Agricultural Damage by Greylag Geese (*Anser anser*): Assessment of Impacts and Actions for Control

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A Master's Thesis Presented to the Faculty of Medicine, Health and Life Sciences

Supervised by Dr. Daniel Pincheira-Donoso

Queen's University Belfast

School of Biological Sciences

By

Mitchell Steele

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Abstract

The global expansion of human populations has led to increasing levels of conflicts with resident wildlife, which often stem from wildlife impact on agriculture. For decades, Greylag geese (*Anser anser*) have established resident populations across the northern hemisphere, with their rising numbers raising concerns among farmers regarding agricultural damage by grazing exploitation on available foliage. However, the quantitative extent of this damage remains unassessed. Here, I implement a field experimental approach to investigate the level of grazing damage by Greylag geese on Rathlin Island by comparing length and weight measurements of sward samples, taken from caged plots where grazing activity is restricted, and corresponding control plots. Furthermore, structured interviews were undertaken with resident farmers. My analyses reveal that Greylag geese have a significant impact on vegetative reduction. Foliage within exclusion cages was significantly greater in terms of length and weight compared to control plots across each study site indicating a high level of consumption over the course of one week. Collectively, I suggest active greylag goose management controls through potential nest manipulation. Further research is required to quantify the effectiveness of management actions.

Introduction

Conflicts between humans and wildlife can form as a result of wildlife damage on human-occupied land. These conflicts arise when such damage causes disturbances in human interests such as farming and conservation (Redpath *et al.* 2013). When such conflicts are being studied, the level of damage being caused, population sizes, and the rate at which such species are visiting the impacted area must be understood to set out appropriate management goals (Conover, 2002; Madsen *et al.* 2017).

Over recent decades, the population numbers of Greylag Geese (*A. anser*) have risen throughout the northern hemisphere (Ankney, 1996; Madsen *et al.* 1999; Fox *et al.* 2010). Relaxed hunting laws (Patton & Frame, 1981), the introduction of refuge areas (Fox & Madsen, 2017), anthropogenic land modification (Gauthier *et al.* 2005), and climatic changes are some causes of these population increases. Such happenings allow for ideal environmental conditions necessary for ensuring prolonged survival in northern locales and idle conditions at breeding grounds (Patton & Frame, 1981; Gauthier *et al.* 2005; Nilsson & Kampe-Persson, 2020). Between a 1990 (Brown & O'Halloran, 1998) and 2007 (Boland & Crowe, 2008) census in Ireland, there has been a 60% increase in resident populations of Greylag geese, indicating a 5% increase in numbers per year. By 2017 population numbers of migratory and resident Greylag Geese were estimated at 140,000 across the United Kingdom (Musgrove *et al.* 2011).

With increasing anthropogenic land modification occurring over space and time Greylag geese have shifted their ecological behaviour patterns from exploiting somewhat natural ecosystems to agricultural settings that are intensively managed (Fox & Abraham, 2017). These settings provide increased quantities of consumable resources which are profitable to Greylag geese, explaining such adaptations in ecological niches (Kirby *et al.* 1999; Gauthier *et al.* 2005; Fox *et al.* 2005; Fox *et al.* 2017; Li *et al.* 2017). The incidence of rising population numbers and alterations in land-use patterns have signified a positive correlation with agricultural damage (Owen, 1990; Abraham *et al.* 2005a; Abraham *et al.* 2005b; Tulloch *et al.* 2017) and farmer/wildlife conflicts (Ankney, 1996; Eythórsson *et al.* 2017; Fox *et al.* 2017) in numerous locations across the Palearctic and Nearctic realms (Fox & Madsen, 2017).

Numerous studies have indicated significant correlations between grazing activity by geese and yield reductions across agricultural grasslands (Lockhart *et al.* 1969; Frame, 1970; Wilman & Griffiths, 1978; Patton & Frame, 1981; Bedard *et al.* 1986; Groot-Bruinderink, 1989). Furthermore, Kear (1965; 1970) and Kuyker (1969) carried out studies concerning wild

goose species causing significant over-grazing in Britain and Belgium, respectively. Both studies indicated that grazing by geese on agricultural grasslands could potentially inflict considerable damage if it occurs indefinitely. The existing scientific evidence supports the concerns that there is an ongoing occurrence of agricultural exploitation by Greylag geese and conflicts between their populations and farmers. This has instigated a movement toward exploring and utilising various management efforts to alleviate such issues (Tulloch *et al.* 2017).

Numerous management and mitigation efforts have been performed and discussed across a range of studies. One of the most popular mitigation schemes is the introduction of refuge areas which are implemented to provide geese with designated zones to graze freely while protecting remaining contiguous pastures (Baveco *et al.* 2017). Another method with a fundamentally opposite approach is the introduction of exclusion zones. These work by restricting specific areas of land with physical barriers (i.e., fencing) to protect vegetation from grazing exploitation (Bakker *et al.* 2018). Scaring practices are employed regularly by farmers and landowners in various forms. These scaring methods are applied to discourage geese from returning to and exploiting specific pastures by creating a deterrent effect (Mansson, 2017; Simonsen *et al.* 2017). One of which is classified as lethal scaring whereby human scarers are employed to shoot a small number of individuals to deter the remaining population. A further, non-lethal, scaring method exists whereby human scarers are employed to fire warning shots using firearms to frighten target species as a response to auditory cues. Moreover, conventional scaring methods such as tape, scarecrows, and flags are used to frighten target species as a response to visual cues.

Mansson (2017) assessed the behavioural responses of populations of Greylag geese using a Before-After-Control-Impact approach with regards to the formerly discussed scaring mechanism. In a single study, 33 (8.9%) individuals from the population were shot and the behaviour of the remaining population was assessed both before and after lethal scaring ensued. The results of the study saw a positive correlation between lethal scaring and reductions in grazing damage (63% reduction at impact sites and 17% reduction at control sites).

A less common management effort is nest manipulation whereby nests and/or the eggs they contain are removed and destroyed to lower reproduction rates (Christens *et al.* 1995). Egg spraying is one form of nest manipulation whereby target eggs are coated with non-toxic oils blocking the shells' pores causing embryonic asphyxiation (Blokpoel & Hamilton, 1989;

Martin *et al.* 2007). Egg pricking is another form of nest manipulation whereby eggs are physically punctured using hypodermic needles, causing the eventual death of the undeveloped embryo (Martinez-Abrain *et al.* 2004). Both practices are seldom discussed in the literature. However, both techniques have shown positive correlations with population decline in target species, signifying the method's potential in limiting population numbers and thus agricultural damage if used frequently.

Ample studies have shown considerable positive results with regards to management efforts successfully controlling population density on vulnerable vegetative landscapes and thus damage as a whole (Cope *et al.* 2005; Tombre *et al.* 2013; Madsen *et al.* 2014). However, some pose ineffective qualities due mainly to species ecological and behavioural flexibility to adapt to agriculturally intensified land (Owen, 1976). Furthermore, control measures that farmers use such as scaring show rapid habituation and thus do not fulfil any long-term impacts (van Roomen & Madsen, 1992; Fox *et al.* 2016).

Meek (2008) stated that over the past two decades there has been a clear northward geographical shift in wintering distributions of Greylag geese which breeds mainly in Iceland. The study states that 60% of this population now winters in the Orkney Islands, Scotland; a location where fewer individuals would aggregate prior to such climatic events. Due to the agricultural damage these shifts have presumably indirectly caused, a culling event was initiated in 2012 to control the growing populations of Greylag geese (Churchill & Younie, 2013). However, it has been made clear that this management practice showed little effect as population numbers continued to rise (Mitchell *et al.* 2012). Based on the existing scientific literature, it appears that there is a knowledge gap regarding how best to understand and manage land exploitation by goose species.

For nineteen years there has been an established resident population of Greylag geese on Rathlin Island (Mellon *et al.* 2017) placing its native vegetation and thus other herbivorous species in a state of vulnerability. Furthermore, three full-time resident farmers have articulated concerns about Greylag geese causing damage to foliage across their land through grazing exploitation and mess by defecation. Existing management efforts such as lethal and non-lethal scaring, shooting and culling events, and the process of exclusion efforts do not fulfil the aim of relieving such damages as population numbers continue to rise and agricultural damage continues to occur. Thus, there still exists a lack of quantitative assessment and knowledge on how best to appropriately alleviate such occurrences. Therefore, this study aims to analyse the

level of damage being caused by Greylag geese to vegetation across three farms on Rathlin Island. This will be done by implementing a field experimental approach consisting of comparisons between enclosed and exposed surfaces for available foraging to investigate the extent to which Greylag geese graze on available vegetation, as well as carrying out structured interviews with resident farmers. The quantitative and qualitative data obtained from both of these approaches will be analysed together to build a relatable understanding of the extent of the impact of Greylag geese on Rathlin Island's grassland habitats.

This study hypothesises that vegetation height will be greater in caged plots where geese grazing has been excluded and thus dry matter weight will be greater from clippings taken from these plots compared to those from control plots. This hypothesis predicts that yield loss is positively correlated with grazing damage and thus goose grazing is having a damaging effect on vegetation growth across the study areas. Furthermore, this study hypothesises that there will be a greater level of vegetative damage occurring in study locations on the perimeters of water bodies as opposed to study locations in arable grassland habitats not within the vicinity of such. It is further anticipated that the study will see greater vegetative damage in study locations consisting of short vegetation as opposed to long vegetation.

Data collected will be combined with previous reports by Allen and Mellon (2017) and Ric Else (2021) of the Causeway Coast and Glens Heritage Trust (CCGHT). From here a case can be made to the Department of Agriculture Environment and Rural Affairs (DAERA) concerning the need for Greylag geese management on Rathlin Island. It is anticipated that this research will enable dialogue with affected parties to consider a consensus of proceeding steps over the coming years. With the collected data from this fieldwork, there is potential to understand whether Greylag geese are causing a significant impact on Rathlin Island with regards to vegetative damage. It is anticipated that the findings from this study will allow for suggestions to be made about potential ideas for management control in the short term whilst considering long-term options to build an effective balance between conservation and sustainable farming.

Methods and Materials

Study Site

Rathlin Island lies approximately six miles north off the coast of Ballycastle, Northern Ireland at latitude 55.298, longitude -6.217, covering a total land area of 1,371ha. Its habitats are made up of heathland, grassland, and wetland, with the island's grassland habitats being predominantly dominated by red fescue (*Festuca rubra*) (JNCC, 2016) and Ryegrass. Three farms, owned by three full-time resident farmers with whom collaborations took place, on Rathlin Island were selected as the primary study sites for which vegetation surveys took place. The study was carried out over a period of 44 days, between the dates of 14 June 2021 and 28 July 2021.

Sward Surveys

To assess the level of sward damage being caused by grazing exploitation, I employed an approach known as 'the moveable cage method' (McNaughton *et al.* 1996) over a period of six weeks. The moveable cage method consists of erecting mesh cages in set locations for a set amount of time depending on the length of the study, to which they are then relocated at timely intervals. Following each period where the cages remain, an equal number of sward samples are clipped and measured in terms of length and weight where comparisons between data are then assessed to understand the extent of grazing damage.

