Knockhatch Adventure Park Conservation Project

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Assessing Bat population and diversity in Knockhatch Adventure Park

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Introduction

Chiroptera make up around 20% of all Mammal life with the exception of*Rodentia* they are the most common of all mammals (Lei and Dong, 2016). Numerous positive impacts on the ecosystem are attributed to *Chiroptera* form pest control to disease management (IUCN, 2012). It is due to the extensive role that *Chiroptera* play in the ecosystem, that it was decided that efforts should be made to provide a rich and diverse habitat for these species as possible at Knockhatch adventure park.

Method

The Intention of the study is twofold to assess and subsequently increase the population Density and Richness of Bat species that use the Various Habitats throughout Knockhatch. This may be achieved through increasing the population of their Primary prey source, Insects. The foundations of this study have been laid with the formation of a Conservation Garden. The first phase of Construction was Completed in the Latter half of February 2019, as can be seen in Fig 1, this Comprised of a Wildlife Pond, Wildflower meadow ,Reptile Rockery and a Bat Roost. Once the preliminary Construction was completed 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.

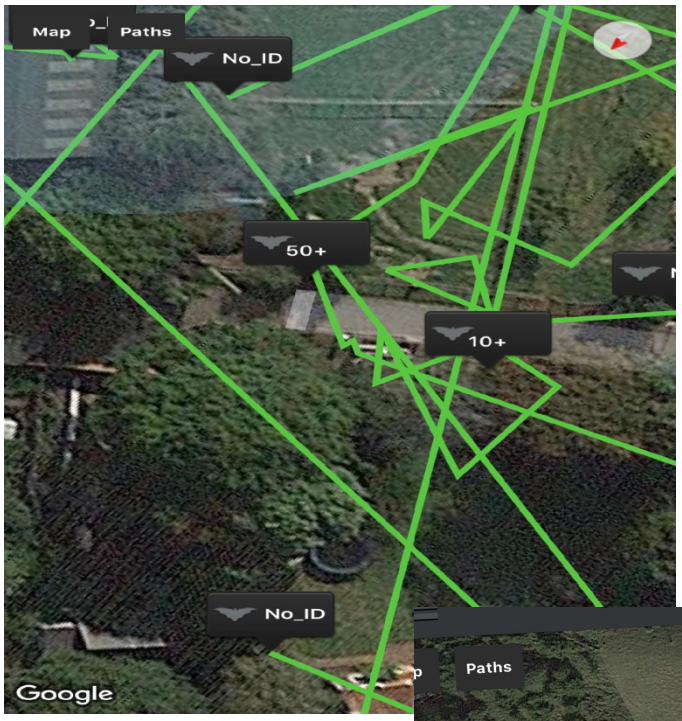
With regard to Data collection, of primary importance was that of the diversity and population of Bat species in and around Knockhatch Adventure Park this involved, surveying with a Bat detector from Dusk until approximately one hour after sunset. The Bat Detector used to survey Bat presence, was the Echometer 3. The Echometer 3 was chosen primarily due to the ease of use, this makes the detector accessible this facilitated another crucial aspect of the study; education. 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, this may lead to the formation of citizen science project or cultivating public interest. The detector automatically Identifies the Bat Species emitting the call with a reasonable degree of accuracy. This Negates the need for specialized Knowledge in this field, the Auto ID function was also considered to be more accurate and efficient than Manual Identification. The device also Suggests the Location of the Individual Emitting the Call this allows the Researcher to identify areas of high Bat density, this may allow researchers to reinforce these areas with Bug hotels, The Planting of Wildflowers and insect surveying, thus ensuring Bat presence on these sites over the coming years.

Sample sites

Three sites were used in the study, these were picked based on the various habitats that they contained. Due to the variability of habitat preferences amongst Bats, its is crucial to survey a variety of habitats so as to avoid limiting the study. The sites B and C were picked as they contained the Three main hunting habitats for UK bat species, these are woodland, bodies of water and open land. Site A was situated in and around the Conservation garden which was at the heart of the study and the close proximity of site A to human habitation.

Site A

Site A, 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.



