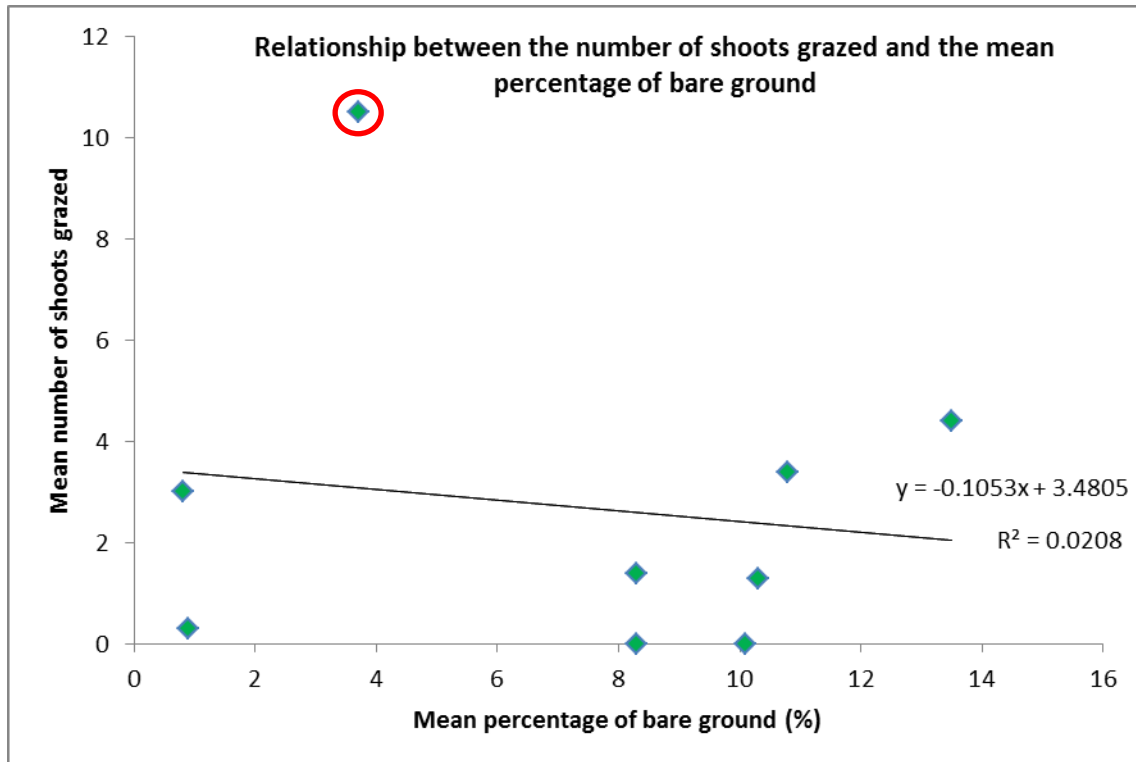
A large area of the western ridge compartment is mature heather. A smaller area in figure 4i is building.



**Figure 4j:** Pie chart displaying the overall stages of maturity of each compartment on Godlingston Heath

Overall Godlingston Heath is dominated by mature areas of Heathland. A large proportion of the area is building, but this area is smaller than mature areas of the heathland. A very small area of the heathland is degenerate and a larger proportion is pioneering.

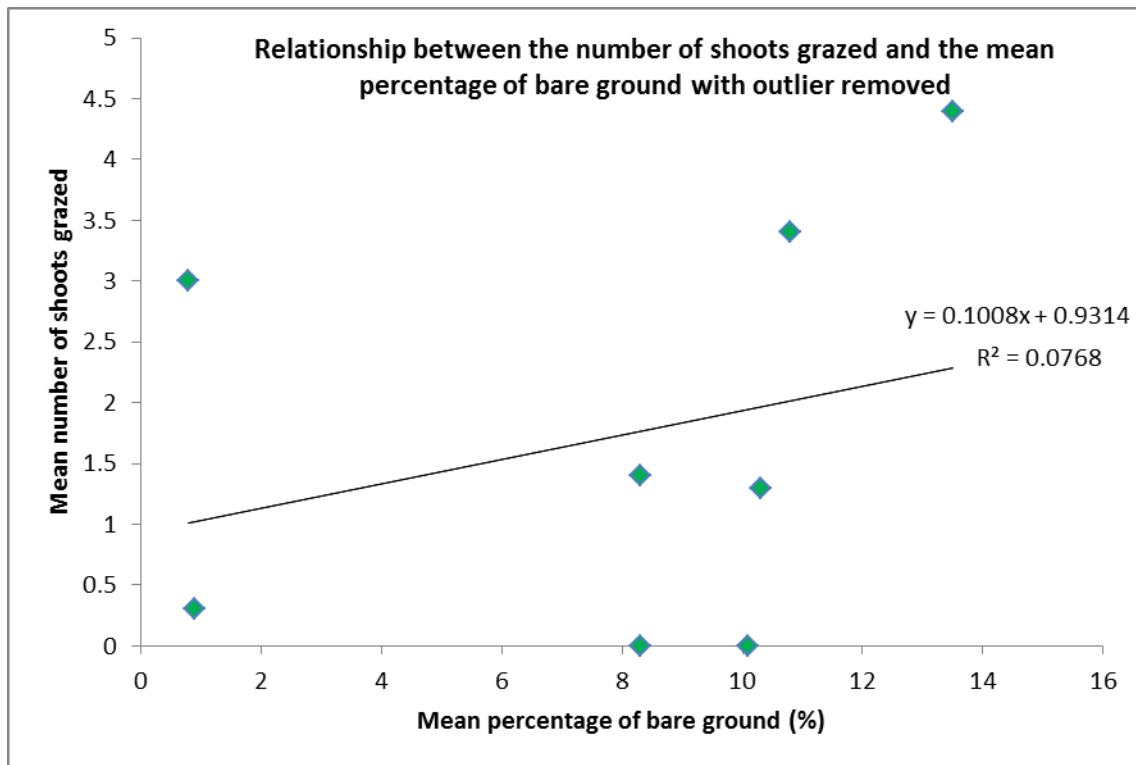
## Relationship between grazing and bare ground on Godlingston Heath



**Figure 5a:** Scatter graph showing the relationship between the mean number of shoots grazed and the mean percentage of bare ground on Godlingston Heath

Figure 5a shows there is a negative correlation between the mean number of shoots grazed and the mean percentage of bare ground. As the number of shoots grazed increases; the percentage of bare ground decreases. The regression line shows a  $R^2$  result of 0.0208, only 2.8% of the total variation in the number of shoots grazed can be explained by the linear relationship between the mean percentage of bare ground and the mean number of shoots grazed.

An outlier (circled in red) has significantly affected the  $R^2$  result. This result was obtained from the compartment Puckstone Plateau South, the results for this compartment was; a mean percentage of bare ground of 3.71% and a mean number of shoots grazed of 10.5%. This outlier highlights limitations of regression analysis; the linear trend line indicates a negative correlation, however once the outlier is removed, the trend line indicates a weak positive correlation; this can be observed in figure 5b.

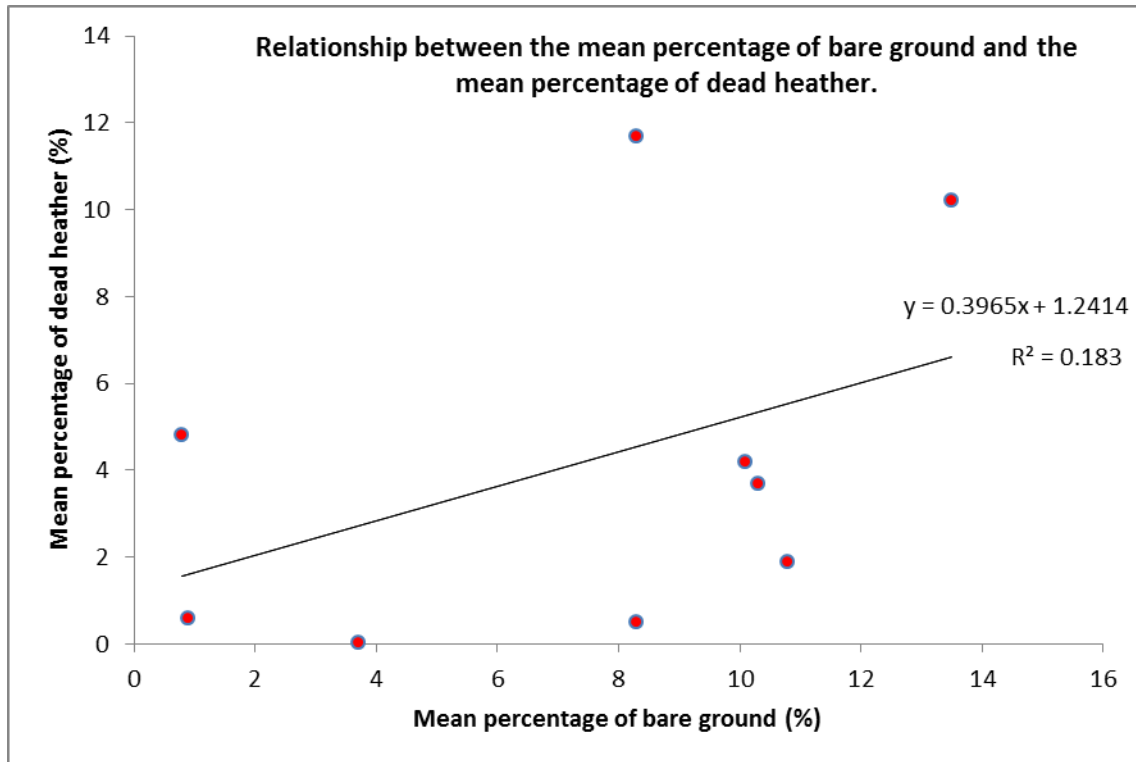


**Figure 5b:** Scatter graph showing the relationship between the mean numbers of shoots grazed and the mean percentage of bare ground on Godlingston Heath, with the outlier removed

Removing the outlier has resulted in a trend line that shows a positive correlation. Although weak, this correlation suggests that as the number of shoots grazed increases, the percentage of bare ground increases. The  $R^2$  result shown by the regression line is 0.0768 this means 7.7% of the total variation in the number of shoots grazed can be explained by the linear relationship between the mean percentage of bare ground and the mean number of shoots grazed. Although this result is higher, both results are close to 0% therefore both models explain very little of the variability of the response data around its mean.