There are numerous benefits associated with this research method. Firstly, it tests the extent to which vegetation is being exploited across arable land of which populations of Greylag geese (*A. anser*) are already known to aggregate, on a physical level. This sets out an approach by gaining important data within a setting already familiar with grazing damage caused by such organisms to further build upon already existing scientific information. Secondly, employing moveable cages provides a rich income of findings from a range of different sites where other factors such as sward length, range of angiosperm species, and proximity to water bodies may be considered when theorizing what may be determining grazing patterns. This provides a system that cannot be easily employed if cages remain in a single location for the duration of the study.

Moveable cages were situated in selected areas where farmers had articulated concerns of exploitation taking place and where the proximity to water bodies (areas which are primarily used by geese as roosting sites (Newton & Campbell, 1973)), were considered (Figs. 1, 2, 3,

4.). A total of two cages were erected in marked locations at any one time and remained in place for a total of seven days. Following each seven-day period, cages were relocated, and the process was repeated.

Cages were made of robust iron mesh with a mesh size of 25mm to restrict access from all herbivores. Cages were collapsible, each consisting of five separate sections; one top section measuring 1m x 1m, and four side sections measuring 0.5m x 1m. Cages were assembled using black zip ties, joined at multiple locations to ensure sturdiness. Cages were held against the ground using grass U-pins and with the placement of rocks on top to ensure they were not easily moved or knocked over by livestock and other wildlife.

Fig. 1. A map of Rathlin Island showing the exact locations of the cages. Three separate locales have been outlined, numbered, and depicted as zoomed-in images in separate figures.

Fig. 2. Zoomed-in image of the exact locations of the cages placed for week two.

Fig. 3. Zoomed-in image of the exact locations of the cages placed for week one.

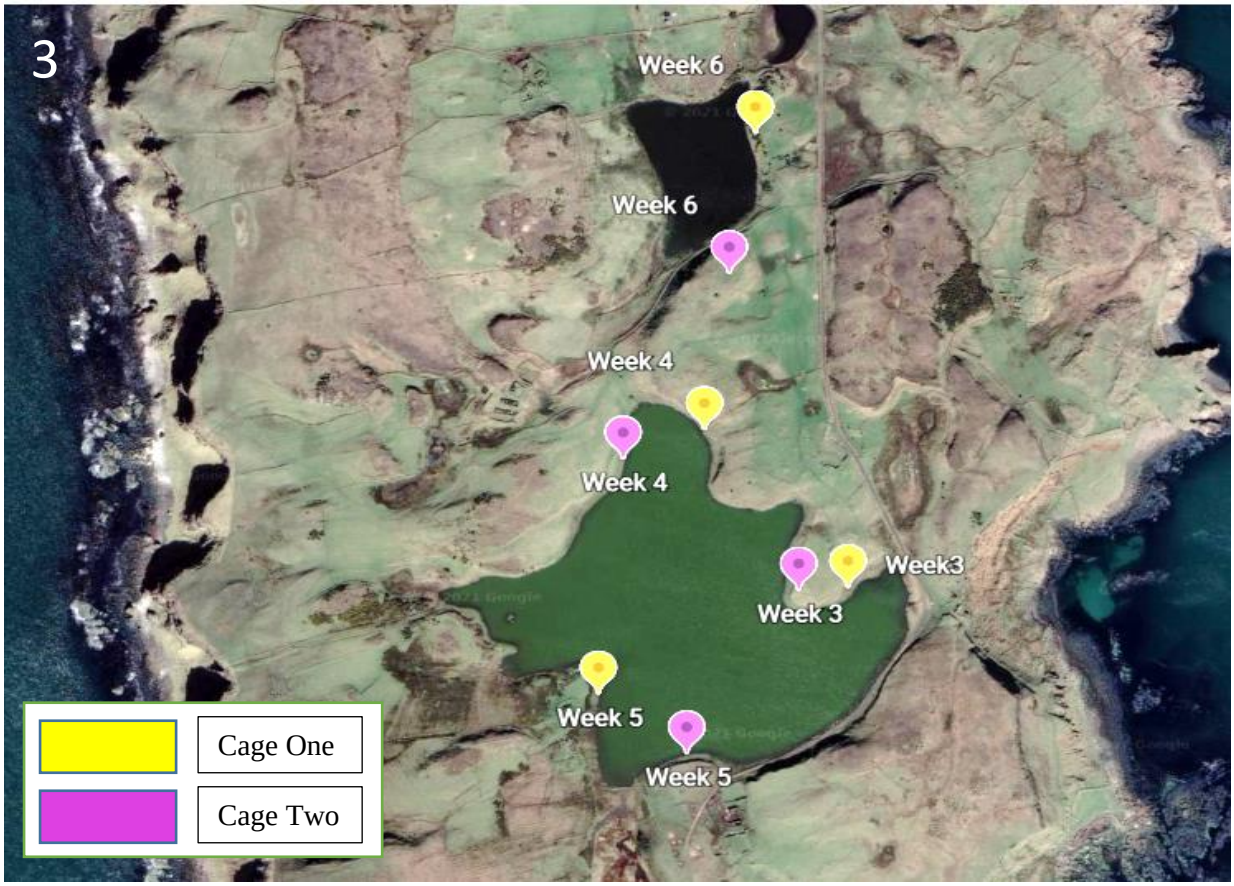

Fig. 4. Zoomed-in image of the exact locations of the cages placed for weeks' three, four, five, and six.

Prior to moveable cages being relocated at the end of each seven-day period, sward samples were collected from both the caged sites and their corresponding control sites which were selected at random outside a radius of ≥20m from the site of the moveable cage. Approximately ten sward samples were clipped using hand shears from each of the caged sites and corresponding control sites (n = 40 week^{-1}; n = 240 total). Upon clipping, dead material and weeds were manually removed from each sample and discarded to ensure a standard value of live grass biomass was retrieved upon weighing. Each clipped sample was rinsed with still water in a 0.5mm mesh sieve, held together using black miniature rubber bands, and stored in containers respective to the site they were clipped from (Cage 1, Cage 2, Control 1, Control 2), to differentiate. Hassall *et al* (2001) state that there exists a strong correlation between length measurements of sward samples and biomass measurements and so, for this study, vegetation length was used as an index for estimating differences in biomass between caged and control plots. Ten individual blades of grass were taken from each sample and measured in length to the nearest millimetre (mm). The ten calculated lengths were added together and divided by the number counted (n = 10) to estimate the mean length of each sample. This process was repeated for all ten samples harvested from each site and the averages for each sample were added together and divided by the number of clipped samples harvested (n = 10) to calculate the mean length of vegetation within the plot. Each sample (now consisting of ten blades of grass) was separately stored in glass containers preserved in ~80% ethanol.

The percentage difference in the length of vegetation between each caged plot and its corresponding control plot (where L_1 = the difference between Cage 1 and Control 1 and L_2 = the difference between Cage 2 and Control 2) was calculated (Formula 1). This provided an understanding of the varying rates of grazing activity across all the locations throughout the study. Formula 1 was executed to calculate L_1 and L_2 where V_1 is cage 1 or cage 2 and V_2 is control 1 or control 2.

All samples were brought to the laboratory at the School of Biological Sciences, Queen's University Belfast, where they were measured for individual and mean weights. All samples were dried at 80°C for eight hours in a laboratory drying oven before being individually weighed using a precision balance. The weights of each sample from each plot (Cage 1, Cage 2, Control 1, Control 2) were recorded to four decimal places. The recorded weight of each sample was averaged to gain the mean weight of vegetation within each plot.

Analogous to what was performed with the average sward length data, the percentage difference in the weight of vegetation between each caged plot and its corresponding control plot (where W_1 = the difference between Cage 1 and Control 1 and W_2 = the difference between Cage 2 and Control 2) was calculated (Formula 1). The following formula was executed to calculate W_1 and W_2 where V_1 is cage 1 or cage 2 and V_2 is control 1 or control 2:

Formula 1:

$$\frac{[V_1 - V_2]}{\left[\frac{(V_1 + V_2)}{2}\right]} \times 100$$

Estimates of Vegetative Consumption across Wider Geographical Scales

To understand the estimated magnitude of live vegetative biomass being consumed on a wider geographical scale over a certain period, all numerical differences between both treatment variables (cage and control) weight data (where Z_1 = the difference between Cage 1 and Control 1 and Z_2 = the difference between Cage 2 and Control 2) were calculated. The values for Z_1 and Z_2 were averaged to obtain a single mean measurement of dry matter intake (DMI) across each week (where Z_a = mean DMI within 1m^2). Z_a was multiplied by the size (m^2) of specific areas (townlands (Fig. 5)) (where A = total land area of the discussed townland in m^2) where the cages were placed at each weekly period to predict an estimated value of consumed biomass in that area in one week (Z_T). Z_a was multiplied by the size (m^2) of Rathlin Island (where A = total land area of Rathlin Island) to gain an estimated value of the amount of live biomass consumed across the entire landmass in one week (Z_T).

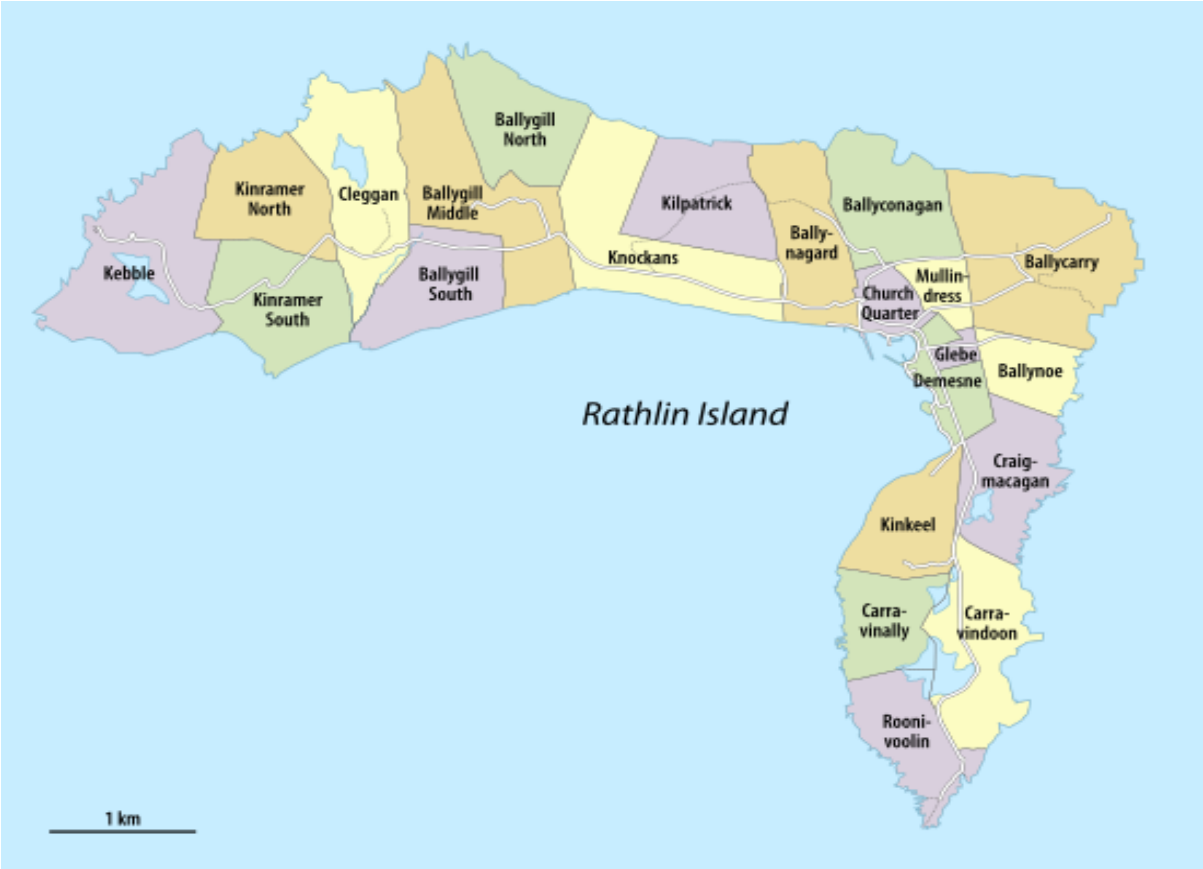

Fig. 5. Map of Rathlin Island sub-divided into individual townlands (RDCA, 2021).