Site B

Site B, 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 summer but are largely left each island a smattering of been but up and begun on a series of bug islands form a corridor of insect rich, feeding stations of the lake. Along the fringes are hedgerows and the spring and undisturbed, on bird boxes have construction has hotels. These undisturbed, along the length of the site there

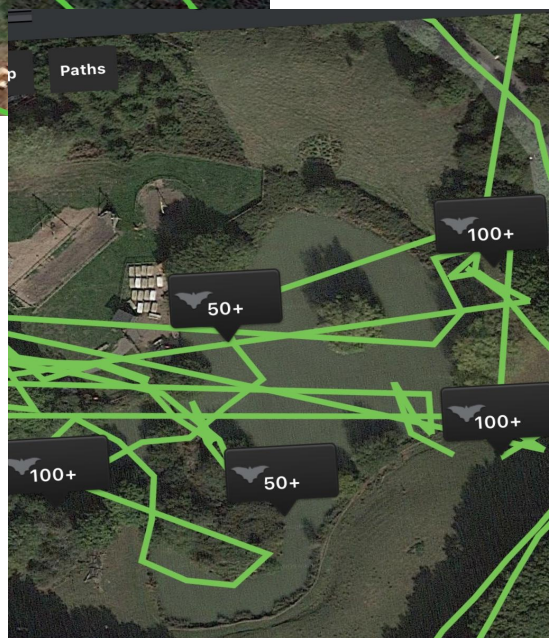


Fig 2- Site B

woodland.

Fig 3- Site C

Site C

Site C 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.

A brief overview of the species present

Pipistrellus pipistrellus (Common Pipistrelle)

P. pipistrellus is found throughout Eurasia as far west as the UK and as far east as Taiwan (IUCN, 2008), this widely distributed species is currently listed as least concern on the IUCN red list of threatened species and is thought to have a stable population, it should be noted however the last assessment of this species was in 2008, thus this may not be an accurate representation of *P. pipistrellus's* population at present (IUCN, 2008). *P. pipistrellus* is an insectivorous species feeding predominantly on flying insects such as mosquitos, gnats and caddisflies (Barlow, 1997; Swift et.al. 1985).

Males will hold breeding territories of around 200m in diameter these are inhabited by a number of males, each emitting vocalizations comparable to singing, a female will then enter the fray and mate with the most desirable male (Sachteleben et.al. 2006). Once mated the females will hibernate, storing the sperm until spring, emerging from hibernation initiates fertilization and pups are born around June and the pups are reared and weaned in large maternity colonies that may number hundreds strong (Davidson-Watts and Jones, 2005).

Pipistrellus pygmaeus (Soprano Pipistrelle)

P. pygmaeus is a species of Pipistrelle that in 1999, was officially recognized as a distinct species, this was based upon the 10 kHZ difference in their echolocation frequency (Masing, 2006). As with their sibling species *P. pipistrellus*, *P. pygmaeus* favors woodland and riparian habitats, as these provide an abundance of prey and roosting opportunities (Rachwald et.al. 2016). There is no fixed mating season and copulation can occur anytime between spring and autumn, breeding is most common during autumn (Schober & Grimmberger, 1989). Typically one pup is born, between June and July, these are then weaned in maternity

colonies (Schober & Grimmberger, 1989).

***Pipistrellus nathusii* (*Pipistrellus nathusii*)**

P. nathusii is suggested to be widespread throughout Europe, their population is strongest in the northern extent of their range, however they are less common in southern Europe, however its has been suggested that their population is increasing in southern Europe (ICUN, 2016). Evidence gathered by Lundy et.al. (2010), implies that due to climate change, specifically warming temperatures in northern and eastern Europe allowing *P. nathusii* to inhabit regions previously considered too cold to support them (Lundy et.al. 2010).

P. nathusii is a migratory species, foraging in a diverse array of habitats as with other members of the *Pipistrellus* family Woodland and riparian habitats are preferred (Krüger et al. 2014). The continued loss of hollow trees with loose bark suitable for roosting, in recent years this lack of roosting opportunities, measures have been taken to provide alternate roosts for *P. nathusii* (Krüger et al. 2014).

Whiskered bat *(Myotis mystacinus)*

M. mystacinus is found throughout Europe and Africa (IUCN 2016), as of 2016 *M. mystacinus* was classified as least concern on the IUCN red list (IUCN, 2016), however their population trend is Unknown, this can be attributed to a number of factors, prominent among them, is *M. mystacinus's* relatively recent designation as a distinct species , however due to their distribution and being registered as least concern on the IUCN red list it is widely regarded as a highly successful predator, with a stable population. They are seen to be in decline in some highly specialized areas as a result conservation techniques such as protecting known territories and using excavation methods to create more suitable terrain and conditions. (IUCN 2016)

While only being distinguished as a separate species from the brands't bat *(myotis banditii)*in 1970, W. Myotis is now recognized but due to the species late discovery there is little information specific to them.(Coroiu, 2016). Being a highly versatile species they have been recorded to roost in a large variety of environments, which subsequently include barns, caves and ravines. While they utilize protected areas their main anthropomorphic threat is found in Africa where *W. myotis* is gathered for medicinal purposes, this exploitation poses no risk to the species as a whole. (IUCN 2016)

Western barbastelle (*Barbastella barbastellus*)

Found throughout Europe and in a heavily restricted territory of north Africa. (IUCN 2016) the species is registered as near threatened on the IUCN list of threatened species, with the mature population in decline, primary reasons such as habitat loss come into fruition due to the high value land they predate on which consists of non aquatic shrub land, less fertile land such as cliff tops and mountains will unlikely be directly affected by human involvement but surrounding areas that contribute to noise/sound pollution are proven catalyst for adaptation to flight patterns, this adaption can lead to individual colonies utilizing niche spots however studies show they can have a detrimental effect on a colonies yield from one night. (IUCN 2016)

Due to diminishing numbers this species is now protected by cities and as a result conservation efforts are in place in a variety of locations, with most being delegated to ensuring the maintained habitat the B. Barbastellus occupies. Despite this, *Barbastella barbastellus* has already gone extinct in Norway and the Netherlands. IUNC 2016.