## Relationship between bare ground and dead heather on Godlingston Heath

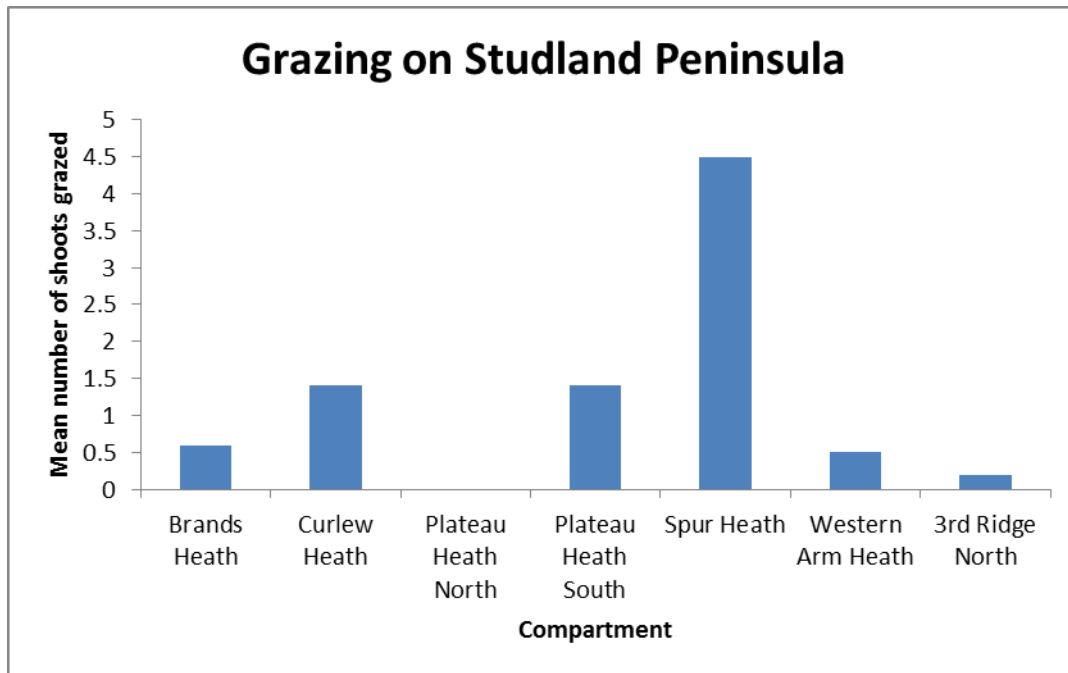
The percentage of bare ground cannot be attributed entirely to grazing; the death of species such as heather may result in an increase in the percentage of bare ground at each site. For this to be the case a positive correlation would be expected; as the percentage of dead heather increases the percentage of bare ground also increases.



**Figure 6:** Scatter graph showing the relationship between the mean percentages of bare ground and the mean percentages of dead heather on Godlingston Heath

Figure 6 shows a positive correlation between the two variables. The regression line shows an  $R^2$  result of 0.183 meaning the 18.3% of the overall variation in the mean percentage of bare ground can be explained by the linear relationship between the mean percentage of dead heather and the mean percentage of bare ground.

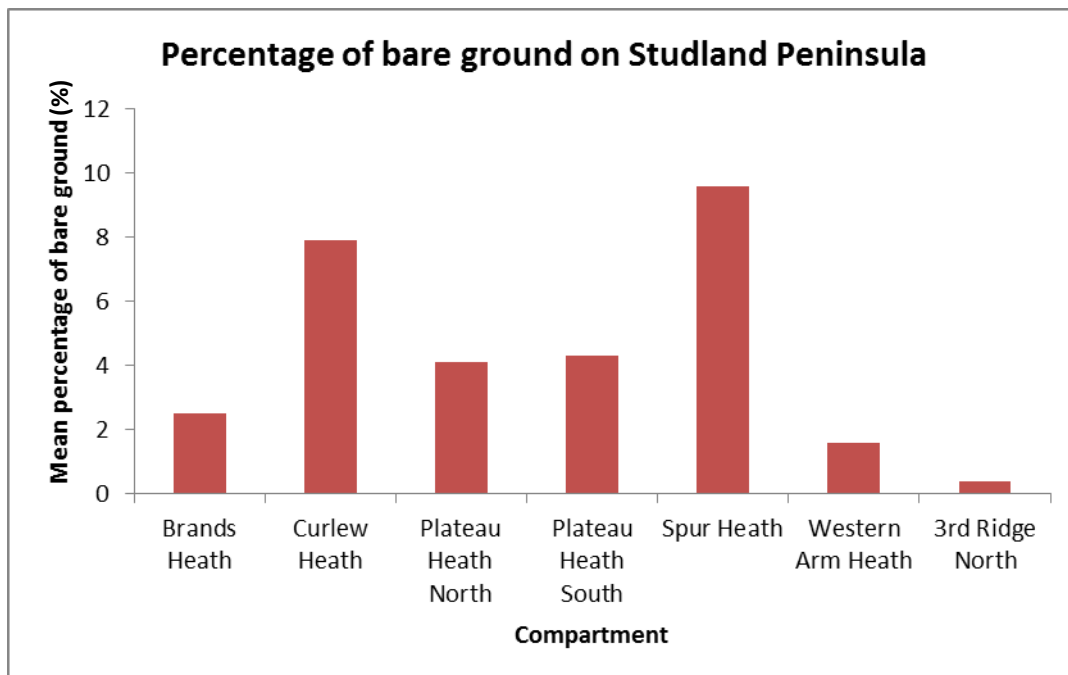
## Grazing on Studland Peninsula



**Figure 7:** Bar chart displaying the mean number of shoots grazed in each compartment on Studland Peninsula

Figure 7 shows the highest mean number of shoots grazed is on Spur Heath with a mean of 4.5 shoots grazed per 4m<sup>2</sup> area. Plateau Heath North has experienced no grazing whereas 3<sup>rd</sup> Ridge North, Brands Heath, Western Arm Heath, Curlew Heath and Plateau Heath South has experienced some grazing within the range of 0.4-1.4 shoots.

## Bare ground on Studland peninsula

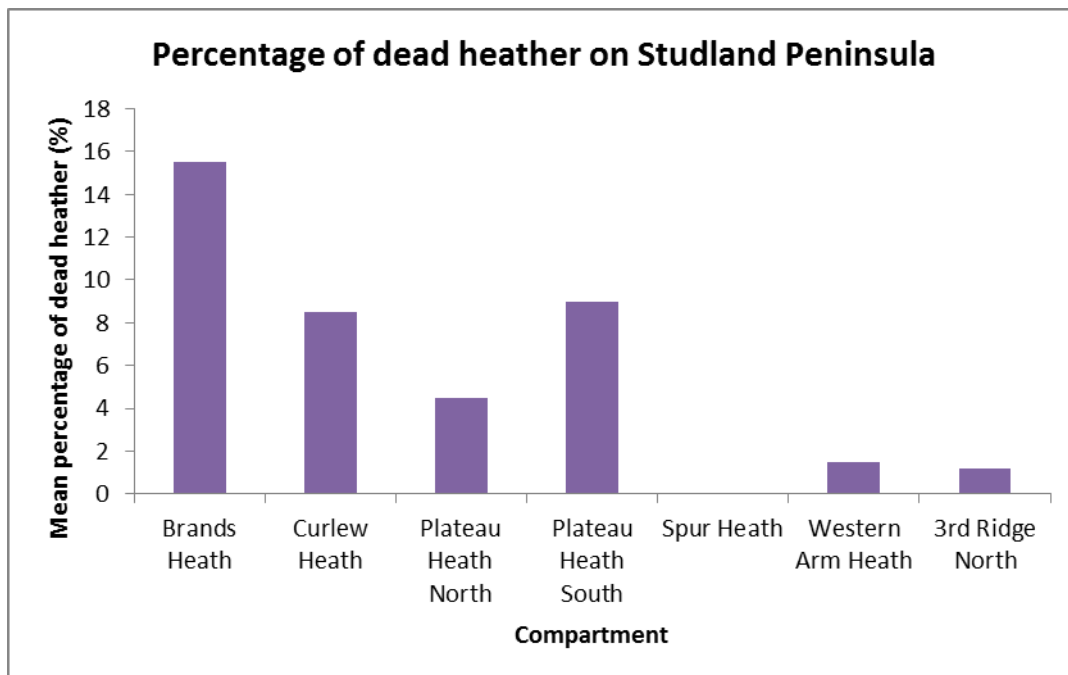


**Figure 8:** Bar chart displaying the mean percentages of bare ground in each compartment on Studland Peninsula

Spur Heath yields the highest mean percentage of bare ground with 9.6% followed by Curlew Heath with 7.9% in figure 8. 3<sup>rd</sup> Ridge North has a very low percentage of bare ground with 0.4% and Western Arm Heath, Plateau Heath North and South and Brands Heath have percentages of bare ground within the range of 1.6-4.3%.