Structured Interviews with Resident Farmers

Three resident farmers on Rathlin Island agreed to be separately interviewed. Respondents were contacted via telephone to arrange meeting times to which interviews were conducted face-to-face at agreed-upon locations on Rathlin Island. Interviews consisted of a structured questionnaire comprising a total of fourteen questions. All questions were associated with the resident Greylag geese population issues on the farmers' lands to which respondents were offered the right to answer or to not answer any question. The questionnaire consisted of closed questions and multiple-choice questions with the opportunity to provide further comments were the information relevant to the research. Each of the respondents' answers was recorded manually during each interview and later uploaded onto a spreadsheet using Microsoft Excel.

The benefit associated with carrying out this research method was that it took on a social scientific approach whereby an understanding of facts based on experience were gathered in a scientific dataset by those immediately affected by such issues. Questionnaire respondents have experienced the short- and long-term effects of the exploitation the species

may be causing and so the information provided will aid in understanding how strenuous the pressures are and what management efforts may be preferred.

Statistical Analyses

Data analyses in the current study aimed to ascertain whether the physical responses of alterations in sward length and sward sample weight (Y) could be determined by a range of predictor variables (X_n) with relation to Greylag goose grazing activity in real-time. With this in mind, the dependent variables (Y) in the current study were sward length and sward weight of which the data was collected by measuring clipped sward samples taken from the selected caged and control sites at the study areas on Rathlin Island. This method was chosen to increase the level of accuracy in data collection. The independent variables (X) were the utilisation of exclusion cages (treatment) (X_1) and the locations of which they were placed across consecutive weeks (X_2). Running X_1 in the model provided a test to examine the extent to which differences in the length and weight between harvested sward samples taken from both caged and control sites thus assuming the occurrence of grazing activity by the study organism. Locations, where cages were placed, differ in terms of vegetation type and distance from water bodies over each consecutive week. Therefore, X_2 will indicate whether location influences differences in the length and weight of harvested sward samples taken from each site thus assuming the occurrence of grazing activity by Greylag geese between areas of varying congregations of species populations.

To determine the extent to which variation in length/weight is explained by X_1 and X_2, six linear regression models were run in R (R Core Team, 2013). To understand whether the placement of exclusion cages had an impact on changes in sward length and sward weight caused by grazing activity two separate generalized linear models (GLM) were run. One GLM was run where sward length was the dependent variable (Y) and the other where sward sample weight was the dependent variable (Y).

Similarly, to understand whether the locations across consecutive weekly timeframes influenced changes in sward length and sward weight between caged and control sites, two separate multiple linear regression models (MLRM) were run. One MLRM was run where sward length was the dependent variable (Y) and the other where sward weight was the dependent variable (Y).

In addition to the previous models, the interaction among variables X_1 and X_2 was examined to understand whether this influenced changes in sward length and sward weight.

This was accomplished by running two separate linear regression models with interaction effects. One model was run where sward length was the dependent variable (Y) and the other where sward weight was the dependent variable (Y).

Further to the previous models where linear models were run with the dataset from the entirety of the study, two generalized linear models were carried out for each weeks' length and weight datasets (totalling twelve linear models). This was performed to understand the influence of the predictor variable X_1 on the differences in sward length (Model 1) and sward weight (Model 2) at each separate location across consecutive weeks.

Results

The results reveal that the vegetative biomass differed significantly between the caged and control plots whereby the lengths and weights of sward samples harvested were significantly greater in the caged plots compared to the control plots.

Sward Sample Length Results

The linear model where X_1 was the predictor variable showed that sward length was significantly greater within the caged plots compared to the control plots (Estimate = 0.6730, F = 79.58, df = 1, 238, R^2 = 0.2506, P < 0.01) (Fig. 6.).

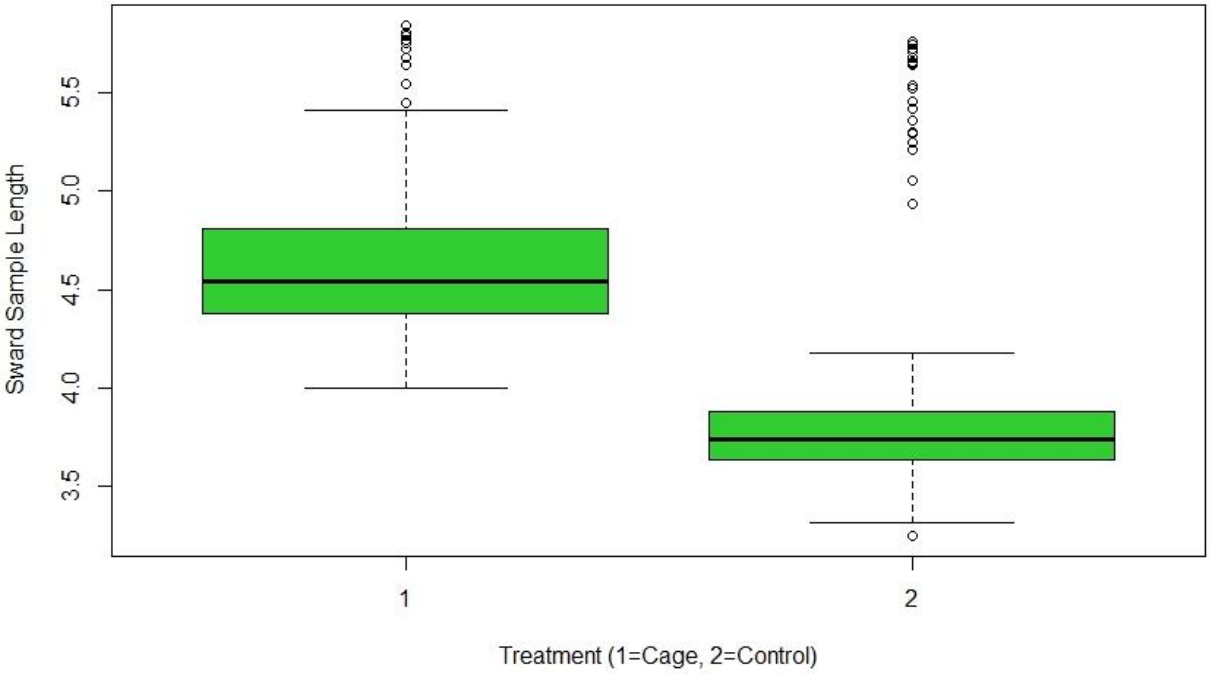

Fig. 6. Boxplot showing the impact of exclusion cage presence on sward length (on a logarithmic scale) as a result of grazing activity.

The multivariate model where X_1 and X_2 were the predictor variables showed that sward length was significantly greater in caged plots compared to control plots (F = 108.3, df = 2, 237, R^2 = 0.4775, P < 0.001) (Fig. 7.).

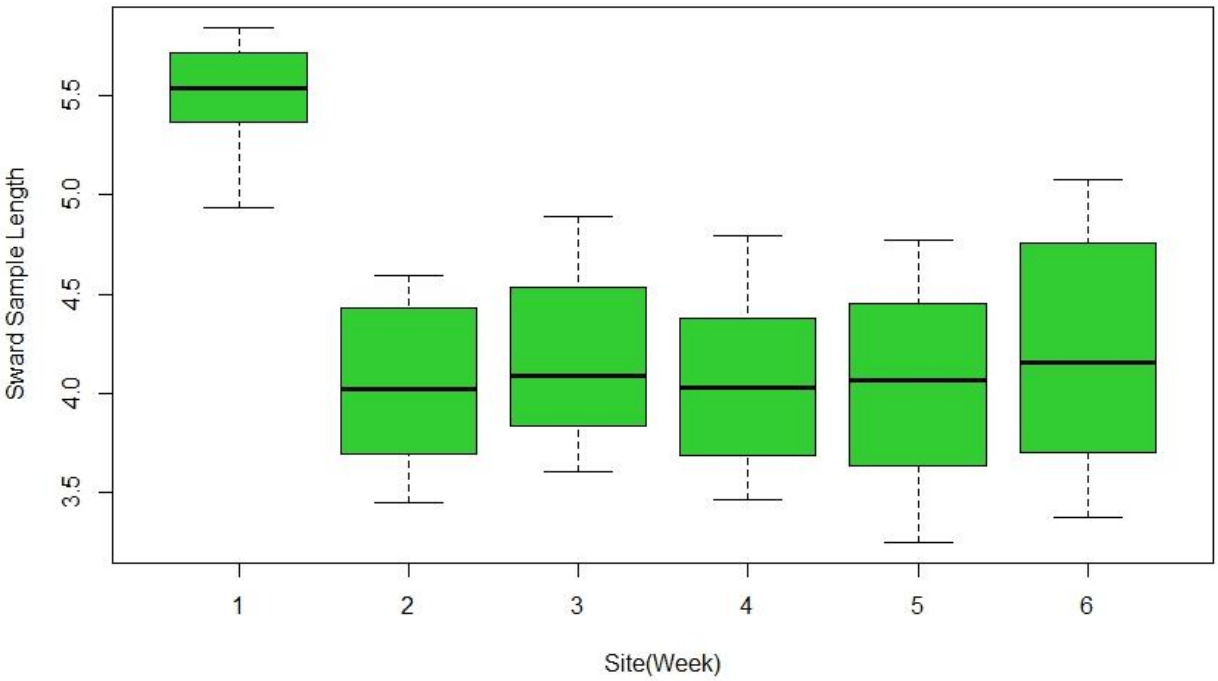

Fig. 7. Boxplot showing the impact of location across each consecutive week (1-6) on sward length (on a logarithmic scale) as a result of grazing activity.

The interaction model showed that the difference in sward length between the caged and control plots where length was greater in the caged plots was significantly driven by the interaction between the X_1 and X_2 predictor variables (Estimate = -0.16196, F = 85.16, df = 3, 236, R^2 = 0.5198, P < 0.001) (Fig. 8.).

