Knockhatch Adventure Park

Conservation project

The longitudinal survey of bat species richness and population density across Knockhatch Adventure Park

2018 - 2024

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Bat Project

Introduction

Chiroptera, with the exception of *Rodentia*, are the most common of all mammals, making up 20% of all mammal life (Lei and Dong, 2016). There are over 1100 species of bats worldwide, distributed across all continents except Antarctica, with the UK home to 18 resident bat species (Berthinussen and Altringham, 2011). Although they have garnered protected status across most countries, almost a quarter of all bat species are globally threatened (Mickleburgh, Hutson and Racey, 2002; Warrell, 2019). The UK's native bats are no exception to this, with growing evidence suggesting that many species are declining across Britain and Europe (Wickranmashinghe *et al.* 2003). Bats provide valuable ecosystem services (Kunz et al., 2011; Barlow et al. 2014), for example as pollinators and as pest suppression, possessing traits that make them sensitive to a wide variety of environmental impacts including habitat loss and fragmentation and climate change and pollution (Barlow et al., 2014). These reasons highlight why they are also important bioindicators of change in ecological systems (Jones et al., 2009; Newson et al., 2009; Haysom et al., 2014). During the second half of the twentieth century, many bat populations began experiencing large declines, with climate change, habitat loss, disease and development suggested to significantly influence their decline.

In an environment of climate crisis and biodiversity loss, the need for zoological gardens and aquariums to be effective conservation organisations has never been more imperative. Since their roots as exotic menageries, zoos have been transformed into conservation centres with extensive expertise and skills which address many of the Sustainable Development Goals (SDG) and Global Biodiversity Framework targets (CBD Convention of Biological Diversity, 2022; DEFRA, 2018, UNEP and CBD, 2011; United Nations, 2015). Zoos play a critical role in the changing landscape of both ex-situ and in-situ conservation, with many collections contributing significantly in species recovery, protection and development. Furthermore, the environment in which these collections both build and further develop their collection are often in ecologically diverse areas.

Many collections have dedicated wildlife areas to promote biodiversity and support local ecosystems, often as the result of meeting zoo licensing criteria and/or other regulating zoo bodies (e.g. BIAZA, EAZA etc.). These can include bug hotels, ponds, bee hives, wildflower areas (etc.) and are often combined with signage to promote education and engagement with visitors about the natural world. However, when even taking into consideration the positive impact of zoos, including the general ethos and care focused on wildlife and nature, there is still the potential to impact local wildlife and the ecosystems in which they habit through the natural growth and expansion of the collections themselves. Consequently, monitoring local wildlife populations through scientific studies is extremely important to potentially identify any mitigating factors and reduce some of this impact.

Knockhatch Adventure Park has many areas of naturally occurring habitats and resources that appear to encourage biodiversity, with many different species having been spotted and recorded by both customers and staff over the years. Therefore, it became imperative to begin scientifically recording

these to gain an understanding of the local ecosystem's biodiversity and overall health. Not only do bats provide important ecosystem services, but they are valuable bioindicators of change in ecological systems. Recording bat diversity can provide us with good insight into not only the health of the local ecosystem, but also any significant impacts on their population density and diversity.

The aim of this study is to conduct a long term study on bat species diversity and bat species frenquency, across the different habitat types found at Knockhatch Adventure Park. However, over the course of the study, as data was collected and resources improved, the study began to expand out to other surveying techniques in order to record other native taxa such as invertebrates, birds and pond life to provide baselines of the local fauna and flora found across Knockhatch. Long term monitoring of both animal and plant populations is of significant importance to the effective conservation of biodiversity at all scales (Barlow et al. 2014). Identifying any trends in diversity and population frequency can allow for the planning and implantation of factors that may mitigate impact. Furthermore, during the course of this project, a wildlife-focused area (the Conservation Garden) was built and developed, so impact of this will be factored into the final results of this study.