## Dead heather on Studland Peninsula



**Figure 9:** Bar chart displaying the mean percentages of dead heather in each compartment on Studland Peninsula

Figure 9 shows that the highest percentage of dead heather is on Brands Heath with 15.5%. Spur Heath has no dead heather and 3<sup>rd</sup> Ridge North has a very low percentage with 1.15% closely followed by Western arm Heath with 1.5% dead heather. The remaining sites; Plateau Heath North and South and Curlew Heath have higher percentages within a range of 4.5-9%.

## Studland Peninsula compartment heather stages

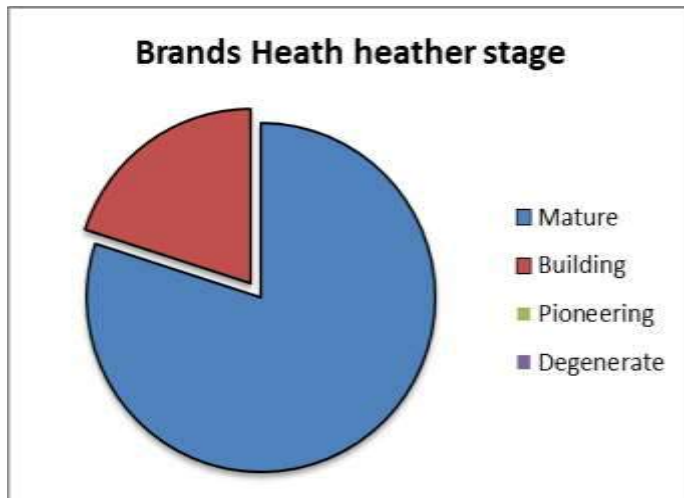


Figure 10a: Pie chart displaying the stages of maturity within compartment: Brands Heath

Figure 10a shows Brands Heath is dominated by heather in a mature stage. Fewer areas of the heather are building.

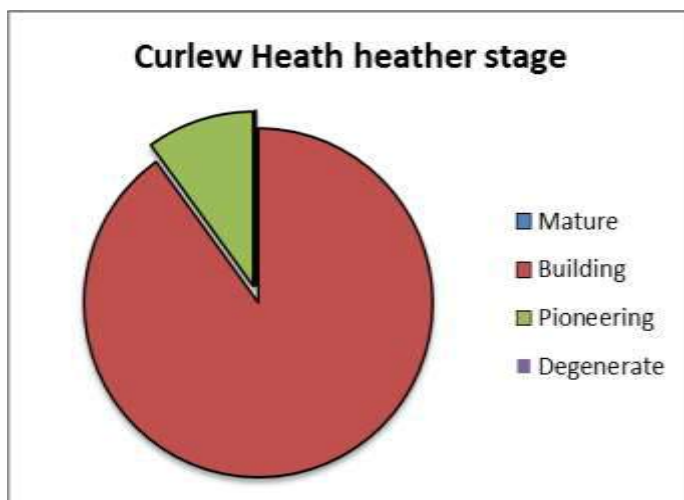
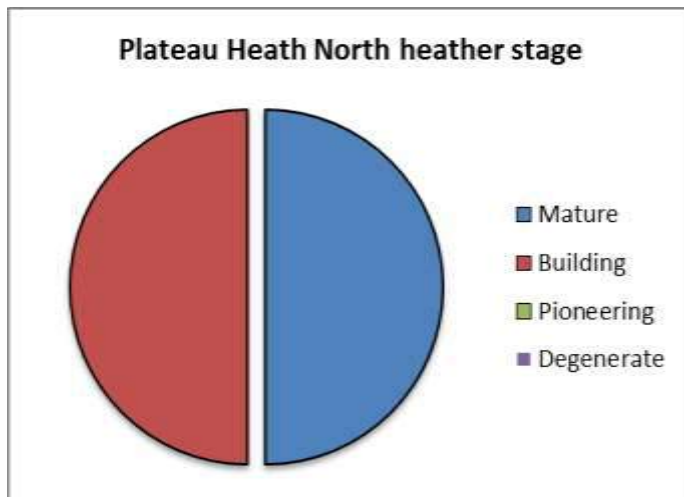


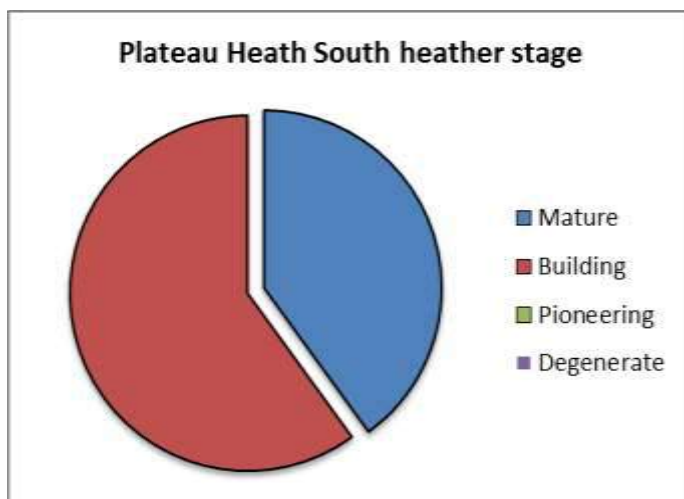
Figure 10b: Pie chart displaying the stages of maturity within compartment: Curlew Heath

Curlew Heath has a small proportion of pioneering heather in figure 10b. Most of the heather in this compartment is building however.



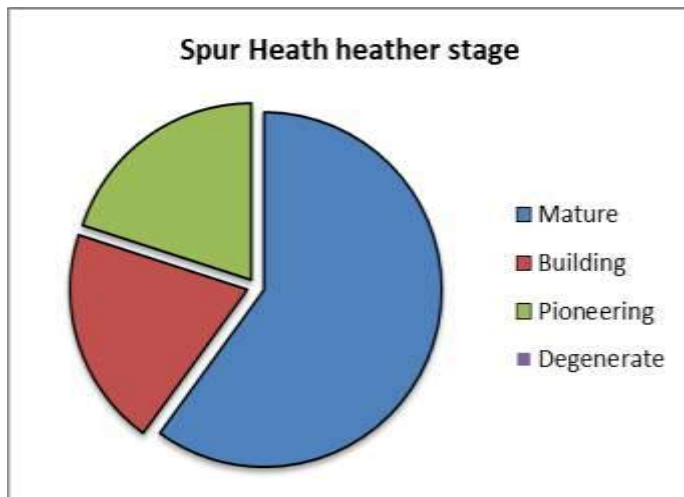
**Figure 10c:** Pie chart displaying the stages of maturity within compartment: Plateau Heath North

Plateau Heath North in figure 10c is equally split between areas of mature and building heather.



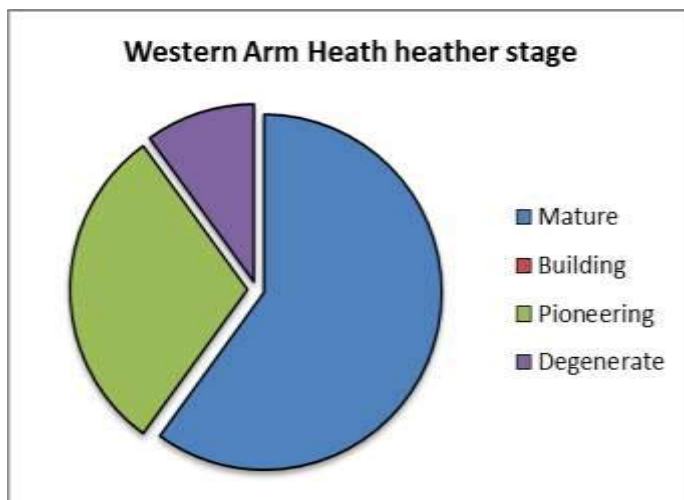
**Figure 10d:** Pie chart displaying the stages of maturity within compartment: Plateau Heath South

Plateau Heath South in figure 10d dominantly consists of heather in a building stage. There is almost an even amount of building and mature heather; however there is slightly less mature heather.



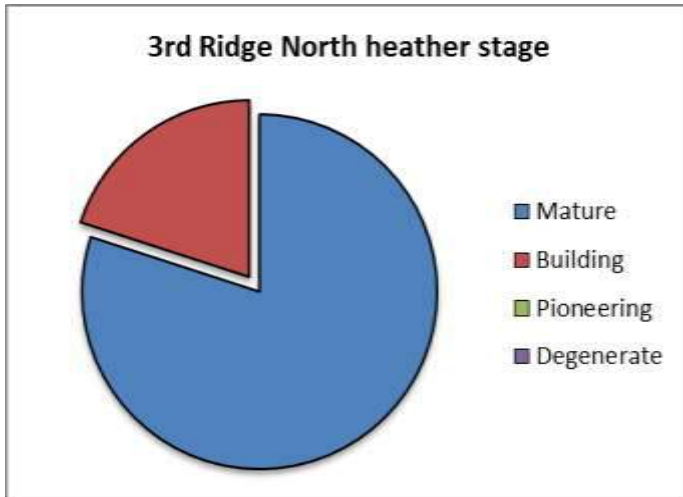
**Figure 10e:** Pie chart displaying the stages of maturity within compartment: Spur Heath

Figure 10e showing Spur Heath has equal amounts of pioneering and building heather. Most of the heather in this compartment is mature.