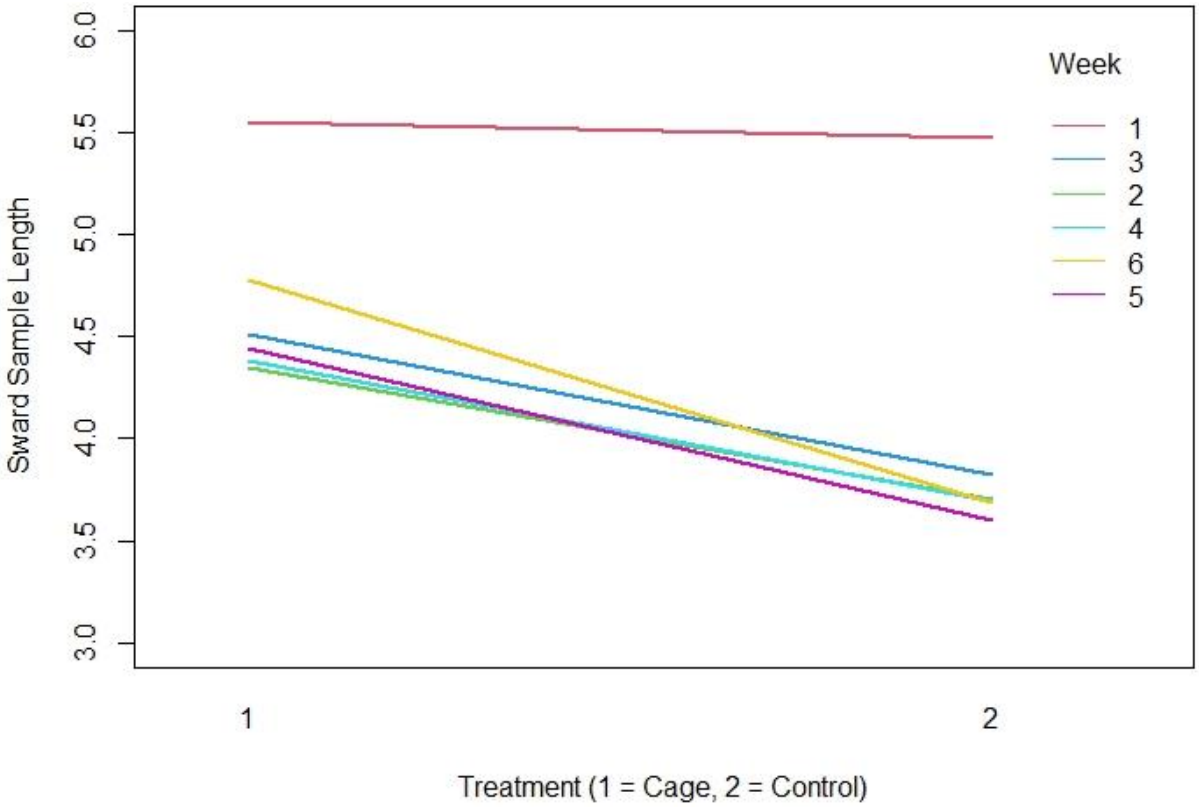

Fig. 8. Interaction plot showing the impact on resulting sward lengths (on a logarithmic scale) where the placement of exclusion cages (treatment) and location across consecutive weeks (week) interact to elicit a predicted response.

Sward Sample Weight Results

The results of the linear model where X_1 was the predictor variable showed that sward weight was significantly greater within the caged plots compared to the control plots (Estimate = -0.7804, F = 54.51, df = 1, 238, R^2 = 0.1864, P < 0.001) (Fig. 9.).

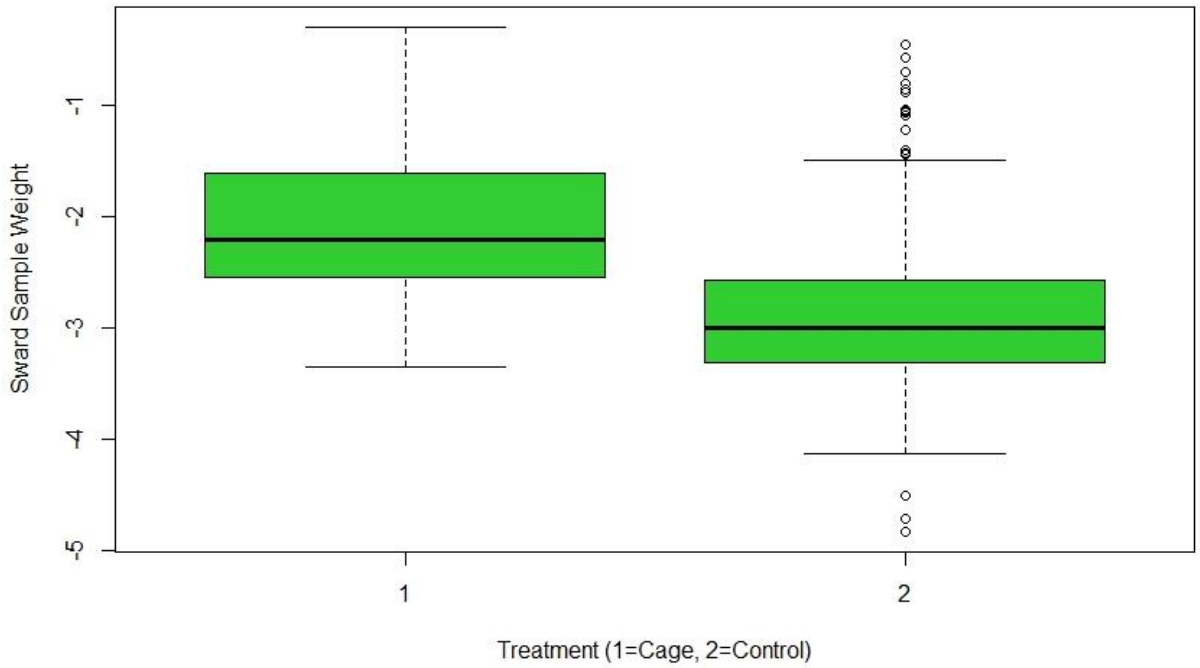

Fig. 9. Boxplot showing the impact of exclusion cage presence on sward weight (on a logarithmic scale) as a result of grazing activity.

The multivariate model where X_1 and X_2 were the predictor variables showed that sward weight was significantly greater in caged plots compared to control plots (F = 63.5, df = 2, 237, R^2 = 0.3489, P < 0.001) (Fig. 10.).

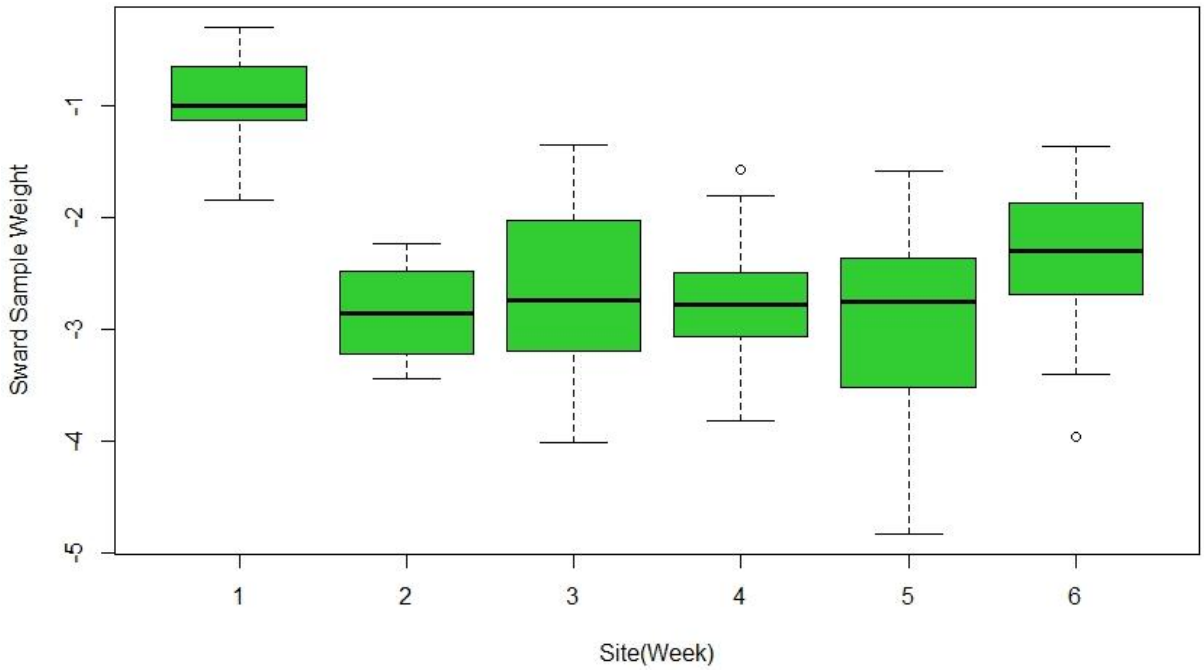

Fig. 10. Boxplot showing the impact of location across each consecutive week (1-6) on sward weight (on a logarithmic scale) as a result of grazing activity.

The interaction model showed that the difference in sward weight between the caged and control plots where weight was greater in the caged plots was significantly driven by the interaction between the X_1 and X_2 predictor variables (Estimate = -0.09677, F = 43.73, df = 3, 236, R^2 = 0.3573, P < 0.001) (Fig. 11.).