Method

The intention of the study has been twofold; to assess overall bat activity and subsequently increase the population ensity and Richness of bat species that use the various habitats throughout the Knockhatch site. At the beginning of this study, a new wild-focused area was built (the Conservation Garden) in the latter half of February 2019, as can be viewed on Figure 1. This area comprised of several dedicated sections including a wildlife pond, wildflower meadow, reptile rockery and a bat barn (roost). Once the preliminary construction was completed, further additions were made such as the construction of two compost heaps, a replica bonfire, the installation for a working beehive and display beehive and a variety of native insect friendly wildflowers – both terrestrial and aquatic.

Surveying bats was primarily conducted using a heterodyne acoustic detector; Echo Meter Touch 2 (Wildlife Acoustics), attached to an iPhone 7, relying on acoustic recordings to identify the bat species. Recordings began at sunset and left to run independently until the phone ran out of battery (normally about 2am). The Echo Meter Touch 2 was the primary recorder for bat acoustics, due to the nature of it being unable to record individuals, only frequency of calls and diversity of bats per surveying night could be utilized. By using a detector that is accessible to both those conducting the study and other keepers and members of the public, this may facilitate potential public and keeper engagement in the second phase of the study. The Echo Meter Touch 2 automatically identifies the bat species emitting the call with reasonable accuracy, thereby negating the need for specialized training or knowledge when carrying out this simple survey method. This created accessibility to both those conducting the study and for other staff to set up the detector when required. The device also provides an overview of the area of individuals emitting calls which allows the researcher to identify areas of high bat density. Data was recorded sporadically between April and October. Weather, temperature and lunar cycle were all recorded at the beginning of each survey session in order to monitor whether these may have an effect on bat diversity and frequency, though these were not initially included until 2022, so data prior to this was inputted at a later data using historic weather data sheets. Data was not recorded during nights of

rain or high wind speeds (above 30 mph). For including in the final data set of each data, a species had to be recorded a minimum of 3 times in one night, and must be recorded at least 3 times in one year's data set to be considered reliable.

Sample Sites

All surveying for this study was conducted at Knockhatch Adventure Park, Hailsham, across three different sample sites. Due to the variability of habitat preferences among bats, surveying a variety of habitats is crucial in order to provide a broad understanding of overall bat activity. Site A (see Figure 1) was situated in and around the conservation garden which was a central point to the study, with suitable feeding habitats; a pond, forest edge and open land, while also being the closest proximity to human habitation and interaction. Sites B and C (refer to Figure 2 and 3) were picked as they contained the three main hunting habitats for UK bat species; woodland, bodies of water and open land.

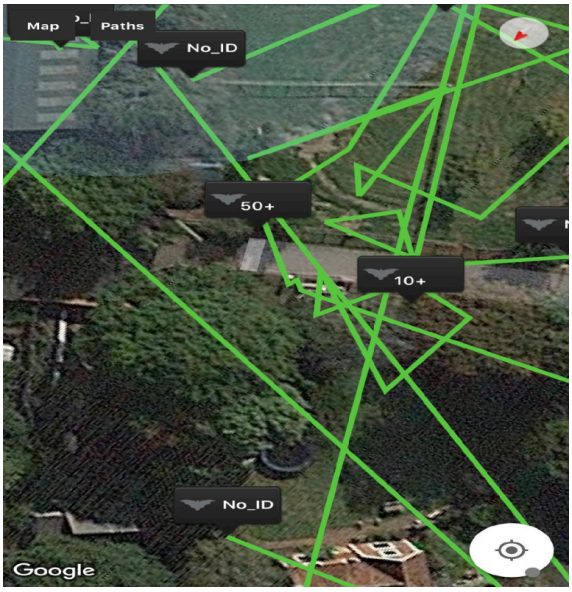

Figure 1; Site A – Conservation Garden, this sampling area contains the conservation garden, this is at the heart of the study, as previously stated this should be a hub of insect life, providing fertile feeding grounds for Various Bat species. An artificial roost may in time provide shelter for these species. Site A is in fairly close proximity to human habitation and all that comes with it, such as artificial light, sound and human presence. The Site is bordered by hedgerows and behind these are thickets of trees. Beyond the garden and hedgerows is a large open field