Daubenton's bat (*Myotis daubentonii)*

Myotis daubentonii is widespread throughout Europe, its population is strongest in central and eastern Europe (IUCN, 2008). It has been suggested that *Myotis daubentonii* is the only European bat species with a continued population increase from 1950- present (*A. Karatas pers. comm. 2007)*. *Myotis daubentonii* is confined to hunting over water sources, *Myotis daubentonii* will grasp prey with its feet or tail membrane over water sources, when foraging *Myotis daubentonii* typically flies at under a meter over water sources. While the Diet of *Myotis daubentonii* is varied, however it has been noted by Vesterinen et.al. (2016) that Chironomidae feature most frequently in *Myotis daubentonii's* diet even when alternative prey is more abundant (Vesterinen et.al. 2016).

***Nyctalus noctula* (Noctule) and *Nyctalus leisleri* (Lesser Noctule)**

Nyctalus noctula is widespread throughout Europe and is found in isolated pockets in Kazakhstan, Lebanon and Cyprus (IUCN, 2016). *Nyctalus noctula*hunts at relatively high altitudes above wooded areas hunting flying insects. *Nyctalus noctula* hunts just before sunset, renowned for is speed and agility *Nyctalus noctula* is reported to have predated upon *Mus musculus* (House mouse) however this is thought to be a rarity (Nowak, 1994).

Nyctalus noctula is a social species, winter roost sites can hold up to 10, 000 individuals, roost sites include tree hollows, caves and made structures (Harrje, 1994). *Nyctalus noctula* has been identified as being a potential vector for Plague causing bacteria andBorrelia recurrentis transferred via Ticks (Poel et.at. 2006).

***Eptesicus Serotinus* (Serotine bat)**

The Serotine bat (Eptesicus Serotinus) is an uncommon bat species found across Southern England . It is one of the first bats to appear at night and typically roosts in old buildings (Wildlife Trust, 2019; Bat Trust UK, 2010). E. serotinus can weigh between 15-35g and measures 5.8-8cm in length. It has a lifespan of up to 19 years, reaching sexual maturity at a year old (Wildlife Trust, 2019). E. serotinus diet primarily consists of flies, moths and chafers (Robinson and Stebbings, 1993). They have been found to have three distinct foraging strategies; predominantly aerial hawking, ground feeding and short flight (Catto et al, 1996). As previously stated, E. serotinus favour old buildings for roost sites; in addition to this, E. serotinus have been found to favour roost sites located with improved grassland and higher cover of arable land (Catto et al, 1996; Tink et al, 2013). Much of Knockhatch consists of this kind of habitat, therefore supporting favourable conditions for E. serotinus. This is crucial for the conservation of E. serotinus due to the decline of roost sites and prey base across the UK (Tink et al, 2013).

Maternity colonies consist almost exclusively of female bats, starting to build up in May, with colonies often stable from the end of May, while males probably remain solitary or in small groups (Bat Trust UK, 2010). The young are birthed early July, relying on their mothers for up to 6 weeks before they can forage and fly on their own. The colony usually disperses by early September with a few remaining in the roosts until early October. Mating normally takes place in Autumn (Bat Trust Uk, 2010).

