Dartmoor Zoo Bioplan

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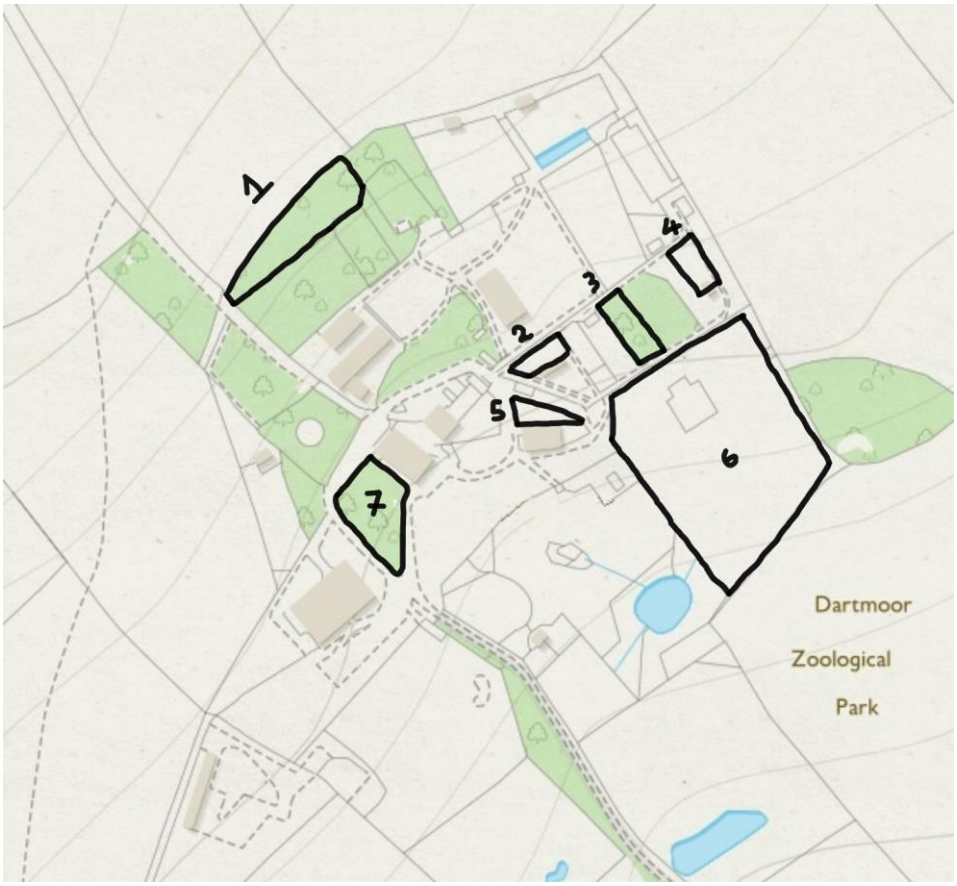
Invertebrate Bioplan



Park map with highlighted sample areas

Introduction

Around the Dartmoor Zoo site there are many areas which have been left undisturbed with little to no input from zoo staff. This has led to many areas having a great deal of biodiversity within them, as well as having some areas with a lack of pre existing diversity. Prior to the production of this bio plan the diversity was tested in each of the highlighted areas on the map above. This section will outline the problems and lack of problems in some areas and will hopefully suggest solutions and measures to put in place to protect and encourage biodiversity. The hope is that this information will help improve the diversity of invertebrates and with it increase the overall diversity around the park, as invertebrates can be considered a key species to the regulation of most ecosystems.

Issues

Across the park there are varying levels of diversity in the areas which have been left untouched, with some areas housing species that are not found elsewhere in the park. For example, out of all the 2,443 individuals identified only one Violet Ground Beetle (*Carabus violaceus*) and only one Chrysolina Bankii (ground beetle) were captured in area 5. However, some areas are very much lacking in diversity and were dominated by one group of invertebrates, for example area 3 was heavily dominated by species of ground beetle (Carabidae). It is an obvious assumption to make that soon the zoo will be planning new developments and will be both adding to and improving the site. This raises many issues for the local diversity of invertebrates as much of this development will be on areas they rely on. Any new developments could cause high levels of disturbance and could have negative consequences for local ecosystems.

Conservation Objectives

- Increase and promote the diversity of terrestrial invertebrates across the park, especially in areas which lack in diversity.
- Increase the habitat availability to terrestrial invertebrates across the site.
- Reduce the impact of development and disturbance on local invertebrate populations.

Current Measures

At present there are very few measures (I am aware of) put in place to increase and protect the native diversity. However one of the main steps the zoo takes to conserve invertebrate diversity is to simply leave areas untouched and aim to reduce the amount of disturbance to certain areas. Some areas are even planted on to attract more biodiversity to the park. These are good steps forward to take in reducing the impact of zoo activity, however it will take further steps to increase the level of biodiversity.