Figure 2; Site B – Lake, harbors a myriad of different habitats, the commanding feature is a large lake scattered with small islands, these islands are lightly maintained to ensure wildflower grown through the spring and summer but are largely left undisturbed, on each island a smattering of bird boxes have been but up and construction has begun on a series of bug hotels. These islands form a corridor of undisturbed, insect rich, feeding stations along the length of the lake. Along the fringes of the site there are hedgerows and woodland.

Figure 3; Site C (Pasture Land) is thickly bordered by hedgerows and woodland, and is dominated by a large field used for grazing, on the woodland floor is a mixture of wildflower growth in the spring and summer and dense leaf litter in the autumn and winter, behind the site is a forested area which contains ample roosting opportunities for Bats.

Results

In total, 9 different species of bat were identified at Knockhatch Adventure Park across the 3 different sites (species list can be viewed on Table 1). As can be viewed on Table 1 and Figure 4, the Common Pipistrelle (*Pipistrellus pipistrellus*) was the most frequently recorded (48%) out of all the bat species recorded during the project. The Soprano pipistrelle was the second most recorded (31%) and the common Noctule being the third highest frequency (7%). The whiskered myotis species had the lowest recordings out of the 9 different species, only making up 2%.

	Common Pipistrelle (*Pipistrellus pipistrellus*)	Soprano pipistrelle (*Pipistrellus pygmaeus*)	Nathusius' pipistrelle (*Pipistrellus nathusii*)	Common/Brown long-eared Bat (*Plecotus auritus*)	Common Noctule (*Nyctalus noctula*)	Lesser Noctule/Leisler's Bat (*Nyctalus leisleri*)	Natterer's myotis (*Myotis nattererei*)	Whiskered myotis (*Myotis mystacinus*)	Daubenton's bat (*Myotis daubentonii*)
Total	1890 (48%)	797 (31%)	95 (2%)	220 (5%)	665 (7%)	125 (3%)	174 (3%)	74 (2%)	255

Table 1; Table depicting the most frequently and consistently recorded bat species recorded during this project at Knockhatch. These were the total times recorded for each species, with *P. Pipstrellus* being the most frequent bat species and *M. Mystacinus* being the least frequent species, according to this data set.