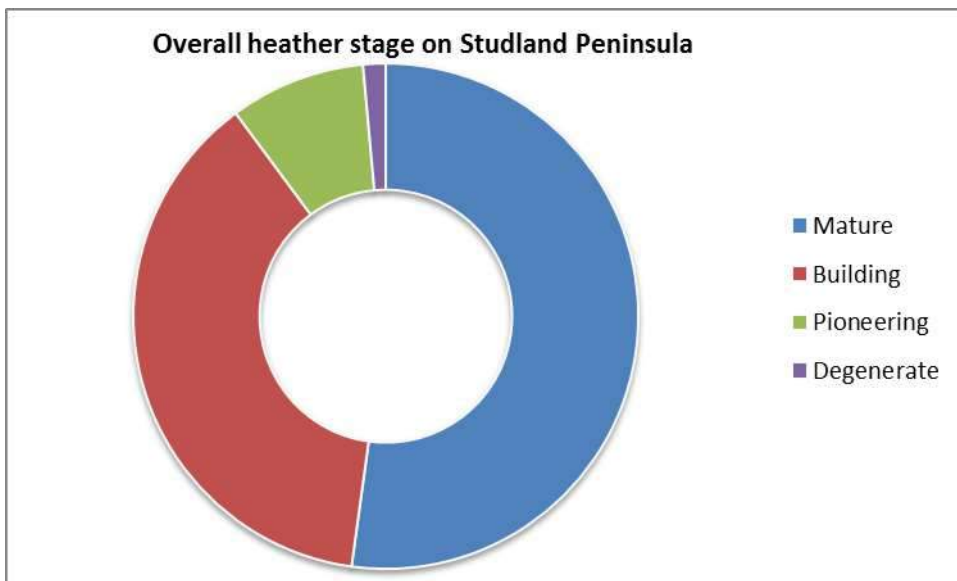
**Figure 10f:** Pie chart displaying the stages of maturity within compartment: Western Arm Heath

Western Arm Heath, shown in figure 10f, is dominantly mature; although there are some areas of pioneering species as well as a small area of degenerate heather.



**Figure 10g:** Pie chart displaying the stages of maturity within compartment: 3<sup>rd</sup> Ridge North

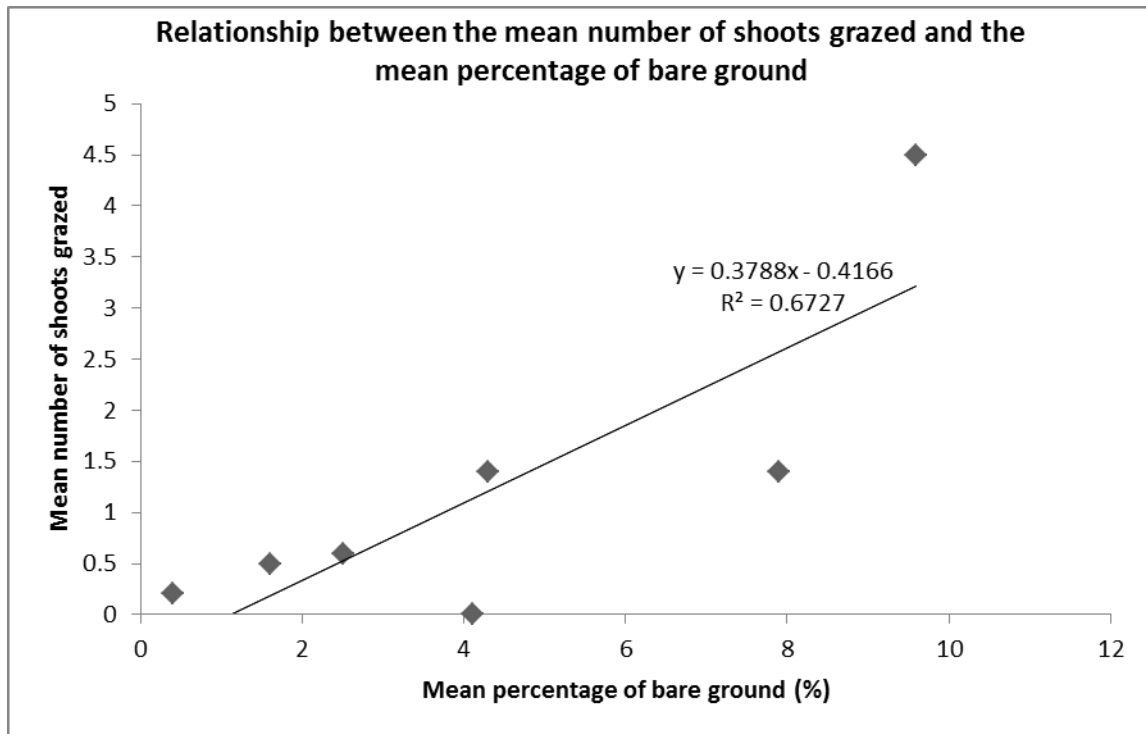
3<sup>rd</sup> Ridge North in figure 10g yields a small proportion of building heather however, the compartment is dominantly mature heather.



**Figure 10h:** Pie chart displaying the overall stages of maturity of each compartment on Studland Peninsula

The entire area of Studland Peninsula consists mainly of heather in a mature stage of development; this can be observed in figure 10h. The other half of the area contains heather that is building; pioneering heather is also present, although in small quantity than building. Even less so than the pioneering is the degenerate heather that is present, in a very small proportion however.

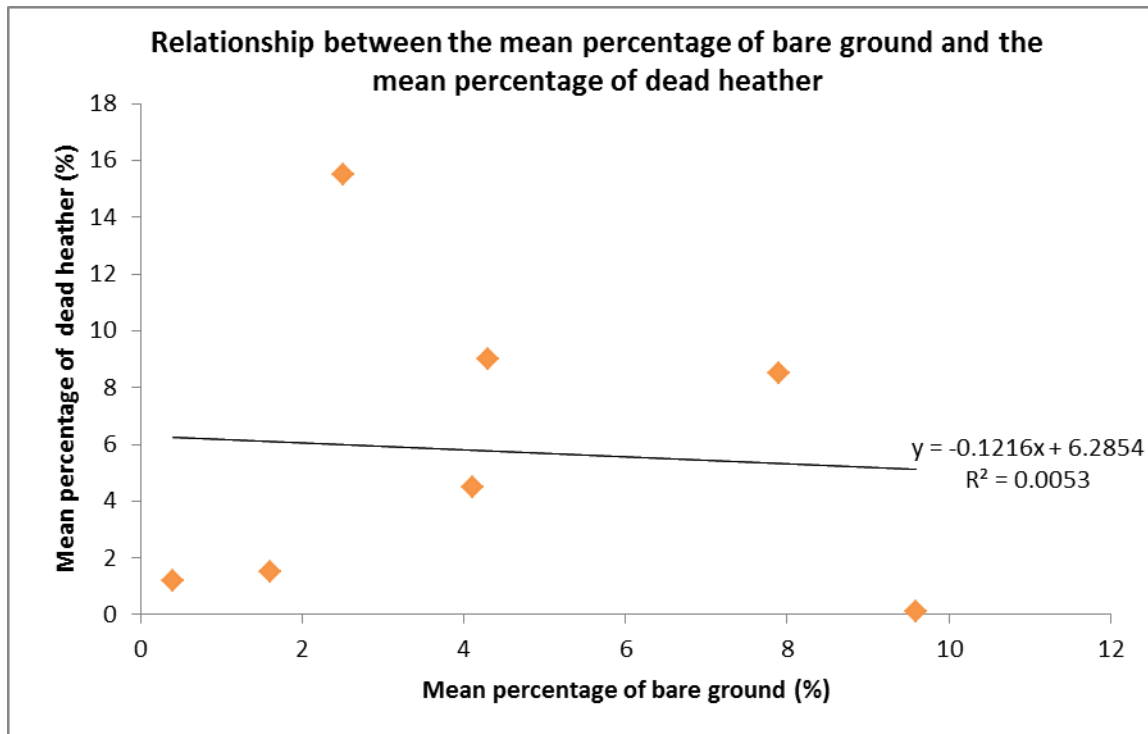
## Relationship between grazing and bare ground on Studland Peninsula



**Figure 11:** Scatter graph showing the relationship between the mean numbers of shoots grazed and the mean percentages of bare ground on Studland Peninsula.

The results in figure 11 show that there is a positive correlation between the mean number of shoots grazed and the mean percentage of bare ground. As the number of shoots grazed increases; the percentage of bare ground increases. The  $R^2$  result shown by the regression line is 0.6727 this means 67.3% of the total variation in the number of shoots grazed can be explained by the linear relationship between the mean percentage of bare ground and the mean number of shoots grazed. This result is close to 100%, suggesting the model is good at explaining the variability of the response data around its mean.

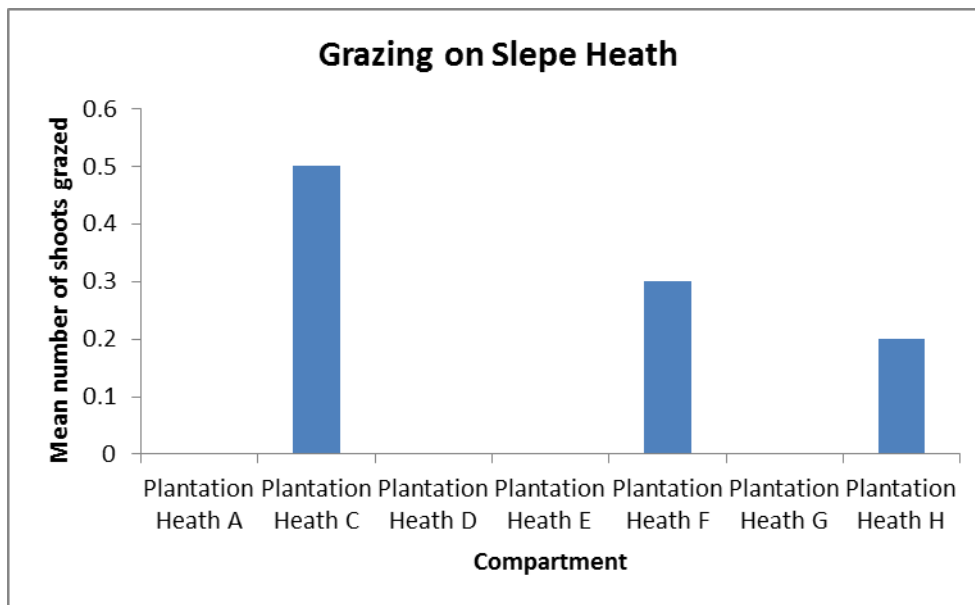
## Relationship between bare ground and dead heather on Studland Peninsula



**Figure 12:** Scatter graph showing the relationship between the mean percentages of bare ground and the mean percentages of dead heather on Studland Peninsula.