Proposed Measures

All around the park there are areas with little input from staff, such as area 6 on the map above. This was an old wolf enclosure and has since been left with little disturbance, this is made apparent by it having the highest biodiversity of all the tested areas. However if there is planned development in the future this diversity should be considered, with this and many other areas. Therefore, I suggest that if new developments are planned e.g., new enclosures, there should be strict considerations and measures taken to leave as much area as possible undisturbed. This could involve leaving the areas that border or areas within enclosures as undisturbed as possible or avoiding building on certain areas.

As mentioned before there are some areas across the park such as area 3 on the map, which have low biodiversity compared to other areas. This will require measures that aim to increase and attract more diversity into the park. One measure is by creating areas for invertebrates to shelter and hibernate. Many species of invertebrate, such as beetles, live in damp areas, such as inside dead logs or under leaves. Creating these hibernation spaces could involve laying down piles of logs or having pallets with material such as logs, straw, pinecones etc, between them. This will attract and encourage more invertebrates into the area as there will be more habitat for them to live in.

https://www.sherborne-international.org/wp-content/uploads/2018/03/Bug-Hotel-Biology.jpg

Another measure to take to attract inverts is by creating more habitat. This can be by planting more wildflowers or by allowing more areas to remain undisturbed. A multitude of wildflowers could be planted in areas, such as area 3, to attract more invertebrates, such as pollinators. The increase in these as well as other invertebrates could help to increase the populations of other organisms in the food chain.
One of the main values that the zoo upholds is education and that can act as another measure to increase and protect biodiversity. If areas of high or low diversity are sign posted this can act as a two birds one stone situation. Signage could be set up to highlight the different diversity of inverts present, which will not only educate the public but will also make them more aware of conservation issues and could lead to them being more wary of disturbing wildlife. Consequently this not only helps protect diversity but also promotes conservation of native biodiversity to the public, which is one of the zoos core values.

Species list
Below is a list of the species found across the park, but this is not intended to be a static list and should not be seen as a complete list. This shows the taxa found in two studies taken across the park. In the future more surveys would need to be done to get a more accurate and a more complete list of the species found across the park. The table shows data from studies undertaken by Seb Crichton and Hollie Campbell with; common names, latin names and family names.

Species Latin Name	**Common name**	**Family**
Carabus violaceus	Violet ground beetle	Carabidae
N/A	Ground Beetle	Carabidae
N/A	Ground Beetle	Carabidae
Pterostichus madidus	Black clock beetle	Carabidae
Pterostichus niger	Ground beetle	Carabidae
Pterostiuchus aethiops	Ground beetle	Carabidae
Pterostichus vernalis	Ground beetle	Carabidae
Cychrus caraboides	Snail Hunter beetle	Carabidae
Calathus melanocephalus	Ground beetle	Carabidae
Poecilus cupreus	Ground beetle	Carabidae
Poecilus versicolor	Ground beetle	Carabidae
Bembidion quadrimaculatum	Ground beetle	Carabidae
leistus fulvibarbis	Ground beetle	Carabidae
Notiophilus biguttatus	Ground beetle	Carabidae
Philonthus fimetarius	Rove Beetle	Staphylinidae
Tachinus rufipes	Rove Beetle	Staphylinidae
Ocypus olens	Devils Coach Horse	Staphylinidae
Volinus sticticus	Scarab beetle	Scarabaeidae

Chrysolina Bankii	Leaf beetle	Chrysomelidae
Tribolium castaneum	Red flower beetle	Tenebrionidae
Meloe violaceus	Violet oil beetle	Meloidae
Meloe proscarabaeus	Black oil beetle	Meloidae
Pyrochroa serraticornis	Red headed cardinal beetle	Pyrochroidae
Coccinella septempunctata	Seven spot ladybird	Coccinellidae
Adalia bipunctata	Two spot ladybird	Coccinellidae
Harmonia axyridis	Harlequin ladybird	Coccinellidae
Tachypodoiulus niger	White-legged snake millipede	Julidae
Ommatoiulus sabulosus	Striped Millipede	Julidae
N/A	Flat back millipede	Polydesmidae
N/A	Centipedes	Lymantriidae
Lithobius variegatus	Banded Centipede	Lithobiidae
N/A	Harvestmen	Phalangiidae
N/A	Orb Web Spider	Araneidae
Araneus diadematus	European garden spider	Araneidae
Araniella cucurbitina	Cucumber green spider	Araneidae
Eratigena duellica	Giant house spider	Agelenidae
Amaurobius ferox	Black lace weaver	Amaurobiidae
Steatoda grossa	False black widow	Theridiidae
Philodromus dispar	N/A	Philodromidae
N/A	Cobweb or funnel spiders	Agelenidae
N/A	Wolf spiders	Lycosidae
N/A	Spider mite	Tetranychidae
N/A	Woodlice	Porcellionidae
N/A	Pill millipedes	Glomeridae
Arcitalitrus dorrieni	Land hopper	Talitridae
N/A	Earthworm	Lumbricidae
N/A	Ant	Formicidae
N/A	Snail	Helicidae
Cornu aspersum	Garden snail	Helicidae
Cepaea nemoralis	Grove snail	Helicidae
Oxychilus draparnaudi	Draparnaud's glass snail	Oxychilidae