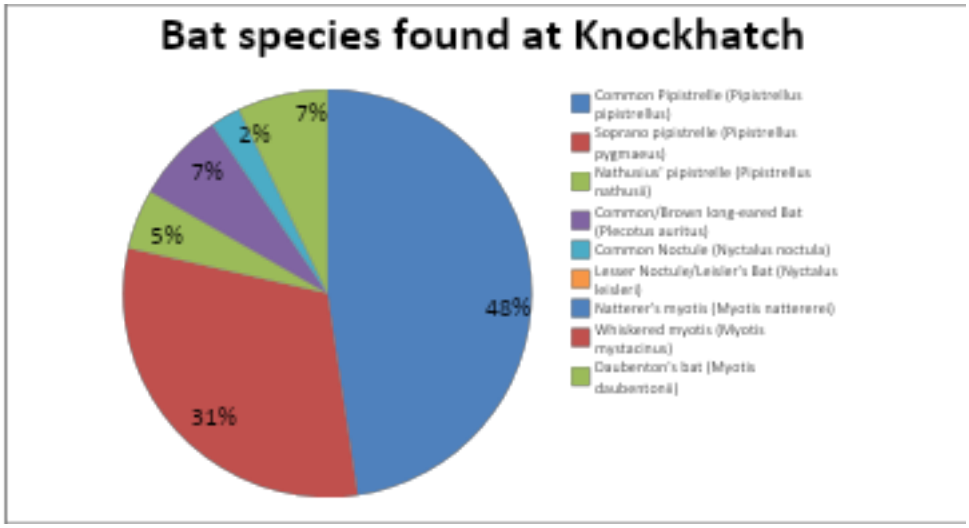

Figure 4; Pie chart highlighting the most frequently occurring species recorded at Knockhatch between 2018 – 2024. *P. Pipistrellus* had the highest frequency out of any species, making up almost 50% of all bat species recorded.

Total species number and total recorded frequency was recorded across the sites, this was then analysed and put into two different boxplots, these are total combined across the entire data set (from 2018 – 2024). Figure 5 depicts species number recorded across the three different sites; Site A (Conservation Garden), Site B (Lake) and Site C (Pasture Land). There appears to be an even distribution of diversity across the three sites, though sites A (mean: 6.8) and B (mean: 6.8) seem to have slightly more number of species recorded totally than Site C (mean: 5) Figure 6 is total recorded frequency of bats (total) across Site A, B and C. Conversely, Site A appears to have the highest frequency recorded, whereas Site C has the lowest total recorded frequency across the three sites.

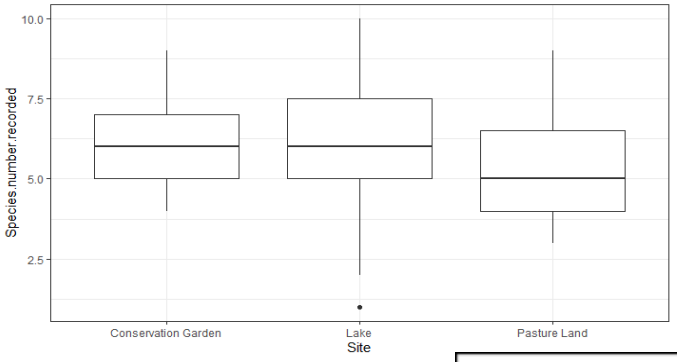

Figure 5; Box chart demonstrating the number of different bat species across the three sites (Site A – Conservation Garden, Site B – Lake and Site C – pasture land) between 2018 and 2024.

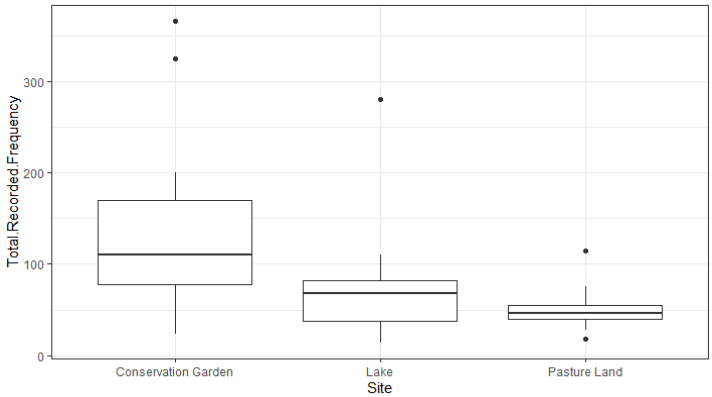

Figure 6; Box chart demonstrating total frequency of bats recorded across the three sites (Site A – Conservation Garden, Site B – Lake and Site C – pasture land) between 2018 and 2024.