The results in figure 12 shows there is a weak negative correlation between the mean percentage of dead heather and the mean percentage of bare ground. As the percentage of dead heather increases, the percentage of bare ground decreases. The regression line gives an  $R^2$  result of 0.0053 this means 0.53% of the total variation in the mean percentage of dead heather can be explained by the linear relationship between the mean percentage of bare ground and the mean percentage of dead heather. This suggests this is not a good model at explaining the variability of the response data around its mean.

## Grazing on Slepe Heath

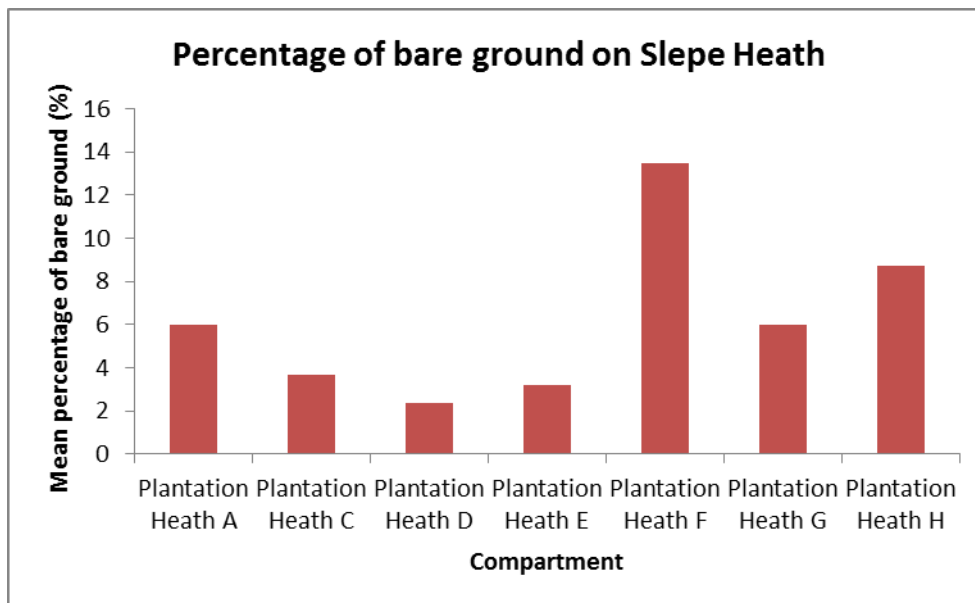


**Figure 13:** bar chart displaying the mean percentage of bare ground for each compartment on Slepe Heath.

Figure 13 shows very little grazing occurs on Slepe Heath. Plantation Heath's C, F and H have a mean number of shoots grazed of less than 1. Plantation heath's A, D, E and G hasn't experienced any grazing. Plantation Heath C possesses the highest number of shoots grazed with  $\frac{1}{2}$  a shoot grazed on average.



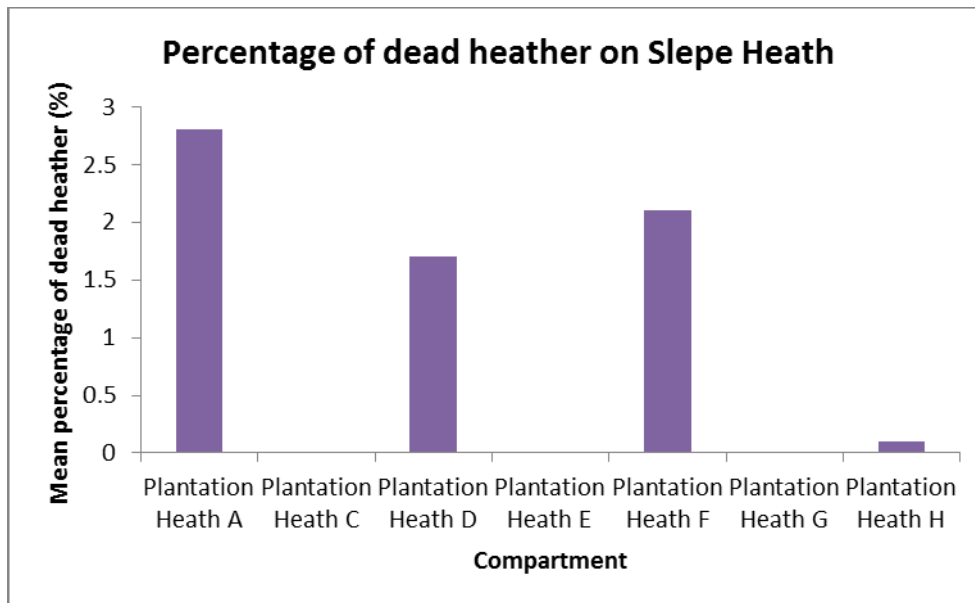
## Bare ground on Slepe heath



**Figure 14:** Bar graph displaying the mean percentages of bare ground for each compartment on Slepe Heath

The highest percentage of bare ground is found on Plantation Heath F; this compartment has an average of 13.5% of bare ground. The lowest percentage of bare ground is on Plantation Heath D where the percentage of bare ground is 2.4%; the range between these two sets of data is 11.1% and within this range lays the remaining compartments. On Slepe heath there are no compartments without bare ground.

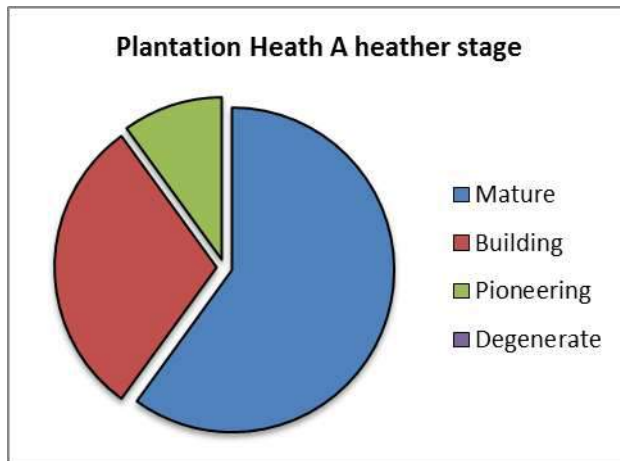
## Dead heather on Slepe Heath



**Figure 15:** Bar graph displaying the mean percentage of dead heather for each compartment on Slepe Heath

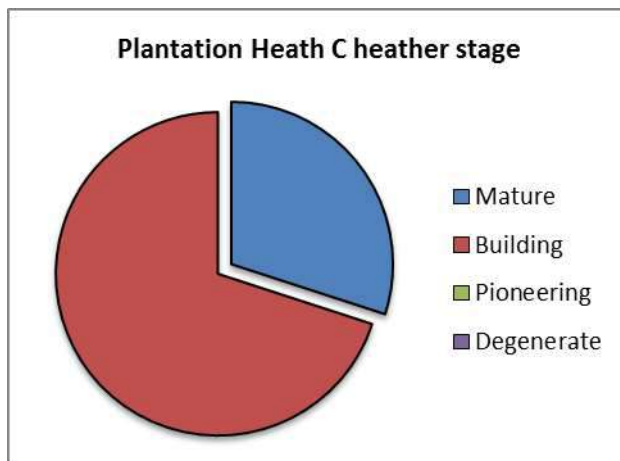
The mean percentages of dead heather for each compartment on Slepe Heath, shown in figure 15, are generally all low. The highest percentage of dead heather is 2.8%; this on Plantation Heath A. Plantation Heath's C, D, E and G possess no dead heather. Plantation Heath H has a very small percentage of dead heather with 0.1%.

## Slepe Heath compartment heather stages



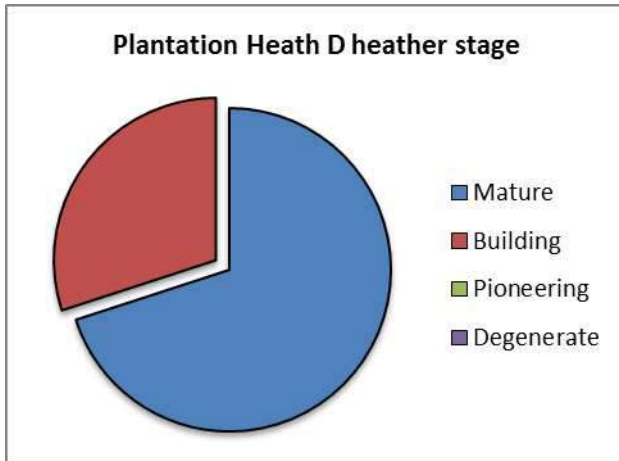
**Figure 16a:** Pie chart displaying the stages of maturity within compartment: Plantation Heath A

Plantation Heath A displayed in figure 16a mainly consists of heather in a mature stage. A smaller area of this compartment is building; some areas of pioneering heather are present, though this proportion is smaller than the areas that are building.



