

Introduction

The *Allium paradoxum*, common name few flowered leek, is a wild garlic distributed in woodland areas largely in the East of Britain (Preston et al., 2002). In 1823 the *A. paradoxum* was brought for cultivation from the Middle East and has naturalized, with the first records of wild growths in 1863 (Clapham et. al., 1952). The species is a perennial plant with a bulbous geophyte which allows rapid spreading and the species grows to cover an increasing area. Therefore *A. paradoxum* has been identified as invasive. Non-native invasive species are defined as posing economic, environmental problems as well as threats to human/animal/plant health (Plantlife, 2016). Invasive species can have numerous negative impacts on the surrounding ecosystems, including smothering the native vegetation and depleting the soil resources. The *Allium paradoxum* can be problematic in habitats such as deciduous woodlands in which native spring flowers can be displaced. Furthermore *A. paradoxum* appears on Schedule 9 of Wildlife and Countryside Act 1981 which lists non-native invasive species which it is an offence to plant or cause to grow in the wild (Wildlife and Countryside Act 1981).

An area of Edinburgh to the east of Craigmillar Castle known as Hawkhill wood was identified to have several patches of *Allium Paradoxum* growing. This study investigates one particular population 500m NE of the castle which spanned 70.4m in length. The aim of this study was to discover if the invasive plant *Allium paradoxum* is spreading in the selected area of Craigmillar Park and what, if any, managing techniques are appropriate. It is expected that the surveys conducted will reveal that the species is spreading in this area.

Methods

The site that was reached in Craigmillar park had a population of *A. paradoxum* growing that was approximately 70 m long. An area was located where samples could be taken along the entire length with few rocks or trees in the way. Quadrats with .25m² area were used to standardize the areas being counted. At each point the ground was dug up 3 cm and the *A. paradoxum* plants were estimated to the nearest factor of five. Only

one quarter of the quadrat (0.0625m^2) was counted as it was unfeasible to dig up the entire area and would cause additional disruption to the population. Samples were done every 3 metres. Twenty-seven samples were taken instead of the expected 23, because the landscape of the site was not completely flat. Another transect, perpendicular to the original, was sampled.

Results

There was significant variation within the plot. When a sample was taken close to a path the number of organisms was significantly lower than the surrounding plots. As shown in Fig. 1, the samples at 3, 4, and 27 were near a walking path. The average number of *A. paradoxum* in the first transect was 165.93. Observe in Fig. 1 that the first seven plots and the last three points are all below the average. In the middle of the population fourteen of the seventeen samples were above the average for the site. In the second transect only six points were taken. The first sample was taken in the middle of the population and subsequent samples moved away from the centre. Between the third and fourth sample points there was an approximately 20 degree incline. The first three samples were very dense, but after the incline *A. paradoxum* became sparse.

Figure 1. A graph of the counted *A. paradoxum* in the first transect.

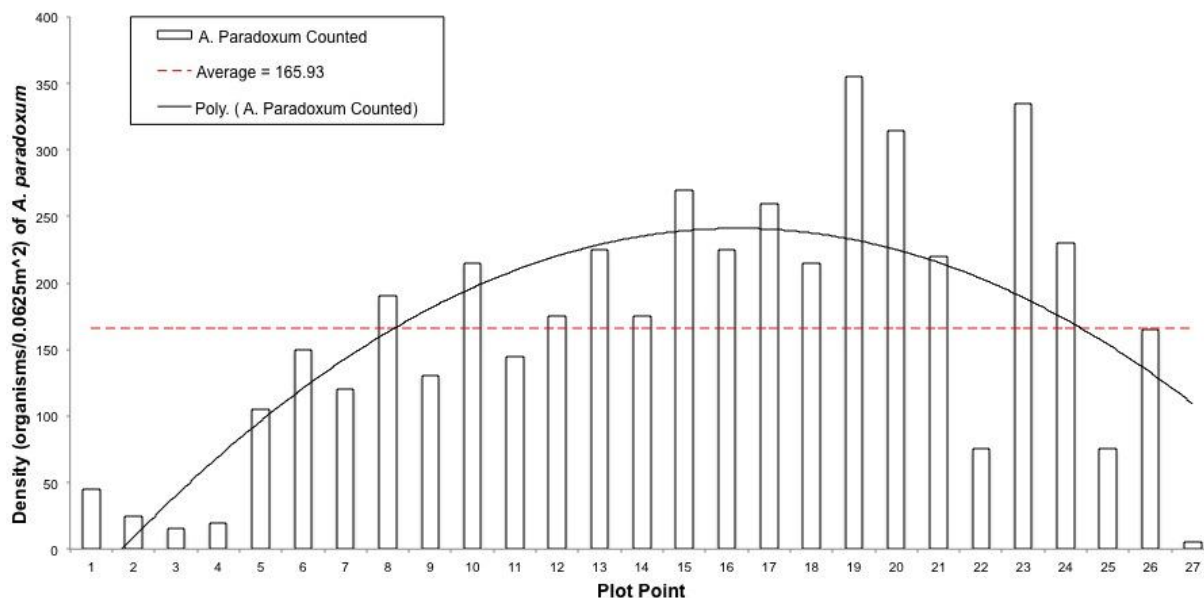
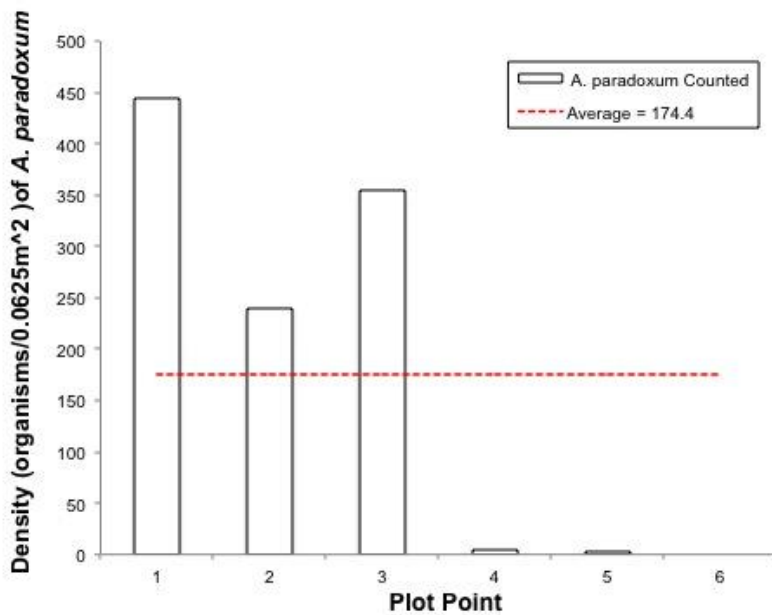