***Plecotus auritus* (Brown Long eared Bat)**

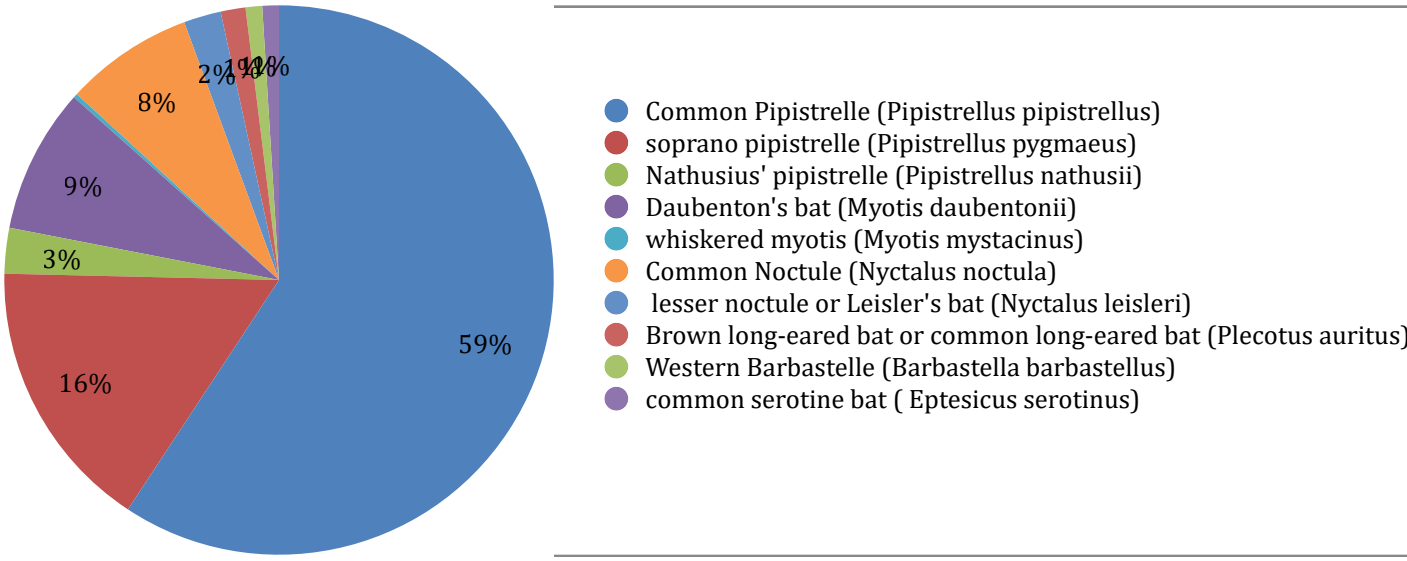
The Brown Long Eared Bat (*Plecotus auritus*) is a medium sized bat found throughout most of the UK. Its primary diet consists of flying insects, but it is also capable of flying slowly through foliage, picking insects directly from leaves (Sussex Wildlife Trust, 2019). They tend to prefer eating prey on perches rather than in flight. *P. auritus* have an average lifespan of 4-5 years, weighing between 6 and 12g. They measure about 3.7-5.2cm in length (Sussex Wildlife Trust, 2019; Bat Trust UK, 2010). Holes in trees and old buildings are favoured for roost sites, feeding along hedgerows, gardens, parks and woodlands. As with other species of bats, females form maternity colonies during Summer, raising a single pup per pair (Sussex Wildlife Trust, 2019). Knockhatch's mixture of

habitats provides substantial support for the population of this species and could further aid in conservation efforts for future management of *P. auritus*.**Results**

A Total of Ten potential Bat species have been identified in and around Knockhatch Adventure park, it should be Noted that species presence is suggested not confirmed as is expected with this form of surveying. The Species Suggested to be Present are The Common Pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), Nathusius' pipistrelle (*Pipistrellus nathusii*), Daubenton's bat (*Myotis daubentonii*) ,whiskered myotis (*Myotis mystacinus*),
Common Noctule (Nyctalus noctula), lesser noctule or Leisler's bat (*Nyctalus leisleri*), Brown long-eared bat or common long-eared bat (*Plecotus auritus*), Western Barbastelle (*Barbastella barbastellus*) and the common serotine bat (*Eptesicus serotinus*).

Fig 4

As can be seen in fig four the *pipistrellus* Genus is heavily represented within the