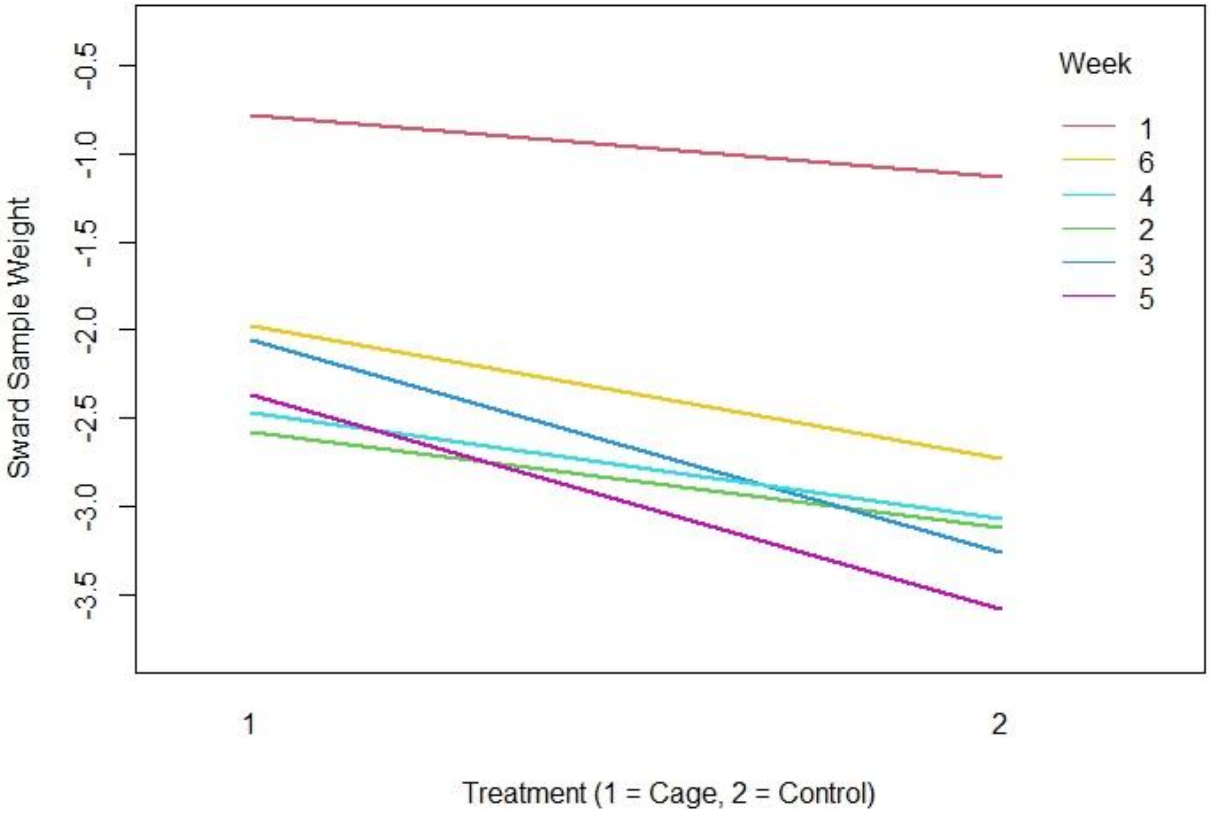

Fig. 11. Interaction plot showing the impact on resulting sward weights (on a logarithmic scale) where the placement of exclusion cages (treatment) and location across consecutive weeks (week) interact to elicit a predicted response.

Weekly Sward Sample Length and Weight Results

Week 1 – Model 1 – The linear model where X_1 was the predictor variable at week ones' location showed that the difference in sward length, where it was greater in caged plots, was not significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.07851, F = 1.22, df = 1, 38, R^2 = 0.03111, P = 0.276) (Fig. 12a.).

Week 1 – Model 2 – The linear model where X_1 was the predictor variable at week ones' location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.3571, F = 9.967, df = 1, 38, R^2 = 0.2078, P = 0.00312) (Fig. 12b.).

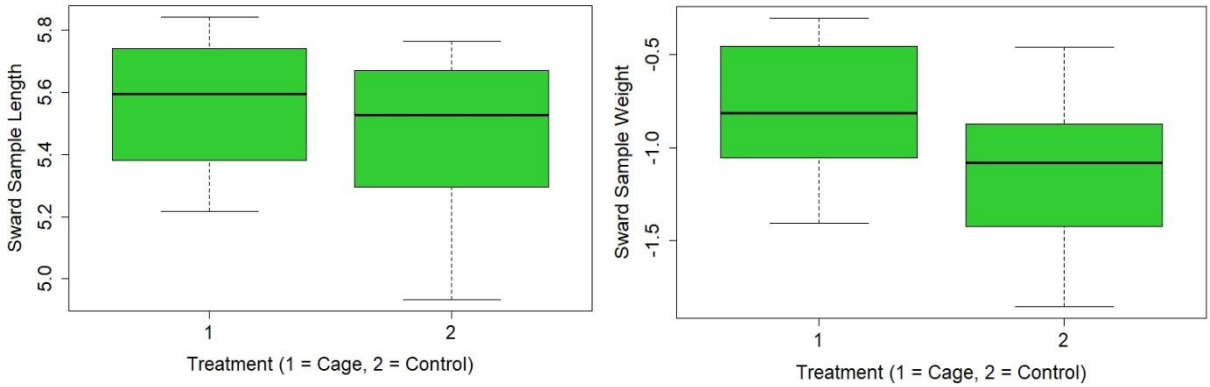

Fig. 12. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week one's data.

Week 2 – Model 1 – The linear model where X_1 was the predictor variable at week twos' location showed that the difference in sward length, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.64512, F = 110, df = 1, 38, R^2 = 0.7433, P < 0.001) (Fig.13a.).

Week 2 – Model 2 – The linear model where X_1 was the predictor variable at week twos' location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.54553, F = 40.65, df = 1, 38, R^2 = 0.5169, P < 0.001) (Fig.13b.).

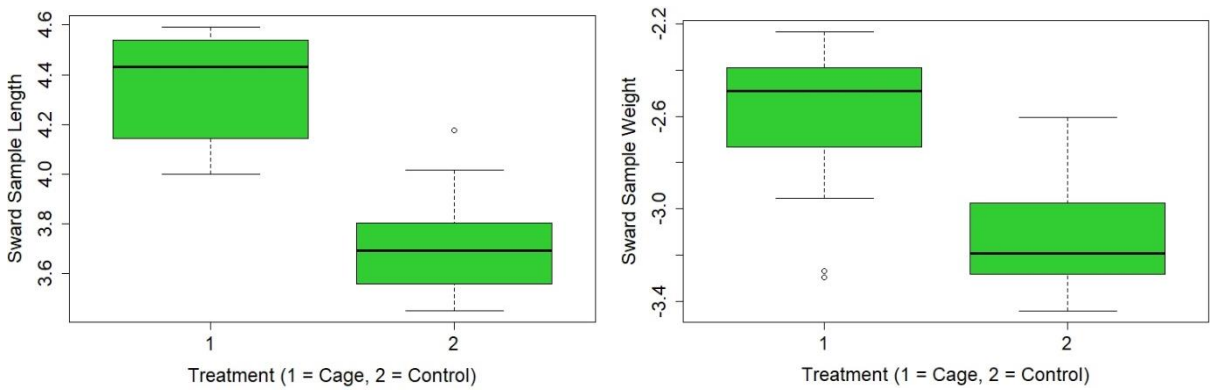

Fig. 13. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week two's data.

Week 3 – Model 1 – The linear model where X_1 was the predictor variable at week threes' location showed that the difference in sward length, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.69134, F = 188.6, df = 1, 38, R^2 = 0.8323, P < 0.001) (Fig. 14a.).

Week 3 – Model 2 – The linear model where X_1 was the predictor variable at week threes' location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -1.2096, F = 74.69, df = 1, 38, R^2 = 0.6628, P < 0.001) (Fig. 14b.).

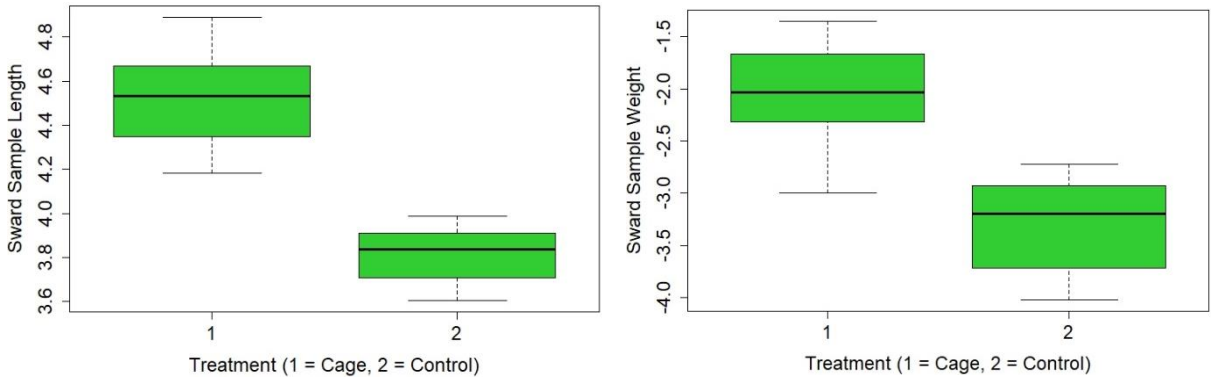

Fig. 14. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week three's data.

Week 4 – Model 1 – The linear model where X_1 was the predictor variable at week fours' location showed that the difference in sward length, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.68656, F = 184.3, df = 1, 38, R^2 = 0.829, P < 0.001) (Fig. 15a.).

Week 4 – Model 2 – The linear model where X_1 was the predictor variable at week fours' location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.6017, F = 23.56, df = 1, 38, R^2 = 0.3827, P < 0.001) (Fig. 15b.).

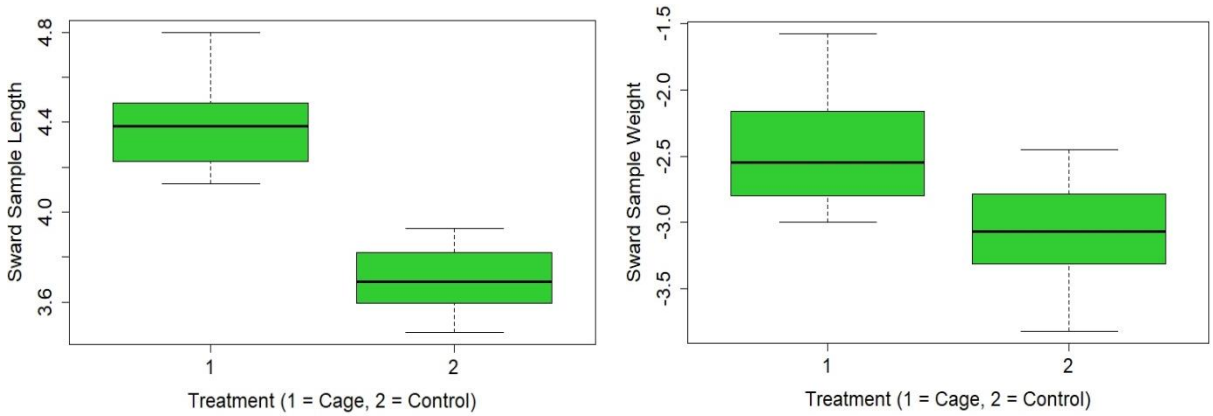

Fig. 15. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week four's data.

Week 5 – Model 1 – The linear model where X_1 was the predictor variable at week fives' location showed that the difference in sward length, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.84656, F = 330.2, df = 1, 38, R^2 = 0.8968, P < 0.001) (Fig. 16a.).

Week 5 – Model 2 – The linear model where X_1 was the predictor variable at week fives' location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -1.2131, F = 48.12, df = 1, 38, R^2 = 0.5587, P < 0.001) (Fig. 16b.).