Figure 2. A graph of the counted *A. paradoxum* in the second transect.



Discussion

This investigation focuses on *Allium paradoxum*, which is considered an invasive non-native species in Scotland (Wildlife and Countryside Act, 1981), and if it was spreading in an area of Craigmillar Park. Rapidly spreading non-native species should be considered as ones that need to be controlled, therefore assessing if a population is spreading in the first place is a good starting point in investigation into whether a species needs to be controlled. Assuming that a spreading species is modelled as a diffusion process, by which it expands its range in all direction from a central point, it was expected that the edges of the species range will display a lower density (Skellam, 1951). Following this definition, the *A. paradoxum* population investigated in Craigmillar Park appears to be spreading since the edges of the population show a lower density than the inside of the patch (Figure 1).

However, errors need to be accounted for in the methods used in this survey. The data was collected on two different occasions which would affect the results in the way that the bulbils may have grown larger, hence appearing more prominent which would make the number of bulbils present seems higher. The quadrats used were of relatively small

area, 0.0625m^2 , and hence the population could be underrepresented as a whole. Furthermore, human error in counting the number of bulbils present within each quadrat has to be considered. Although an effort was made to standardise the counting method used, whereby the number of bulbils was estimated in a factor of fives in each handful of soil, the fact that 2 sets of people carried out the counting will affect the results since everyone will be estimating numbers slightly differently. Moreover, the same diffusion pattern could be seen due to other factors, such as gradients of nutrients present in the soil or elevation of land on which the bulbils can roll.

From this investigation, it is apparent that the population of *A. paradoxum* studied is spreading and hence more attention needs to be paid to this plant because, as it is already known, this species has the potential to be negatively impacting the native community of the park. However, to be able to conclude what, if any, control techniques should be applied to *A. paradoxum* an analysis needs to be done into what effects, such as decreasing the biodiversity of the ecosystem of Craigmillar Park or depleting soil nutrients, the population is having on the ecosystem of Craigmillar Park (Department for Environment, Food & Rural Affairs, 2015). If the population is having significant negative effects on the ecosystem it is occupying, then managing controls, such as using herbicides, need to be considered. Finally, this survey can act as a base to provide information on how fast the range-expansion of this particular patch of *A. paradoxum* is spreading if more surveys are carried out in regular time intervals.

Conclusion

The purpose of this study was to discover if a particular population of *Allium paradoxum* in Craigmillar Park was spreading and if it needed any control techniques put in place in order to protect the local ecosystem, economy and health. It was hypothesised that the species would be spreading in this locality due to the rapid rate of dispersion of the *A. paradoxum* across Britain as a result of the competitive nature of the invasive species. The results of density counts along transect 1 support the hypothesis and reveal that the *A. paradoxum* is spreading because the density at the edges are lower than those recorded in the centre of the transect. However these results should not be used

conclusively to state that *Allium paradoxum* will take over an area if planted unless further research was carried out, and the rate of spread would require subsequent surveys. Furthermore it cannot be certain that the data obtained proves that the *Allium paradoxum* is spreading as there are several other variables which may have impacted on the values. In conclusion the results of the study do reveal that the *Allium paradoxum* is spreading in the area investigated yet since the impact on the local environment is negligible no management techniques should be put in place.

References

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