sample area, which combined had an occurrence of 78%

Fig 5

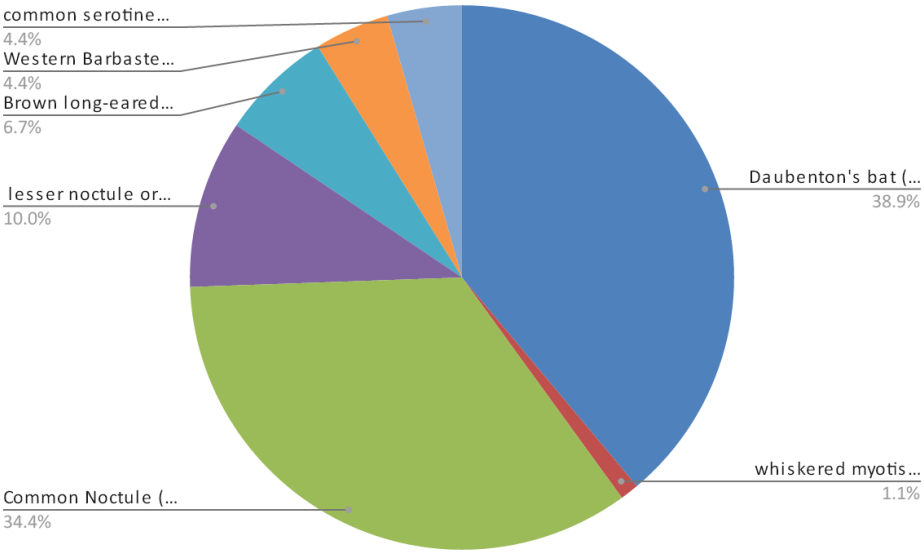


Fig Five, depicts the number of Bats recorded, with the *pipistrellus* genus excluded, this allows for a more accurate representation of the species that were recorded, this is due to the vastly higher numbers of *pipistrellus* in the data set, relative to the other species. As this chart demonstrates *M. daubentonii* was the most prolific species outside of the *pipistrellus genus*, this may be due to their preference for feeding over water and the sampling area's close proximity to water. The same is true for *N. noctula*, these widely distributed Bats favor woodland fringe, wetlands and over bodies of water such as lakes and rivers this makes site B an ideal habitat for them. *N. leisleri*, the third most prominent species, found exclusively in site C this species appears to have fed in and around the wooded border of the site, this is so be expected as they favor wooded and grazing land. *P. auritus* was the fourth most recorded species, unlike the first two *P. auritus's* presence was higher in sample sites A and C Rather than B, this could be due to *P. auritus* favoring the edges of woodland and hedgerows, both of these Habitats feature heavily in sites A and C. The fifth most recorded Bat species was *B. barbastellus*, this species was recorded in sites B and C, although in site B they appear stay within the fringe of trees that surrounds the site rather than over the lake, this in in keeping with *B. barbastellus's* habitat preferences. *E. serotinus*

tied with *B. barbastellus* in regard to how Frequently it was recorded during the study, like *B. barbastellus*, *E. serotinus* favor woodland and pasture when hunting, this may explain why they only feature in site C. *M. mystacinus* was the lowest recorded species found only over site C, this is in keeping with the habitat preferences of *M. mystacinus* which are known to favor woodland edge and meadow habitats.

Conclusion

The impact of the conservation garden on bat populations around Knockhatch is difficult to ascertain due to the longevity of the study. However, the early results suggest up to ten species of Bat foraging in the three sites highlighted in the study. This may provide an opportunity for further study and examination into the habitat preferences and conservation of these Bats. Future study will continue to assess the population of these species in the sample sites and identify a trend.

Conservation project 2020-2022

Introduction

The basis of this year's conservation project would be to follow on from the Bat population data collected in 2019, this will entail collecting further population data and assessing changes in population and diversity, furthermore, establishing population changes in the three sample sites. Secondly preparing the conservation garden and other sample sites with an aim to increasing overall biodiversity.