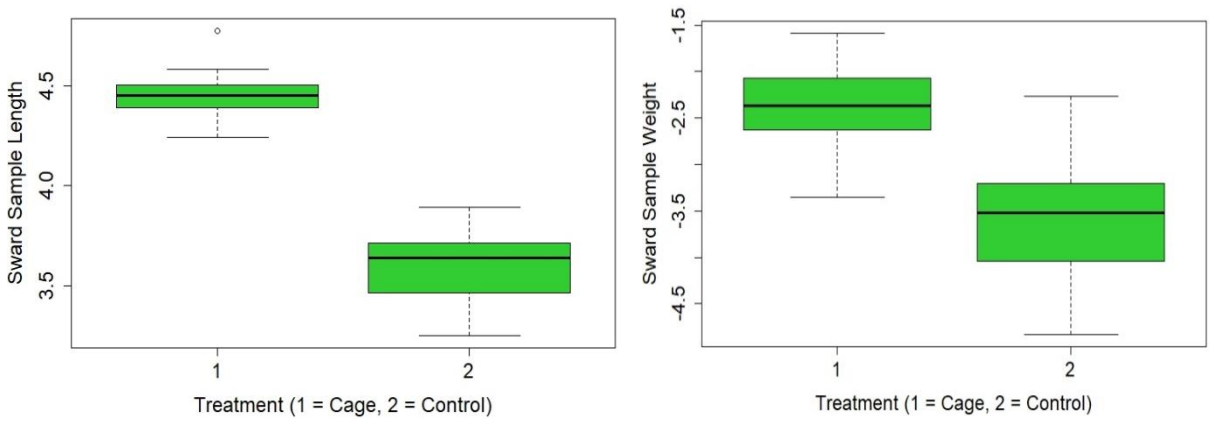

Fig. 16. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week five's data.

Week 6 – Model 1 – The linear model where X_1 was the predictor variable at week six's location showed that the difference in sward length, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -1.09232, F = 494, df = 1, 38, R^2 = 0.9286, P < 0.001) (Fig. 17a.).

Week 6 – Model 2 – The linear model where X_1 was the predictor variable at week six's location showed that the difference in sward weight, where it was greater in caged plots, was significantly driven by goose grazing activity as seen with the placement of exclusion cages (Estimate = -0.7556, F = 28.56, df = 1, 38, R^2 = 0.4291, P < 0.001) (Fig. 17b.).

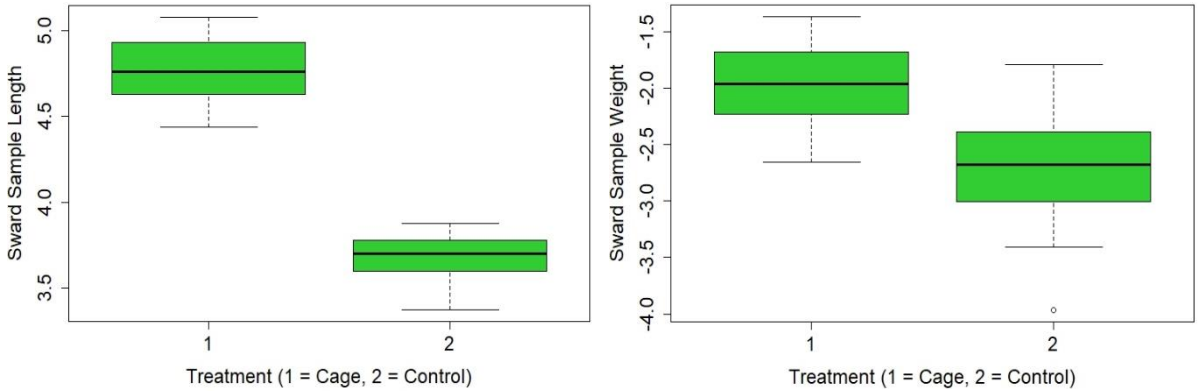

Fig. 17. Box plots showing the impact of exclusion cage presence on sward length (a (left)) (on a logarithmic scale) and sward weight (b (right)) (on a logarithmic scale) from week six's data.

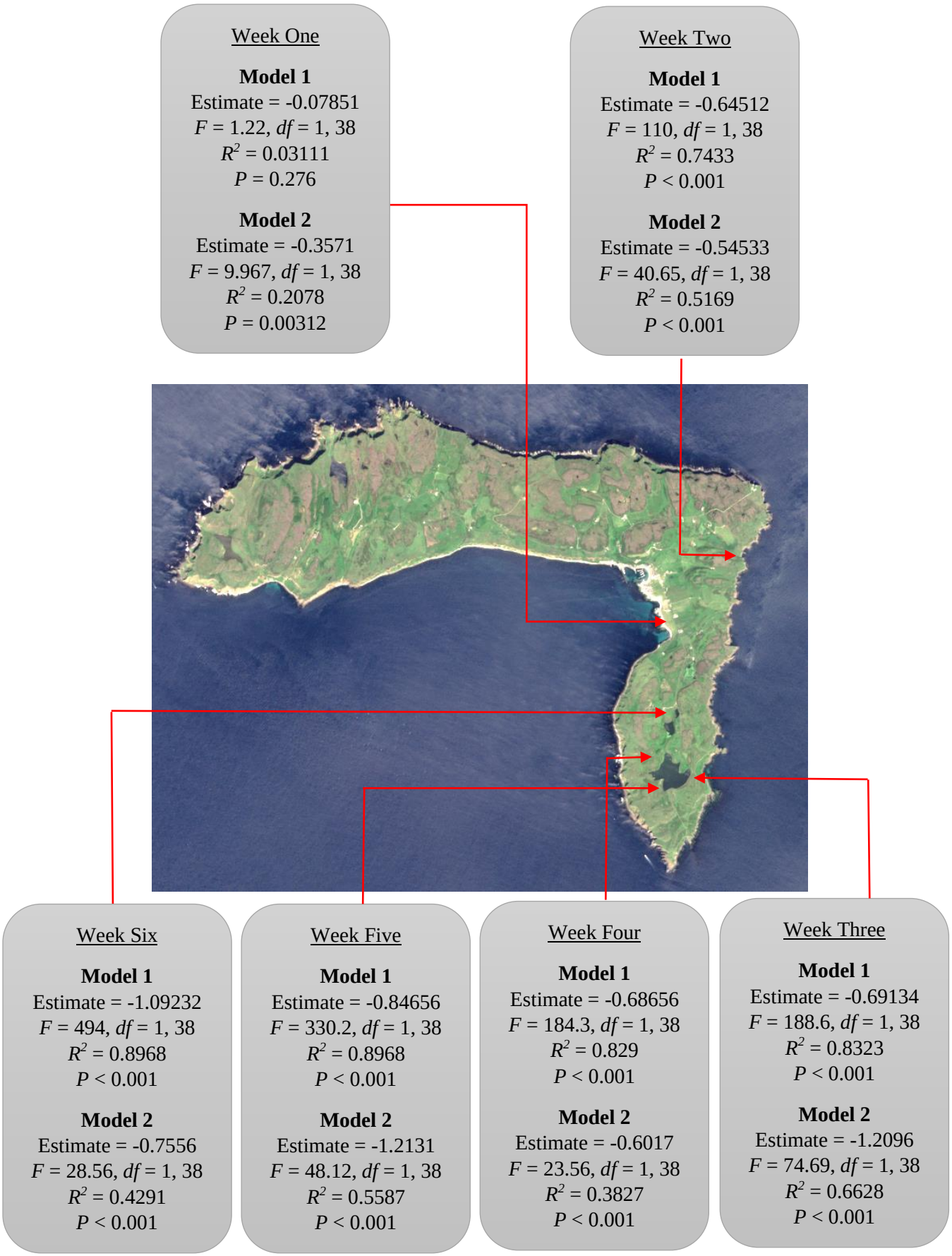

Fig. 18. Map of Rathlin Island illustrating the statistical outputs regarding length and weight data between caged and control plots taken from their respective sites (red arrows).

Percentage Differences of Length and Weight Data between Caged and Control Plots

For week one, L_1 = 6.40%, and L_2 = 8.30%, while W_1 = 39.50%, and W_2 = 25.83%. For week two, L_1 = 74.60%, and L_2 = 47.40%, while W_1 = 68.12%, and W_2 = 42.17%. For week three, L_1 = 73.00%, and L_2 = 61.10%, while W_1 = 110.90%, and W_2 = 105.87%. For week four, L_1 = 67.60%, and L_2 = 65.80%, while W_1 = 76.02%, and W_2 = 43.30%. For week five, L_1 = 88.80%, and L_2 = 69.70%, while W_1 = 103.10%, and W_2 = 90.20%. For week six, L_1 = 91.93%, and L_2 = 106.80%, while W_1 = 71.34%, and W_2 = 66.72%.

Estimates of Vegetative Consumption across Wider Geographical Scales

For week one Z_1 = 0.1978g and Z_2 = 0.0850g, thus Z_a = 0.1415g within Demesne (A = 271,139m^2), so predicts Z_T = 38,366.2g. For week two Z_1 = 0.0407g and Z_2 = 0.0272g, thus Z_a = 0.0340g within Ballycarry (A = 1,206,000m^2), so predicts Z_T = 41,004.0g. For week three Z_1 = 0.1150g and Z_2 = 0.0830g, thus Z_a = 0.0990g within Carravindoon (A = 760,809m^2), so predicts Z_T = 75,320.1g. For week four Z_1 = 0.0558g and Z_2 = 0.0294g, thus Z_a = 0.0426g within Carravinally (A = 469,435m^2), so predicts Z_T = 19,997.9g. For week five Z_1 = 0.0815g and Z_2 = 0.0506g, thus Z_a = 0.0661g within Roonivoolin (A = 526,091m^2), so predicts Z_T = 34,774.6g. For week six Z_1 = 0.0621g and Z_2 = 0.0900g, thus Z_a = 0.0761g within Carravindoon (A = 760,809m^2), so predicts Z_T = 57,897.6g. Extending the model to the full land area of Rathlin Island (A = 13,436,832m^2) and using Z_a = 0.0661g from week five for example, this would predict Z_T = 888,174.6g (Fig. 19.).