Discussion

The duration of this study has been running for 5 years at the time of writing, so there has been a substantial amount of data collected. There appears to be a somewhat even distribution of species diversity across the three sites, and over the duration of the study, a total of 9 different species have been recorded at the site, with at least 5 species being consistently present. The five species found consistently at Knockhatch are the Common Pipistrelle (*Pipistrellus pipistrellus*), Soprano pipistrelle (*Pipistrellus pygmaeus*), Common Noctule (*Nyctalus noctulai*), Daubenton's Myotis (*Myotis daubentoni*) and the Common Brown Long eared bat (*Plecotus auritus*). These can be considered consistent resident species due to their continued recordings; all species have been present and recorded since the beginning of the study in 2018. Furthermore, both the Daubenton's and Brown long-eared have seen a notable increase in recordings since 2021. This could potentially be due to the maturation of the conservation garden by this stage, thereby increasing food availability and suitable habitat, or it could be due to improvements made on recording data, including adjusting the settings to encourage more reliable and accurate recordings. Other species recorded include the Nathusius' pipistrelle (*Pipistrellus nathusii*), Lesser Noctule (*Nyctalus leisleri*), and the Natterer's myotis *(Myotis nattererei*). Interestingly, the Greater Horseshoe Bat (*Rhinolophus ferrumequinum*) was recorded fairly consistently across the year of 2020 and somewhat in 2021 to be considered notable, but had not been recorded prior to this or since 2021. These recordings are highly unusual due to the declining population of this species making it quite rare, with no roosting recorded in East Sussex. A maternity roost was discovered in West Sussex in January 2022, so the reason as to how our bat monitoring picked this species up – or the accuracy as to whether it was this species or not – currently remain unclear. There has also been an overall increase in frequency of bats recorded, seeing a positive trend in bat activity; this could be due to the maturation of the site and creating more wildlife-focused areas, although it could also be due to being able to leave the bat protector out overnight and thereby increasing overall recordings during each session. Further analysis would determine these theories.

Species diversity across the three sites remained similar; this is likely due to the amount of similar suitable feeding sites found through the three areas that allow the support of multiple different bat species. Due to having a large lake, hedgerows, forested areas and open space, along with these areas being substantial in size, has likely allowed for excellent feeding opportunities for a wide variety of bat species. Having an understanding of our species diversity is not only exciting but crucial in being able to take the project onto the next step of further improving bat species richness and, where possible, the overall ecological health of the area. Site C appeared to have lowest recorded frequency of bats out of the three sites but this likely due to the *P. Pipistrellus* being the highest recorded out of any bat species on the study and generally just overshadowing most other bat species in terms of frequency recorded, while being predominantly found across Site A and B due to more suitable habitat and feeding area compared to Site C. Having 5 species resident at Knockhatch is an excellent baseline however and with bats generally being good bioindicators, gives good indication about the overall ecological health of Knockhatch at the time of this study.

Future work

Going forward with the project there are several directions we would like to take with this project. As the study has progressed, improvements and adjustments to the data set, including how the data is recorded on the Echo Meter Touch 2, have been made. This in turn has potentially affected the overall data. A full complete analysis of the data set still has yet to be conducted which would potentially give us greater insight into the overall bat diversity of the site and whether external environmental changes have impacted our local bats. Further data analysis of several other factors to investigate any correlations in population density and species diversity would help provide further clarity on the data. This could include species specific data analysis, such as following trends in the *P. Pipistrellus* across the different years. Furthermore, it would be useful to potentially analyse whether variables such as weather, temperature and the lunar cycle had any impact on bat activity, as well as any population trends in the various species recorded between 2018 and 2024. Some species have been historically recorded but not recorded within the last 2 years, thereby monitoring as to whether these species may reoccur is paramount. Before the next data collection season, we will be installing bat boxes around the site as our next step to increase habitat sites. We also intend to inspect the 'bat barn' building (situated in the conservation garden) for its suitability in housing bats and what improvements and adjustments could be made to further increase its suitability as a roosting site for our resident bat species. Over the duration of the project, due to the nature of development across the site, artificial lighting has been introduced into parts of Site A and Site B, though still devoid in Site C, so future work could include this as a variable in the data set to investigate whether there is any shift in bat activity between artificially lit and non-lit areas. Future study will continue to assess the population of these species in the sample sites and potentially identify a trend.

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