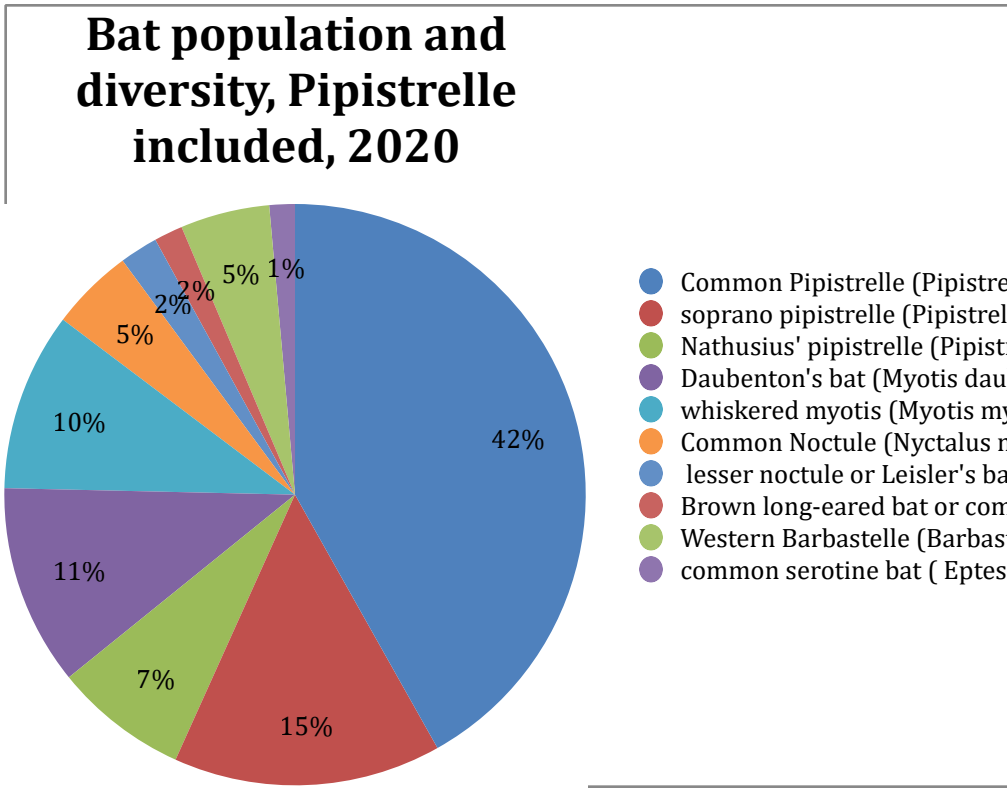
Method

Throughout 2020- 2021 progress has been made to develop the ecological health of the sample sites with regard to targeting Invertebrates with a focus was on pollinators and invertebrates that inhabit bodies of water, while this covers a broad range of species the objectives are manageable. Wildflowers were deemed essential in any project with the intention of benefiting invertebrates in particular pollinators, this is due to the fundamental role wildflowers play in the lives of many inverts as a source of food, shelter and a place to breed (Haaland et.al. 2011), Studies have suggested that the presence of wildflower meadows, even those Confined to narrow strips boarding cultivated land are suggested to significantly increase the Population and diversity of insects in the areas studies (Haaland et.al. 2011l; Haslet, 2007). On this basis areas of land were cleared in the conservation garden, the soil was prepped, and a variety of wildflower species were planted, care was taken to ensure that those wildflowers that were planted would provide the greatest benefit to the ecological health of the sample site for example Corn flowers, Poppies Foxglove, lavender. Due to the importance of bodies of water to many insects, it was essential to ensure that the wildlife pond was planted with wildflowers conducive to pollinators and other insects. Bodies of water whether these be Ponds, streams, lakes, rivers ect. play an intrinsic role in the life cycles of many insects in particular when it comes to breeding, insects such as Mayflies

(*Ephemeroptera*), Midges (*C. impunctatus)*, Mosquitoes (*Culicidae*) and other *Diptera*, these species are preyed upon by a wide variety of native animals including insects amphibians and the majority of UK bats (Swift et.al. 1985), all of the species listed above have been seen to be present in and around the wildlife pond as well as damselflies, Dragonflies, greater and lesser water boatmen, and a variety of nymph species.

Summery 2020

The data presented in fig six indicates the predominance of the *Pipistrellus* Genus on the data set with 42% of all recordings suggested to be attributed to *P. Pipistrellus,* in addition to 15% and 7% respectively for *P. pygmaeus* and *P. nathusii*, This predominance is unsurprising, as the data collected in 2019 indicated this trend. However compared to 2019 both *P. Pipistrellus and P. pygmaeushas* have seen a decrease of 17% and 1% respectively, contrastingly *P. nathusii* was increased by 4 % . A notable change from 2019 is the marked increase of the *Myotis* genus; *M. daubentonii* saw a 3% increase and *M. mystacinus* increased by 10%. The numbers of *N. noctula* saw a decrease of 3% from 2019; *N. leisleri* frequency was unchanged from 2019 as *was P. auratus and E. serotinus*. *B. barbastellus* saw an increase of 4% from the 2019.