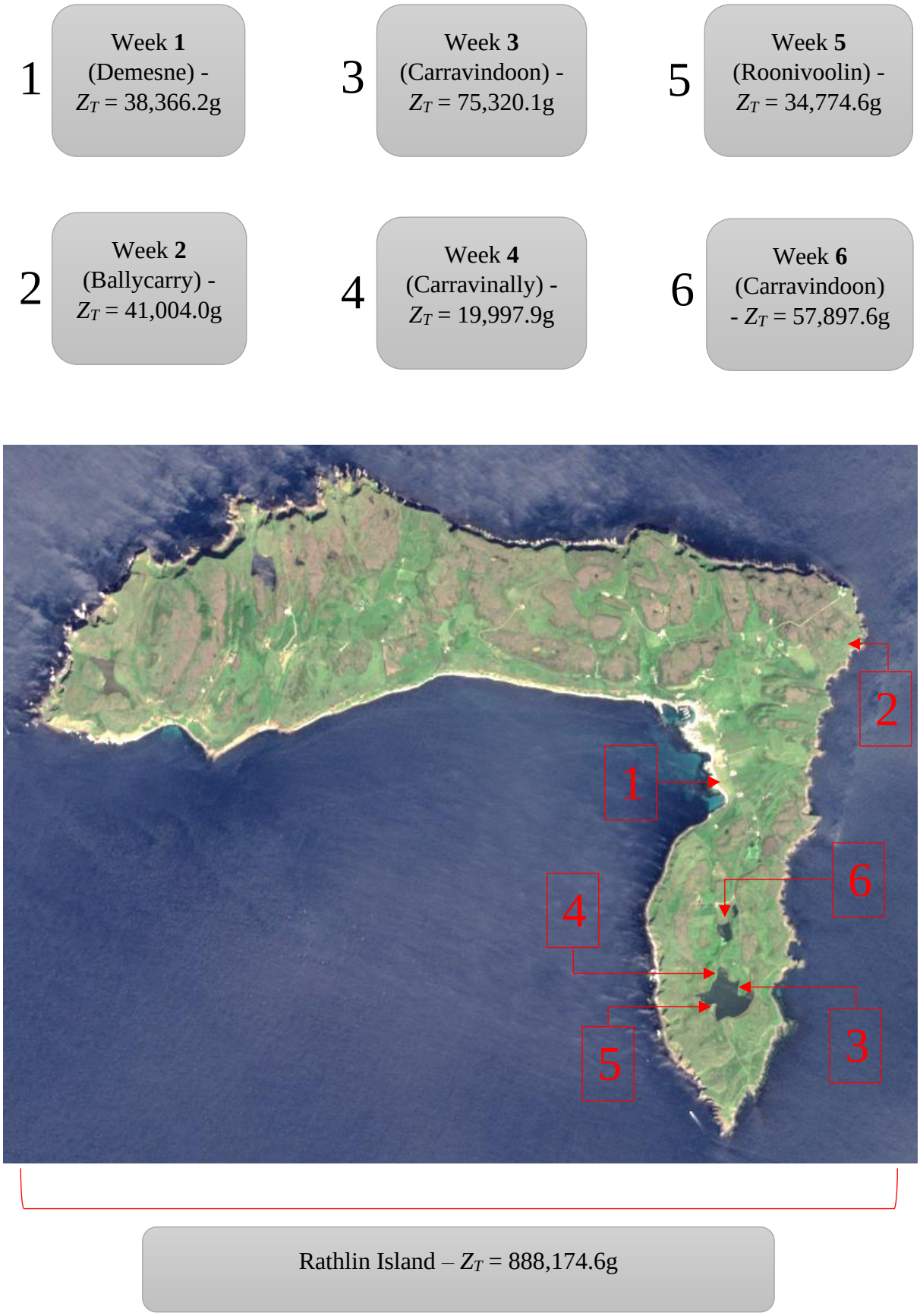

Fig. 19. Map of Rathlin Island showing all Z_T estimates of consumption across townlands and the entirety of the island's landmass.

Structured Interviews with Resident Farmers

Three questionnaire responses are summarised in appendix 1. The questionnaire showed that all three respondents believe Greylag geese (*A. anser*) pose a problem to the island's agriculture. Furthermore, all respondents were directly affected by the Greylag geese population, experiencing problems associated with grazing/vegetative damage, livestock damage, and mess on their land (defecation). All respondents explained how Greylag geese cause a greater impact during the summer months when they use the island as a breeding site but that they still pose a problem year-round. The respondents followed up on this point by expressing their understanding that Rathlin Island hosts as a wintering site for Greylag geese migrating from northern regions such as Scandinavia, and Iceland. All respondents indicated that populations of Greylag geese increase substantially on an annual basis where they claimed this to have been the case for approximately ten to fifteen years, soon after Greylag geese began establishing a resident population on Rathlin Island. All respondents admitted to attempting to control Greylag geese populations themselves using a range of methods. One respondent solely focused on non-lethal scaring tactics by means of shooting firearms at non-targets to elicit an auditory-provoked deterrent effect, while the remaining two respondents proclaimed to adhere to lethal scaring practices involving shooting. All respondents said they attempted to scare Greylag geese from their lands using conventional scaring methods involving scarecrows but stated that geese became quickly habituated to these methods and so their effect rapidly diminished. None of the respondents answered yes when asked if Greylag geese provided any benefits to the island's landmass and exclaimed that management practices to be put in place to control the geese populations would be of great benefit to them. When asked what management protocols they would support taking place on the island, all three respondents accepted the utilisation of egg-pricking practices and agreed that it would be an effective measure. Should management protocols be utilised on Rathlin Island to control populations of Greylag geese, all three respondents exclaimed their support and allowance for external personnel to have access to their land for the purposes of monitoring and controlling. Further comments raised by the farmers included their concerns involving limited food availability for cattle and sheep as a result of goose grazing competition, which is especially concerning during periods of breeding cycles, at which point the value of pastures is high for pregnant and lactating livestock, as well as calves and lambs.

Discussion

This study provides field experimental evidence that Greylag geese (*A. anser*) have a significant impact on reductions in live grass biomass in grassland habitats across the study sites. Based on comparative analyses of sward length and weight data between caged and control plots, the study shows that the live grass biomass was greater in caged plots where grazing access was restricted by the target species. This is indicative that increased grazing activity occurred in the study areas where grazing access was unobstructed. These findings support the hypothesis that yield loss is positively correlated with grazing damage and thus goose grazing has a significant impact on vegetation growth. Furthermore, this study provides field experimental evidence that the rate of grazing damage is greater in areas located in the vicinity of water bodies. The differences of length and weight data between caged and control plots were greater at the study sites located in the vicinity of Ushet Lough, compared to those located away from any water body and where vegetation was taller. This supports the hypotheses that there will be a greater level of vegetative damage on the perimeters of water bodies and in areas where vegetation is relatively short, as opposed to areas that do not fulfil such dynamics.

Rathlin Island's rich grassland habitats have been established feeding grounds for Greylag geese for some nineteen years, where the presence of wetland environments is suitable for roosting (Gauthier *et al.* 2005). Furthermore, the vast cover of energy-rich vegetative resources such as Red fescue (*F. rubra*) and Ryegrass (*Lolium spp.*) are plentiful to support the species generalist diet. This allows for congregations of large populations to continually accumulate within these areas. Being generalist feeders, it is probable that populations of Greylag geese will continue to congregate on Rathlin Islands' grassland habitats. This is because they are more likely to fulfil their nutritional requirements within available pastures rich in profitable resources, rather than selecting new feeding grounds with less diverse vegetation (Chudzinska *et al.* 2015). Consequently, when particular available resources are not obtainable, they can quickly adjust their feeding preference and formulate a new strategy for optimal foraging based on what resources are readily available. Such incidences along with annual increases in population numbers of Greylag geese are subsequently resulting in considerable damage to the foliage that thrives on Rathlin Island of which can be substantial if not effectively controlled (Hunt, 1984).

The Impact of Grazing Activity by Greylag Geese on the Availability of Foliage

Across each study site throughout the entirety of the experimental fieldwork, live grass biomass was significantly greater within plots where grazing activity was restricted compared to control plots where grazing activity was unobstructed. However, the level of grazing activity seen at each weeks' location fluctuated and some locations such as those during weeks three, four, five, and six, saw greater grazing activity than those from weeks one and two. This is not surprising as geese do not graze uniformly and, although Rathlin Island is rich in grassland habitats, certain locations across the island possess unpalatable and tall vegetation, that is undesirable to geese.

Although the percentage differences of length and weight data between caged and control plots during week one were minimal compared to the remaining weeks, this does not supply any long-term evidence that goose grazing does not have an impact at the location outside the study period. The pastures that made up this study location are periodically ploughed to prepare for the planting of new seeds. This periodic ploughing results in vegetation being reduced in length, while also causing the uppermost layer of soil to be turned over, allowing for fresh nutrients, such as nitrogen and phosphorus, to be brought to the surface (Laurence *et al.* 2010). Both of these incidences are beneficial to Greylag geese as shorter swards allow for easy and efficient foraging and the ability to easily watch for oncoming threats while ploughed fields rich in fresh nutrients provide Greylag geese with optimal nutrition to build energy stores (Fox & Abraham, 2017). As neither of these incidences was occurring during the point of experimental study, this supplies a probable explanation for the lack of grazing activity. Allowing swards to exceed certain lengths would likely discourage aggregations of foraging geese. However, such an effort would not be feasible on Rathlin Island given that dense swards would shade crops, restricting interspecific growth potential, and providing the inevitable requirement to plough periodically to reseed and provide grazing resources for livestock. With this in mind, population management control is the best option to alleviate such agricultural damage.

Further supporting the theory that vegetation length at the study location played a role in limited grazing activity, week one's site was a species-rich meadow habitat consisting of plant species such as Meadow foxtail (*Alopecurus pratensis*). *A. pratensis* is an angiosperm that can grow up to 100cm in length during the summer (Nawrocki, 2010). According to Olsson *et al.* (2017), both broods and non-breeding geese prefer habitats consisting of swards that are short in length (0-1dm) in which to forage compared to those where longer swards exist (≥5-

6dm). This preference signifies an anti-predatory response whereby foraging sites are selected with the ability to look out for oncoming threats as a considered factor, an ability that cannot be accomplished in pastures consisting of swards beyond a certain height. This provides a probable explanation as to why goose grazing was not as intense at this site compared to others where shorter swards existed.

Dissimilar to week one's results, week two's difference values were substantially higher and clearly show that the live biomass within the exclusion cages was significantly greater than that measured in the corresponding control plots, indicating major grazing activity. There is one fundamental difference between week one's and week two's selected locations. The vegetation that made up the habitat of week two's location consisted of Red Fescue (*F. rubra*); a floral species preferred by Greylag geese as a feeding resource. Furthermore, tall vegetation such as *A. pratensis* was not present, fulfilling the capacity for geese to forage at this site without the encumbrance of tall vegetation preventing their ability to visually detect oncoming threats.

The selected locations for weeks three through six were all on the perimeter of water bodies, locations crucially preferred by populations of Greylag geese given the suitability of such for roosting (Gauthier *et al.* 2005). This suggests that Greylag geese will graze more heavily in areas in the vicinity of a water body as opposed to those where a water body cannot be quickly accessed. Furthermore, similar to the location selected for week two, the vegetation that comprised the selected areas for weeks three through six was predominantly Red Fescue (*F. rubra*) as well as scarce amounts of other particularly short standing vegetation such as Crowfoot (*Ranunculus aquatilis*), Compact Rush (*Juncus conglomeratus*), Heal-all (*Prunella vulgaris*), Common Velvetgrass (*Holcus lanatus*), Bracken (*Pteridium*), and Marsh Thistle (*Cirsium palustre*). Although the aforementioned species of vegetation may not be palatable to Greylag geese, they do not impede the geese's ability to graze within the area due to its scarce cover and short height.

The results collected in this study show that the percentage differences for length data are the greatest during week six and the percentage differences for weight data are the greatest during week three. A probable explanation for these results is that the locations chosen for week three's and week six's data collection were at higher altitudes compared to those chosen for weeks one, two, four, and five. Caged and control plots were chosen atop large hills in these weeks where the Greylag geese's field of vision was greater than in areas closer to sea level

where hills, buildings, and surrounding taller vegetation may limit such extended visual ranges. A natural predator of Greylag geese is the White-tailed Eagle (*Haliaeetus albicilla*) (Roder *et al.* 2008). Winged predators such as *H. albicilla* are much more easily spotted by prey from higher altitudes given the prey's wider field of view. Thus, having a wider visual scope whilst foraging is favourable to Greylag geese as it heightens their ability to look for potential threats, providing them with extra time to flee if they observe a predator closing in from a certain distance. This presents a plausible explanation for why greater grazing damage occurred in these areas and promotes the necessity for population management on Rathlin Island given its undulating topography.