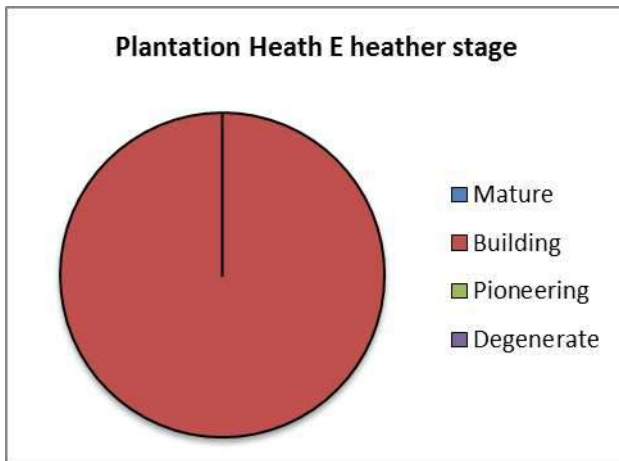
**Figure 16b:** Pie chart displaying the stages of maturity within compartment: Plantation Heath C

Heather in a building stage of development dominates Plantation Heath C. Figure 16b shows that a small proportion of the compartment is mature.



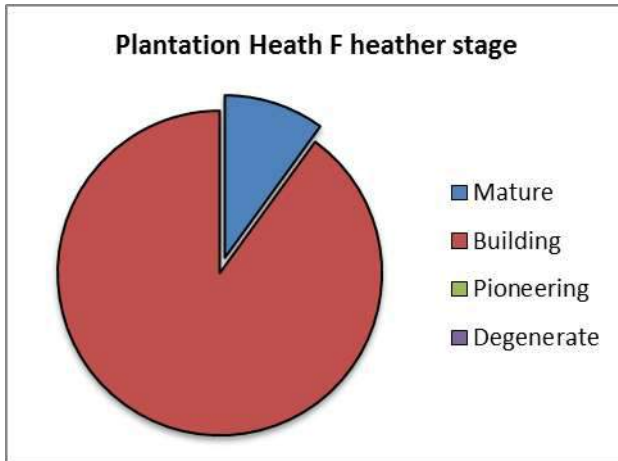
**Figure 16c:** Pie chart displaying the stages of maturity within compartment: Plantation Heath D

Plantation Heath D is dominantly mature; figure 16c shows the largest proportion of the chart is mature and a smaller proportion is building.



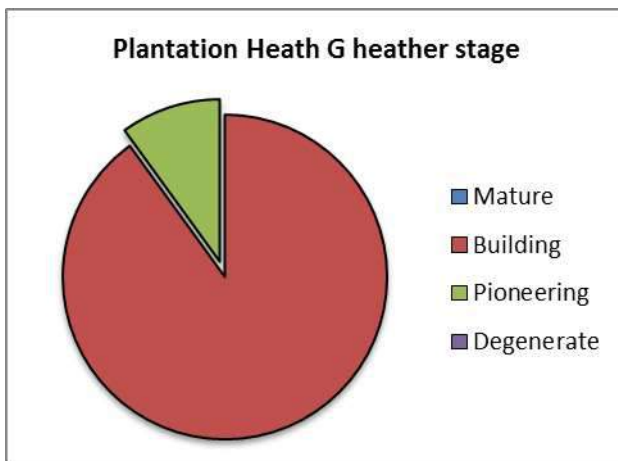
**Figure 16d:** Pie chart displaying the stages of maturity within compartment: Plantation Heath E

The entire area of Plantation Heath E is in a building stage; this is shown in figure 16d.



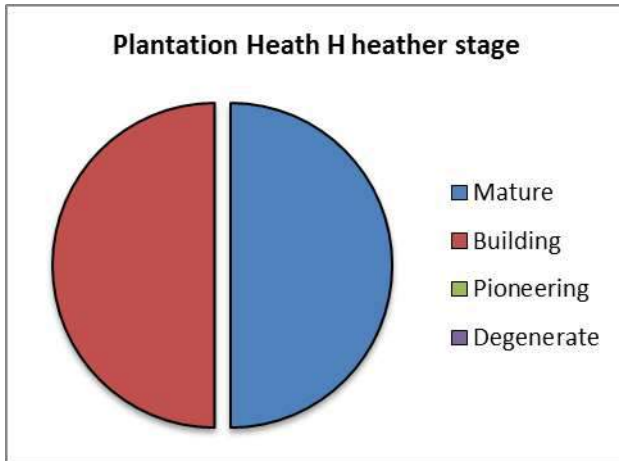
**Figure 16e:** Pie chart displaying the stages of maturity within compartment: Plantation Heath F

The majority of Plantation Heath F is building; as can be seen in figure 16e. A small area of the compartment is mature.



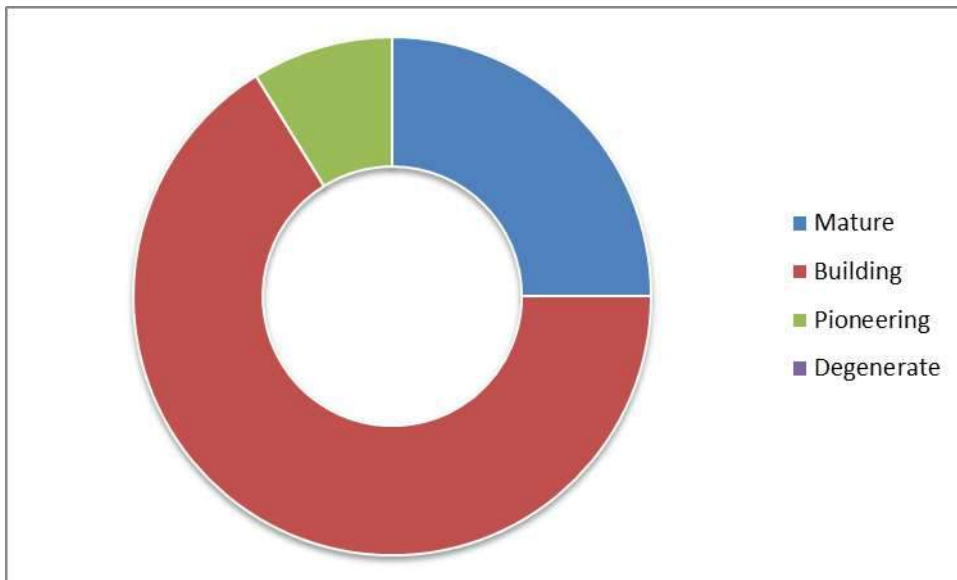
**Figure 16f:** Pie chart displaying the stages of maturity within compartment: Plantation Heath G

A small proportion of Plantation Heath G is pioneering; the rest of the compartment in figure 16f is building.



**Figure 16g:** Pie chart displaying the stages of maturity within compartment: Plantation Heath A

Plantation Heath G in figure 16g has an equal split of heather that is mature and building.



**Figure 16h:** Pie chart displaying the overall stages of maturity of each compartment on Slepe Heath

Figure 16h shows the overall stages of maturity of each compartment on Slepe Heath; heather in a building stage of development dominates the heath. Whilst mature heather takes up the next highest proportion, it only takes up a quarter of the chart, the range between heather in a building and mature stage of development is large. Greater still is the range between building and pioneering heather; only a small proportion of the heath is in a pioneering stage of development.