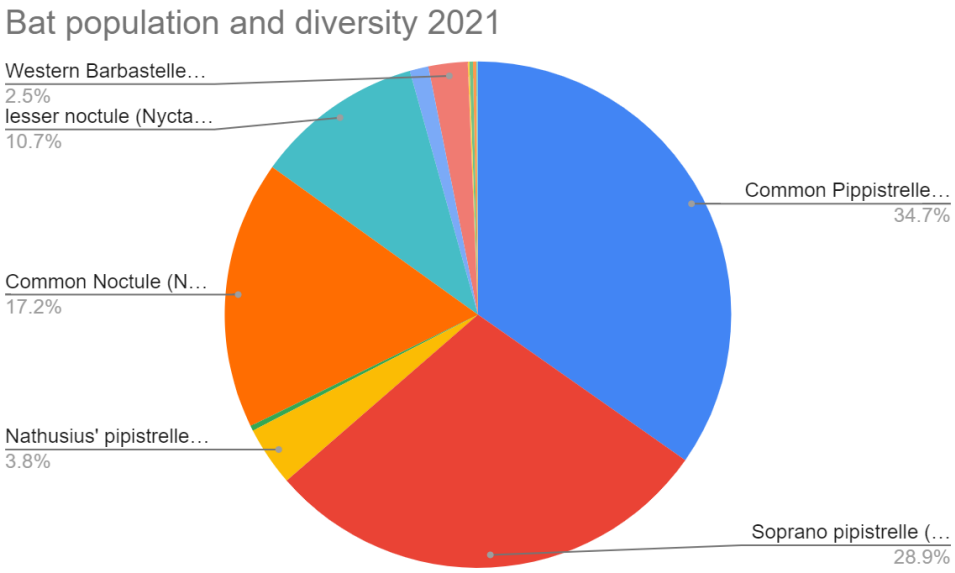


Conclusion

The data collected in 2020 suggests an interesting change in diversity when contrasted with the data collected in 2019, notable increases in the recorded frequency of *P. nathusii*, *M.* daubentoniid, M*. mystacinus* and *B. barbastellus* may indicate that the overall diversity of bat species are increasing, this may be due to the efforts made to increase insect population and diversity at Knockhatch. However, a myriad of other variables may have had an impact such as weather, lunar cycle, and temperature. Another variable that may have affected the results was the dramatic drop in visitor presence at sample sites A and B, due to the COVID pandemic and subsequent lockdown. The change seen in in Bat diversity across the three sample sites is encouraging, as previously stated there are a number of limiting factors that make it difficult to accurately determine whether the changes made to increase insect population had an effect on the bat population and diversity. Further data collection and analysis over the coming years should provide a more accurate picture of the changes in the population and diversity of Bat species around the three sample sites.

Summary of data collected in 2021.

The data indicated in fig 7 suggests a similar trend to that of 2019 and 2020, with regard to the Pipistrelle genus, *P. pipistrellus* is still predominant featuring in 34.7% of the data set, however *P. pipistrellus* has witnessed a continued decline of 7.3% from 2020 and 24% from 2019. *Pipistrellus pygmaeus* also featured heavily in the data sets with a presence of 28.9% this is an increase of 14.8% from 2020. *P. nathusii* saw a decrease of 3.2% from 2020. *N. noctula* increased by 12.4% from 2020. *N. leisleri* increased by 5.7% from 2020 and 8.7% from 2019. *B. barbastellus* decreased by 2.5% from 2020. *P. auritus* decreased by 1% from 2020. *E. serotinus* was unchanged from 2020. *M. nattereri*, *M. bechsteinii* and *R. ferrumequinum* all occurred for the first time in the data set in 2021, each had an occurrence of 1%.



Conclusion

The Data collected in 2021 suggests that there have been changes to Bat diversity since 2019 and 2020. One notable change is the gradual decline in prominence of P. *Pipistrellus* from 59% in 2019 to 34% in 2021, while this change could be due to a myriad of variables, it could be suggested that this decline is precipitated by the emergence of other less common species which would be an encouraging result. However, this result can not be confirmed due to the small sample size and the relatively short longevity of the study. Another change that was somewhat anomalous was the decline of *M. daubentonii*, no recordings of *M. daubentonii* were collected during sampling, it is difficult to attribute this decline to any particular factor, however greater efforts were made during the data collection to move around the sample sites to ensure an even spread of data was collected from the various habitats in the sample sites. Be this at it may sample sites A and B are occupied by bodies of water which is *M. daubentonii's* preferred hunting grounds. The new method of moving around the sample sites while sampling may suggest why *N. noctula* experienced an increase of 12.4%, this is due to each of the sample sites with the possible exclusion of sample site A, being bordered by woodland, this is the preferred hunting ground for *N. noctula* and the increase of *N. leisleri*.

The appearance of *M. nattereri*, *M. bechsteinii* and *R. ferrumequinum*, is another encouraging development seen in 2021, the reason for this cannot be confirmed as it could be due to any number of variables such as lunar cycle, temperature, weather, or the lack of visitor presence due to the COVID pandemic. Another possible explanation for could be misidentification by the bat detector, however, both *M. nattereri* and *M. bechsteinii* were identified twice on the detector and in the case of *M. nattereri* this occurred over two separate days. To enable confirmation of the reasons behind these changes to the data set, further data collection should take place and

within this data collection, variables such as lunar cycle, temperature, weather should be recorded. With regard to data collection, to assess whether variables namely weather, lunar cycle and temperature do have an impact on the presence of specific species, these variables will be recorded on future data collection trips.

Plans for 2022

The plans for 2022 encompass a broad range of objectives. The intention for the project is to create Oasis's in the respective sample sites to encourage population growth and greater diversity in these areas. Each of the sites were designed to achieve is outcome. In 2022 the focus of this project will be on Insects and Amphibians. The reason for this focus is due to both Insects and Amphibians being indicator species, it could be suggested that the increased population and diversity of key Insect and amphibian species indicate that the re-wilding efforts of the project are succeeding, however The due to lack of sampling of these key species prior to the start of this project basing the success or failure of the re-Wilding effort on the presence of these species would be unlikely to provide an accurate assessment of the ecological health of the sample sites, for the first couple of years. It is for this reason insect and Amphibian population sampling should begin in 2022.

References

Arlettaz, Raphaël; Godat, Saskia; Meyer, Harry (2000). "Competition for food by expanding pipistrelle bat populations (Pipistrellus pipistrellus) might contribute to the decline of lesser horseshoe bats (Rhinolophus hipposideros)". Biological Conservation.