Estimates of Vegetative Consumption across Wider Geographical Scales

The calculations are estimates of the level of vegetative damage that could potentially be caused by grazing activity by congregations of Greylag geese over a one-week period. These calculations have been formulated assuming that the weight of the sward samples harvested account for the full grazed weight of the sample area, that the entire area within each townland is sufficient for grazing, and assuming that geese were to graze at a uniform rate. Furthermore, the calculations have been made whilst only considering the current population sizes of Greylag geese on Rathlin Island over a small period of time. Assuming resident populations increase at an annular steady rate as a result of reproduction, and with further population increases during the winter staging period where migratory populations arrive on Rathlin Island from northern locations such as Iceland, rates of grazing activity by Greylag geese could further increase.

The consequences of climate change where rising temperatures are prolonging the survival of vegetation at locales across the northern hemisphere mean that geese remain in such areas with continuous access to profitable resources for extended periods of time (Both & Visser, 2001; Cotton, 2003; Ramo *et al.* 2015). This could indicate that migratory species of Greylag geese on Rathlin Island may remain for longer periods of time further exacerbating grazing damage as climatic changes continue to occur. Based on the estimation model outlined, this study can predict that the rate of grazing activity by Greylag geese over a prolonged period of time can be exponentially impactful if population control is not utilised.

Structured Interviews with Resident Farmers

The premise of the research study was manifested following the articulated concerns of three resident full-time farmers on Rathlin Island regarding sward damage being caused to their farms as a result of grazing activity by Greylag geese. It is evident from the answers and

comments received from the constructed interviews that, for a significant period of time, the farmers have been increasingly affected by the presence of Greylag geese on their farmland. It has also been made clear that the issue regarding grazing damage is a growing concern as congregations of Greylag geese on their land appears to be increasing on an annual basis. Further comments raised by the farmers included their concerns involving limited food availability for cattle and sheep as a result of goose grazing competition. This is especially concerning during periods of breeding cycles, at which point the value of pastures is high for livestock; and how geese grazing causes significant reductions in vegetative yields. One farmer articulated the need to purchase supplementary food to provide to sheep as the silage yield, in terms of expanse and quality, is not sufficient. The insufficient expanse of available silage is resultant from the high levels of grazing activity by Greylag geese. The insufficient quality of available silage is resultant from the fear that bacteria such as *Claustridium chauvoei,* which may be present in goose faeces, can cause blackleg in cattle (Abreu *et al.* 2017) and potentially cause ewes to abort foetuses if consumed.

The three farmers articulated that they sow their fields at the end of April and their grazing ground annually at the end of May. This fertilizing treatment enhances vegetation growth for grazing cattle and sheep but is highly profitable for grazing Greylag geese meaning such treatment can increase the likeliness of grazing exploitation and thus limit available resources for livestock (Patton & Frame, 1981).

Concepts for Future Research

Goose grazing damage can be difficult to assess without the utilisation of exclusion zones as an estimate in vegetation growth, where grazing activity is both restricted and unhindered, is required to make clear comparisons (Conover, 1988). With this in mind, the use of exclusion cages was a useful and effective tool in the current study and has allowed accurate results to be drawn. Furthermore, the presence of cages did not deter Greylag geese from grazing at the selected study sites as populations were seen grazing right up to the edge of the cages (Pers. Obs.), meaning their presence did not have any clear impact on individual/species behaviour.

For the premise of future research where similar hypotheses wish to be answered, some alterations could be made to the study design to collect more elaborate data. For instance, exclusion cages could be larger for more samples to be collected, thus effectively producing more accurate data, while larger cages will allow for the Edge Effect to be more easily avoided

(Borman *et al.* 2000). Furthermore, equal numbers of cages of the same design to those used in the current study could be set up in areas where no grazing activity occurs to make even clearer comparisons that go beyond comparing data from caged and control plots within whole areas where geese can be present. However, this study design could prove difficult as grazing by goose species is ubiquitous and cannot be easily manipulated. A potential method for trialling this would be to set up exclusion zones large enough to make accurate comparisons between both caged and control plots within and outside such zones. Having such areas where no goose-related activity occurs could act as a negative control providing a better understanding of other environmental factors that may influence differences between swards from within and outside exclusion cages.

A further method for collecting more accurate data would be to leave cages at their fixed study sites for longer durations (>1 week). This would allow more time for vegetation to grow inside the cages and thus see greater differences between harvested sward samples where grazing activity by Greylag geese to be excessive. Additionally, this method would allow for the possibility of not obtaining efficient data during potential periods of limited vegetation growth due to unsuitable weather to be more easily avoided. Percival (1988) performed an experiment whereby cages of varying mesh sizes were set up and examined to determine whether grass productivity fluctuated with mesh size being a specific factor, a phenomenon known as the 'Sheltering Effect'. Upon reviewing this study, I was confident that the cages used in the current study did not adhere to such limitations and thus the mesh size chosen was suitable. Growth potential under cages could be dependent on length of time, however, as although Percival (1988) concluded that the cages used in the current study did not adhere to any sheltering effect on the covered vegetation, length of time was not mentioned by the author. Furthermore, Dobb & Elliot (1964) have reported a reduction in the growth potential of Red fescue (*F. rubra*) under cages. Further research would be required to understand the sheltering effect on the growth potential of a target vegetative species, concerning the length of study, before extended sward survey studies could take place.

Concepts for Potential Management

Grazing damage to vegetation can be devastating in areas where Greylag geese have established a resident population, which is the case on Rathlin Island, and where population numbers are on the rise. Numerous methods have been discussed in the literature over recent years to suggest techniques for alleviating such damages. However, it is seen that some methods work better than others and few prove to have little effect. For instance, some studies

have discussed the effectiveness of lethal scaring practices to deter geese away from valuable vegetation (Conover, 2002; Simonsen *et al.* 2016; Mansson, 2017). While positive outcomes to using such techniques have been made, conclusions have been drawn where scaring does not necessarily alleviate problems associated with grazing damage but prolongs it on a spatiotemporal scale as geese will relocate to a new location where the same level of damage continues (Castelli & Sleggs, 2000). In other cases, geese will simply habituate to non-lethal scaring practices such as the use of scarecrows, which was an issue raised by all three farmers in the current study. Furthermore, the implementation of shooting/controlled hunting practices to control goose populations on arable land has been explored and widely used. However, this technique still holds negative factors, for example, Bauer *et al.* (2018) found that shooting as a means of management can elicit counterintuitive effects where the level of agricultural damage caused by geese can worsen. The author found a positive correlation between shooting geese and increased cumulative consumption by remaining individuals. Furthermore, similar to lethal scaring practices, shooting/controlled hunting may cause further damage in contiguous and/or distant pastures where migratory behaviours have been disturbed, and thus shooting does not necessarily alleviate the problem but continue it spatiotemporally.

Not all farmers interviewed in the current study were keen on the implementation of shooting or lethal scaring practices on Rathlin Island to alleviate grazing damage by Greylag geese. However, they voiced their keenness on the implementation of egg-pricking as a means of management control. Egg-pricking has not been as widely explored as other management techniques but a similar practice, known as egg-oiling, has been experimented on Canada geese (*Branta canadensis*) and has seen a success rate of 90-100% in reducing reproduction (Beaumont *et al.* 2018). This effectiveness of nest manipulation, where egg-pricking was utilised to control Gull populations, was also further supported by Thomas (1972). With this and the understanding that all farmers interviewed preferred egg-pricking practices taking place, this method may be an ideal next step forward in controlling population numbers of Greylag geese to a point the species are effectively conserved and sustainable farming can develop on Rathlin Island.

Conclusion

While a range of management protocols have been carried out across the northern hemisphere, such as on Rathlin Island where goose grazing is impactful, wildlife damage continues to ensue conflicts with farmers and landowners, presenting an experimental knowledge gap. By undertaking the experimental fieldwork, of which the moveable cage method was utilised, on Rathlin Island, this study recognised that grazing damage by Greylag geese (*A. anser*) was significantly impactful across the site's grassland habitats. This was seen where length and weight results of harvested sward samples were significantly greater in study plots where grazing access was restricted (cages) than in study plots where grazing activity was unhindered (controls). These findings support the hypothesis that yield loss is positively correlated with grazing activity by Greylag geese. Furthermore, this study recognised that the differences in length and weight data between caged and control plots were greater during weeks three, four, five, and six. This supports the hypothesis that greater grazing activity will occur at sites close to water bodies and where short vegetation is present. Future research into the intensity of grazing damage will be benefitted by moveable cages remaining in set locations for extended periods of time (>1 week), for more moveable cages to be erected across multiple locations at any one time, and for the overall period of fieldwork to be extended to acquire more accurate results of grazing damage. Based on the findings of this study, I suggest active Greylag goose management controls where egg-pricking is the favoured choice articulated by resident farmers. Such management controls are potentially the best next step forward to controlling populations of Greylag geese while continuing sustainable farming practices.

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Appendices

Appendix 1

Question	Answer(s)	Respondent One	Respondent Two	Respondent Three
Question 1 - Do you consider Greylag geese to be a major problem on Rathlin Island?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 2 – Are you aware that Rathlin Island hosts as a wintering site for Greylag geese migrating from northern regions such as Iceland and Scandinavia?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 3 - Has the presence of Greylag geese been a problem for you personally?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 4 – If you answered 'yes' to Question 2 then what is the nature of the problem?	Vegetative/Grazing Damage	/	/	/
	Livestock Damage	/	/	/
	Creating a Mess (Defecation)	/	/	/
	Excessive Noise			
	No Response			
Question 5 – Do you find Greylag geese to pose a greater problem during the summer months?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 6 – Are populations of Greylag geese increasing, decreasing, or	Increasing	/	/	/
	Decreasing			
	Remaining Stable			
	Unsure			

remaining stable over time?	No Response			
Question 7 - For how long have Greylag geese posed a problem on Rathlin Island?	20-29 Years			
	10-19 Years	/	/	/
	<10 Years			
	Unsure			
	No Response			
Question 8 – Have you ever attempted to control populations yourself?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 9 – If you answered 'yes' to question 7, what methods have you used?	Shooting		/	/
	Scaring/Chasing	/	/	/
	Exclusion			
	Unsure			
	No Response			
Question 10 – Do you consider there to be any benefits associated with Greylag geese being present on the island?	Yes			
	No	/	/	/
	Unsure			
	No Response			
Question 11 – Would you benefit from Greylag geese populations being controlled using appropriate management techniques?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 12 - Would you be in favour of Greylag geese population control methods being implemented if needed?	Yes	/	/	/
	No			
	Unsure			
	No Response			
Question 13 – From the following,	Egg Pricking	/	/	/
	Lethal Scaring		/	/
	Non-lethal Scaring	/	/	/

which management techniques would you support being implemented on Rathlin island if needed?	Shooting During Open Season		/	/
	Shooting During Extended Season		/	/
	Culling		/	/
	Providing Refuges			
	Unsure			
	No Response			
Question 14 - Would you be happy for external personnel to have access to your land for the purposes of monitoring and controlling Greylag geese?	Yes	/	/	/
	No			
	Unsure			
	No Response			