## Relationship between grazing and bare ground on Slepe Heath

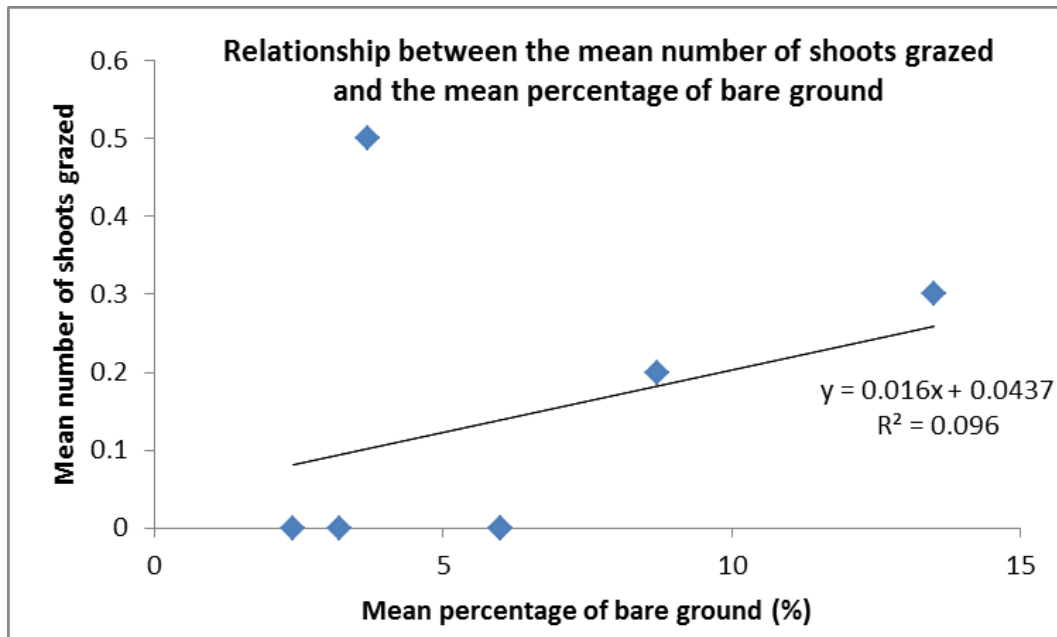
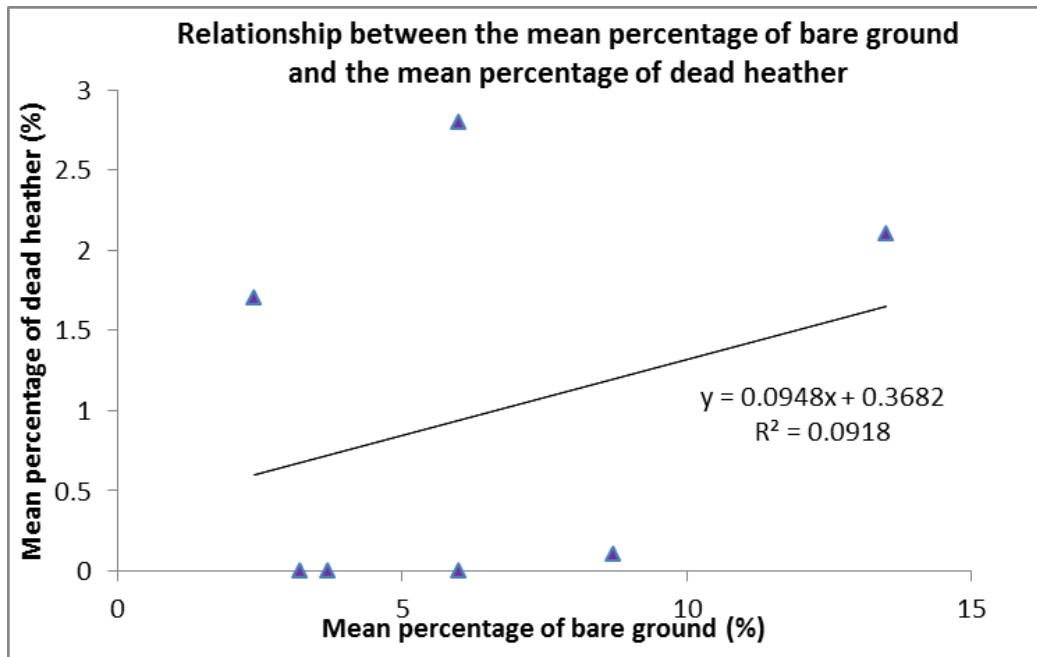


Figure 17: Scatter graph showing the relationship between the mean numbers of shoots grazed and the mean percentage of bare ground on Slepe Heath

Figure 17 shows there is a positive correlation between the mean number of shoots grazed and the mean percentage of bare ground. As the mean number of shoots grazed increases; the percentage of bare ground increases. The regression line gives an  $R^2$  result of 0.096 this means 9.6% of the total variation in the mean percentage of bare ground can be explained by the linear relationship between the mean number of shoots grazed and the mean percentage of bare ground. The low  $R^2$  result suggests that this is not a good model for explaining the variability of the response data around its mean.

## Relationship between bare ground and dead heather on Slepe Heath



**Figure 18:** Scatter graph showing the relationship between the mean percentage of bare ground and the mean percentage of dead heather on Slepe Heath

Figure 18 shows there is a weak positive correlation between the mean percentage of bare ground and the mean percentage of dead heather. As the mean percentage of dead heather increases; the mean percentage of bare ground increases. The regression line gives an  $R^2$  result of 0.0918 this means 9.2% of the total variation in the mean percentage of dead heather can be explained by the linear relationship between the mean percentage of bare ground and the mean percentage of dead heather. The low  $R^2$  result suggests that this is not a good model for explaining the variability of the response data around its mean.



## **Discussion**

### **Godlingston Heath compartments**

Aggleston Ridge showed no signs of grazing; this could be due to the area being undesirable to the cattle and horses. However, it is likely due to accessibility; physical obstructions impede their ability to reach the compartment. The 10 sites where data was collected on Aggleston Ridge had a mean percentage of bare ground of 8.3%; due to there being no grazing observed in these sites this percentage of bare ground is likely to be due to the high mean percentage of dead heather; 11.65%. The compartment was dominantly in a mature stage of development; there were however, small areas of building heather and even some degenerate areas.

Aggleston South did show signs of grazing; a mean number of 1.3 shoots had been grazed within each site tested in the compartment. This is unlikely to be the cause of the high mean percentage of bare ground; 10.3%. Dead heather is also unlikely to have resulted in large patches of bare ground, in comparison to Aggleston Ridge; there is a small percentage of 3.7%. This compartment did show more areas of heather in a building stage of development. Whilst building heather does not tend to show gaps in the heath exposing bare ground or any underlying flora, it could be that these areas are only just building and have recently come out of a pioneering stage of development. It is more likely however that the flora has been trampled and disturbed by grazing deer, horse or cattle.

Brands Bog Heath showed no signs of grazing. The highest percentage of bare ground (10.1%) could be attributed to the wide sand path that cuts through the centre of the compartment. As well as the many paths that had been formed by vehicles and humans walking off of this path. There were a few areas of dead heather; 4.2% though the percentage is not as high as Aggleston Ridge. Overall, the compartment is dominated by mature heather with some areas of Building heather.

Coronella Hill Heath had a mean of 1.4 shoots grazed in each site studied. This is not enough to create the percentage of bare ground that was observed; 8.3%. This compartment had very little dead heather; 0.5% is a desirable percentage. It is likely that the presence of heather in a pioneering stage of development is attributable for the high percentage of bare ground.

Central Plateau shows the mean number of shoots grazed within each site is 3.4. This is higher than that of Aggleston South and Coronella Hill heath. The mean percentage of bare ground is 10.8% and the mean percentage of dead heather is low at 1.9%. The bare ground can be attributed to the majority of the heather being in a building stage of development. The higher number of shoots grazed could also suggest that trampling of the heath from horses, cattle and deer is creating exposed areas of bare ground.

Central Ridge has a mean number of shoots grazed in each site of 3. There is very little bare ground with an average of less than 1% per site and a mean total of dead heather per site of 4.8%. The compartment is generally building.

Puckstone Plateau North has experienced a mean total of 4.4 shoots grazed in each site studied. There is a lot of bare ground (13.5%) which is likely to be attributable to the presence of cattle or horses trampling the heath; however there is also an abundance of dead heather which may also have exposed the ground within this compartment. This compartment also showed areas of pioneering heather; this stage of heather development characteristically leaves gaps in the shrub until it is mature. The compartment is dominantly mature however, with some areas of building heather.

Puckstone Plateau South yields the highest mean number of shoots grazed on Godlingston Heath with an average of 10.5 shoots grazed in each site. There is little bare ground (3.7%) and there is almost no dead heather within the sites that were studied. Large mammals may not have grazed this area henceforth the bare ground may not be attributed to trampling. Smaller mammals such as rabbits may have fed on the shoots, similarly; deer could have grazed in this compartment. Their legs are smaller than that of cattle and horse and they do not group together so tightly when grazing therefore fewer shrubs are trampled as a result. The heathland in this compartment is dominantly building; there are some areas of pioneering heather present which could have resulted in the bare ground.

Western Ridge has witnessed very little grazing; less than  $\frac{1}{2}$  a shoot on average within each site studied has been grazed. There is also very little bare ground with less than 1% on average in each site; this applies to dead heather also. The compartment is dominantly mature, though some areas of building heather are present.

The areas that have experienced most grazing such as; Puckstone Plateau North and South, Central Plateau and Central Ridge, are all situated in or near the centre of Godlingston Heath. These areas are all linked suggesting these are the compartments mostly visited by the cattle and horses as well as other animals grazing on the heath. Aggleston South and Coronella Hill Heath have also experienced grazing; but the extent to which grazing has occurred is less in these compartments. Grazing halts the succession to scrub and woodland which occurs, according to Rose *et al.*, (2000), at a rate of 1.7% per year despite conservation management.

Bare ground is present within each compartment on Godlingston Heath. Bare ground is desirable; it may be created during heathland succession such as during the transition from the pioneering stage of heather to heather in a building stage of development or created by the removal of scrub and other management actions. Similarly, burning areas of heathland creates bare ground. Hobbs and Legg (1984) used a Markov model to test the hypothesis that the floristic composition of vegetation colonizing bare ground immediately after burning is the major factor influencing post-fire development in heathland vegetation.

Whilst the dominant management method used by the National Trust isn't burning, it is a good example by which bare ground is created. Bare ground is important for invertebrate species that use open areas for nesting; it also facilitates burrowing. These areas of bare ground can be colonized by desirable heathland species. The model used by Hobbs and Legg (1984) supports the hypothesis that burning influences heathland development through the process of colonization of bare ground.

The data collected shows very little bare ground is present on Western Ridge and Central Ridge. However, bare ground is abundant in areas such as Aggleston Ridge, Aggleston South, Brands Bog Heath, Central Plateau, Coronella Hill Heath and Puckstone Plateau North.

Dead Heather is generally infrequent on Godlingston Heath. Aggleston Ridge and Puckstone Plateau North possess the highest average percentages of dead heather, whilst dead heather is not desirable; figure 6 shows a positive correlation between dead heather and bare ground suggesting bare ground forms as a result of dead heather. The formation of dead heather may not have a causal relationship with the presence of bare ground as the correlation is weak. The model does express a causal conjunction however and the trend line forecasts further increase in percentages of bare ground as a result of an increase in dead heather.

Godlingston Heath possesses heather that is dominantly in a mature stage of development. This implies that within the areas where mature heather is present; any bare ground will likely have formed as a result of anthropogenic processes such as walking, removal of scrub and other management methods as well as trampling from cattle, horses and deer. Similarly, paths are present throughout the heath; desire lines may also have formed over time and have since been abandoned; leaving behind bare areas. A large proportion of Godlingston Heath is building, although this area is smaller than that of the mature heather. Smaller still is the area of heather that is in a pioneering stage of development; characteristically pioneering heather leaves gaps which could be one of the contributing factors for bare ground on the heath.