Benda, P., Coroiu, I. &Paunović, M. 2016. Pipistrellus pygmaeus . The IUCN Red List of Threatened Species 2016: e.T136649A21990234. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T136649A21990234.en. Downloaded on 17 January 2020.

Coroiu, I. 2016. Myotis mystacinus . The IUCN Red List of Threatened Species 2016: e.T14134A22052250. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T14134A22052250.en. Downloaded on 17 January 2020.

Davidson-Watts, I; Jones, G (2005). "Differences in foraging behaviour between Pipistrellus pipistrellus (Schreber, 1774) and Pipistrellus pygmaeus (Leach, 1825)". Journal of Zoology. 268: 55–62.

HAALAND, C., NAISBIT, R.E. and BERSIER, L.–F. (2011), Sown wildflower strips for insect conservation: a review. Insect Conservation and Diversity, 4: 60-80. https://doi.org/10.1111/j.1752-4598.2010.00098.x

Harrje, C. 1994. Fledermaus-Massenwinterquartier in der LevensauerKanalhochbrückebei Kiel. Nyctalus 5: 274-276.

Haslett, J.R. (2007) *European Strategy for the Conservation of Invertebrates*. Council of Europe Publishing, Strasbourg, France.

Hutson, A.M., Aulagnier, S. &Spitzenberger, F. 2010. Barbastella barbastellus . The IUCN Red List of Threatened Species 2010: e.T2553A9452972. Downloaded on 17 January 2020.

Hutson, A.M., Spitzenberger, F., Aulagnier, S., Coroiu, I., Karataş, A., Juste, J., Paunovic, M., Palmeirim, J. & Benda, P. 2008. Pipistrellus pipistrellus . The IUCN Red List of Threatened Species 2008: e.T17317A6968203. https://dx.doi.org/10.2305/IUCN.UK.2008.RLTS.T17317A6968203.en. Downloaded on 17 January 2020.

Lei, M. and Dong, D., 2016. Phylogenomic analyses of bat subordinal relationships based on transcriptome data. Scientific reports, 6, p.27726.

Lundy, M., Montgomery, I. and Russ, J., 2010. Climate change–linked range expansion of Nathusius' pipistrelle bat, Pipistrellus nathusii (Keyserling & Blasius, 1839). Journal of Biogeography, 37(12), pp.2232-2242.

Masing, M. 2006. Sound diagnostics in the genus Pipistrellus (Chiroptera, Vespertilionidae) in northern Europe and the finds of Pipistrellus pygmaeus in Estonia. Year-book of the Estonian Naturalists´ Society 84: 185-206

Nowak, R.M. 1994. Walker's bats of the world. John Hopkins University Press, Baltimore, MD.
Poel, W.H.V.D., Lina, P.H. and Kramps, J.A., 2006. Public health awareness of emerging zoonotic viruses of bats: a European perspective. Vector-Borne & Zoonotic Diseases, 6(4), pp.315-324.

Paunović, M. &Juste, J. 2016. Pipistrellus nathusii . The IUCN Red List of Threatened Species 2016: e.T17316A22132621. https://dx.doi.org/10.2305/IUCN.UK.2016-2.RLTS.T17316A22132621.en. Downloaded on 17 January 2020.

Rachwald, A., Bradford, T., Borowski, Z. and Racey, P.A., 2016. Habitat preferences of soprano pipistrelle Pipistrellus pygmaeus (Leach, 1825) and common pipistrelle Pipistrellus pipistrellus (Schreber, 1774) in two different woodlands in North East Scotland. Zoological Studies, 55(2016).

Sachteleben, Jens; von Helversen, Otto (2006)."Songflightbehaviour and mating system of the pipistrelle bat (Pipistrellus pipistrellus) in an urban habitat" (PDF). Acta Chiropterologica. 8 (2): 391.

Swift, S. M; Racey, P. A; Avery, M. I (1985). "Feeding Ecology of Pipistrellus pipistrellus (Chiroptera: Vespertilionidae) During Pregnancy and Lactation. II. Diet". The Journal of Animal Ecology. 54 (1): 217–225. doi:10.2307/4632. JSTOR 4632.

Vesterinen, E.J., Ruokolainen, L., Wahlberg, N., Peña, C., Roslin, T., Laine, V.N., Vasko, V., Sääksjärvi, I.E., Norrdahl, K. and Lilley, T.M., 2016. What you need is what you eat? Prey selection by the bat Myotis daubentonii. Molecular Ecology, 25(7), pp.1581-1594.

Barlow, Kate E (1997). "The diets of two phonic types of the bat Pipistrellus pipistrellus in Britain".Journal of Zoology. 243 (3): 597–609.