Overall, Godlingston heath presents a good example of a desirable heathland. The heath possesses a mosaic of different vegetation types in which multiple species can occupy a specific niche. Bare ground can be utilised by a range of insects for nesting, chasing after prey and basking, these areas also facilitate burrowing by solitary bees and wasps. Bare ground can be colonised by lichen thus creating a habitat favoured by the endangered ladybird spider (Buglife, 2017). Sparse vegetation is desirable as it does not overshadow the ground; allowing it to warm in the sun; the six native reptiles that are present on this heath are dependent on the warmth provided by these areas of bare ground as they are ectothermic; and rely on external sources of heat such as sunlight. The National Trust has used appropriate stocking levels as the results collected on Godlingston Heath suggest that grazing has created areas of bare ground through trampling and through the upholstery of scrub thus allowing species to colonize bare areas. Grazing creates more varied vegetation

structure; suppresses bracken growth and provides areas of disturbed ground. The areas that are infrequently grazed on the heath are generally still desirable as part of the entire area of Godlingston Heath as these areas contribute to the desirable 'mosaic' vegetation types. McFerran *et al.*, (1995) highlight how mature heather and in particular; heather that is degenerate and capable of producing litter, can create a rise in biomass and canopy height of heather shoots. In order to avoid the succession of a habitat that is uniform in moderately aged stands of heather, burning should be implicated. Grazing reduces the height of the stand thus preventing the loss of less competitive species by blocking the sunlight (Grant, 1968; Meharg and Montgomery, 1988)

Burning is an effective management method as it halts succession on heathland habitats and creates variation in heather stage development. Furthermore 'deep burns' can remove the humus layer depriving the soil of nutrients; creating an environment that is desirable for heather species. McFerran *et al.*, (1995) observed a period of high plant species diversity after burning areas of heathland. The creation of varying stages in heathland succession greatly increases the diversity of micro-environments available to different plant and invertebrate species.

### **Studland Peninsula Compartments**

Brands Heath on average receives grazing of less than half a shoot grazed, per site studied. Bare ground is sparse with an average of 2.5% in each site. Dead heather is abundant however, with an average of 15.5% in each site. As a result, many of the heather in a mature stage of development is degenerate, although some areas are building also.

Curlew Heath has experienced a mean of 1.4 shoots grazed. There is higher average percentage of bare ground than that of Brands Heath with 7.9% and a higher percentage of dead heather (8.5%). The bare ground could be attributed to the fact that a small proportion of the heather Curlew Heath is in a pioneering stage of development although the heather in this compartment is dominantly building. This highlights concern as to why the percentage of dead heather is high; three sites in this compartment had mean percentages of dead heather above 10%. This could be due to heather beetle attacks which have been prevalent in previous years.

Plateau Heath North has experienced no grazing. A mean of 4.1% of bare ground is present in this compartment as well as a mean dead heather percentage of 4.45%. The results suggest a split between building and mature heather.

Plateau Heath South has had a mean of 1.4 shoots grazed in each study site. Furthermore, an average of 4.3% of bare ground was calculated to be within the area and 9% dead heather was also present. This compartment is also dominantly building.

Spur Heath has experienced the most grazing on Studland Peninsula; an average of 4.5 shoots has been grazed; the presence of grazing livestock will likely have created bare ground through trampling. There is a mean percentage of bare ground of 9.6%. There is very little dead heather. The heather is dominantly mature; there are areas of building and pioneering heather also. The pioneering heather may contribute to the bare ground as well as the presence of livestock.

Western Arm Heath has an average of 0.5 shoots grazed, in this compartment it is worth noting that the cattle present were fenced in and so were limited in area, to where they could graze. There is a mean of 1.7% bare ground. There is a mean total of dead heather of 1.5%. Especially within the fenced area of the compartment there is heather in a pioneering stage of development, there is equally as much building heather outside of the fenced area as well mature heather which is dominant.

3<sup>rd</sup> Ridge North has had very little grazing; an average of 0.2% of the compartment has been grazed. Furthermore, there is very little bare ground (0.4%) and 1.5% of dead heather, on average, is present. This compartment is dominantly mature, a small proportion is building.

Overall, Studland Peninsula has not been grazed to as great an extent as Godlingston Heath. Spur heath has experienced the most grazing followed by Curlew Heath and Plateau Heath South; there is a range of 3.1 between these compartments. Studland heath would benefit from more grazing. Furthermore, bare ground is sparse on the heath; grazing will disturb the soil and create more bare ground. After burning, bare ground can be colonized quickly by diverse range of species as the result of burning old stands is the extremely slow regrowth of *Calluna vulgaris* and *Erica cinerea*, it does however result in the persistence of bare ground for many years after the fire (Hobbs & Gimingham, 1984).

Communities dominated by the presence of *Calluna vulgaris* such as those situated on Studland Peninsula are characterised by the absence of trees and herbaceous species, and by the fact that they occur on acid mor-humus soils (Jalal & Read, 1983). McFerran and McAdam (1995) highlighted how the cessation of grazing can result in a rise in biomass and canopy height of heather shoots resulting in a 'shading-out' of less vigorous species by competition (Meharg and Montgomery, 1988). This process will result in the degeneration of any vegetation beneath the heath canopy, as a result this vegetation will decay and a nutrient rich layer of humus will form over time. This could be the process occurring that is causing some areas of the heathland to become degenerate despite the surrounding shrubs being in a building stage of development. Therefore, in order to maintain a soil that is deprived of nutrients and acidic in pH; burning may be an effective method that can be implicated to achieve this.

## **Slepe Heath compartments**

Plantation Heath A on Slepe has not been grazed. This compartment has a mean percentage of bare ground of 6% and a mean percentage of dead heather of 3%. This compartment is dominantly mature; however, there are some areas of building and pioneering heather.

Plantation Heath C has experienced grazing of  $\frac{1}{2}$  a shoot on average. There is a mean percentage of 4% bare ground and no dead heather. This compartment is building, there are a few areas are in a mature stage of development.

Plantation Heath D has also experienced no grazing. The compartment possesses a mean percentage of bare ground of 2% and a mean percentage of dead heather of 2%. This compartment is dominantly mature with a small proportion of building areas.

Plantation Heath E has not been grazed. This compartment yields the highest percentage of bare ground with 32%. There is no dead heather present. The entire area is in a building stage of development.

Plantation Heath F has experienced grazing of less than  $\frac{1}{2}$  a shoot on average. There is a mean of 14% bare ground and 2% dead heather. The vast majority of the compartment is in a building stage of development with a very small proportion in a mature stage.

Plantation Heath G has not experienced any grazing. The compartment has a mean percentage of bare ground of 6%. There is no dead heather. The majority of the compartment is in a building stage of development with some areas in a pioneering stage of development.

Plantation Heath G has experienced a very small amount of grazing, with an average of 0.2 shoots grazed. This heath has a mean percentage of bare ground of 9% and no dead heather. There is almost an equal split in heather stages; there is more building heather however and the remainder is pioneering.

Slepe Heath until recently was a conifer plantation, therefore; the dominantly building stage of development that it is currently in is justifiable. It will take more time still for this area to reach a mature stage of development. Henceforth, to graze the area whilst it is in such a juvenile state would not aid its development as it is still in a stage of succession that favours the direction of becoming a thriving heathland habitat. Compartments where the heather is pioneering may require assistance, such as through the removal of saplings to avoid the heather being out-competed. There is little bare ground on the heath in general; disturbing the soil through rotovation and grazing (when grazing becomes an appropriate management method in this area), will encourage the development of bare ground and therefore its colonisation by species other than heather, thus allowing the heathland to progress into a desirable mosaic heathland.

The removal of bracken and saplings as well as other species that are undesirable on heathland habitat will ensure the heather is not out-competed, and that the area does not return to woodland dominated by conifers through succession.

## **Conclusion**

The time we devoted to conduct research was sufficient enough to allow for the collection of data for the vast majority of the compartments in the three heathland areas that were studied. The number of sites data was collected from, within each compartment, gave a very good overlook of the conditions of each compartment. As a result, comparisons between compartments could be made and an overall conclusion in regards to the state of each major heathland habitat could be given.

This data can be effectively utilised by the National Trust to determine adaptive management methods for each compartment. The data collected was detailed to such an extent that it will permit the planning of even more specific management methods within certain areas of each compartment. The data can be compared with data collected in previous years; although the period of time in which succession occurs is very long, should data in these areas be collected in the future; the significance of the changes that have occurred will increase. Therefore, the desirability of the succession occurring within each compartment can be determined. As a result, constructive measures can be taken to maintain heathland that is desirable in terms of the flora and fauna that inhabit it thus ensuring the continuation of a rare habitat of which a diverse plethora of species are reliant.

The method used to collect the data was very effective; whilst some of the data collected using this method is discussed in this report, a large amount of it has not been. The species abundance for example has not been mentioned; this data will be used in conjunction with the rest of the data collected in this method to determine management methods. The abundance of species at each site is relevant as it highlights the presence of species that are indicative of desirable and non-desirable routes of succession. Similarly, this data foretells of the species that may be present on the heath in the future; if they are undesirable they may be removed, if they are desirable; action can be taken to ensure their continued survival.

Overall, the research conducted has successfully determined the present condition of Godlingston Heath, Studland Peninsula and Slepe Heath. Researching such a large array of variables has provided key data that will be considered when planning adaptive management methods that will ensure not only the continuation, but the expansion of this diverse and essential habitat.

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