Trochulus striolatus	Strawberry snail	Hygromiidae
N/A	Pond snail	Lymnaeidae
Balea sarsii	N/A	Clausilioidae
N/A	Flies	Diptera
N/A	Leafhoppers	Cicadellidae
N/A	slug	Limacidae
Limax maximus	Leopard slug	Limacidae
Arion ater	Black slug	Arionidae
Arion circumscriptus	Brown-banded arion	Arionidae
Arion distinctus	N/A	Arionidae
N/A	Clover mite	Trombidiformes
Volucella pellucens	Pellucid fly	Syrphidae
Ixodes scapularis	Deer tick	Ixodidae
Oniscus asellus	Common shiny woodlouse	Oniscidae
Philoscia muscorum	Common striped woodlouse	Philosciidae
Trichoniscus pusillus	Common pygmy woodlouse	Trichoniscidae
Forficula auricularia	Common earwig	Forficulidae
Forficula lesnei	Lesnes earwig	Forficulidae
Pentatoma rufipes	Red-legged shield bug	Pentatomidae
Palomena prasina	Green shield bug	Pentatomidae
Eucallipterus tiliae	Lime-tree aphid	Aphididae
Vespula vulgaris	Common wasp	Vespidae
Vespa crabro	European hornet	Vespidae

References

Gerlach, J., Samways, M. and Pryke, J. (2013). Terrestrial invertebrates as bioindicators: an overview of available taxonomic groups. *Journal of Insect Conservation*, 17(4), pp.831-850.

Wang, Y., Cadotte, M., Chen, Y., Fraser, L., Zhang, Y., Huang, F., Luo, S., Shi, N. and Loreau, M. (2019). Global evidence of positive biodiversity effects on spatial ecosystem stability in natural grasslands. *Nature Communications*, 10(1).

Pollinator bioplan

Introduction

In recent years it has become more prominent in literature that the conservation and increase in species of bees as well as other pollinators is becoming of higher importance. This is not only because of their threatened existence but also because of their value to humans. Pollinating species such as bees and butterflies which are found across the UK, play a vital role in the regulation and upkeep of local ecosystems through the pollination of plant species. Dartmoor aims to have not only a variety of exotic animals but also aims to have a diversity of local plants and wildlife. This section will outline the measures which will help the zoo not only conserve the local diversity of pollinators but will also help to increase their diversity. If Dartmoor Zoo is to uphold the image of being conservation and education driven it must not only protect the exotic wildlife which people come to see but should also protect the wildlife which they do not see but surrounds them every day.

Issues

After looking into data it is clear that dartmoor does have the presents of some bee species and other pollinators such as butterflies, however the diversity could be much higher across the zoo site. A study undertaken by Hollie Campbell over a month period only recorded 4 different species of bee and bumblebee. There were also only 5 different species of butterfly recorded across the zoo site in a similar study also done by Hollie Campbell. This can not only be detrimental to the local populations of these species but can also have negative effects on the local flora species. Pollinators are key species in ecosystems and for an organisation such as Dartmoor Zoo, it is vital to have these species present to help keep the local habitats stable.

Conservation Objectives

- Increase the number and diversity of local pollinator species e.g. bumblebees, honey bees, butterflies etc
- Increase the availability of food and shelter for pollinator species
- Educate the public about issues surrounding pollinators

Current Measures

The zoo does already have a herb garden which is useful for attracting pollinators such as bees which are fond of most herb plants. In recent months there has also been talks and applications for making a honey beehive on the zoo site through the company Pollenize. The aim for this is to not only increase the presence of honey bees on the site but to also use it as a valuable tool for education. The hopes are to train people to care for the bees and to maintain the hive with little outside input other than monitoring. Having a hive on the zoo site could be particularly useful for future research projects done on the site regarding this species.

Proposed Measures

As mentioned in other sections of this document there are areas around the zoo with little input from staff and with little disturbance. This means that these areas could be useful for promoting more habitat and food sources for local pollinator species. One way of doing this is by planting a variety of flowering plants which will attract pollinating species to the zoo site. Pollinators rely on pollen and

nectar for food and indirectly pollinate local flowers when searching for food. The aim would be to have a mixture of plants which flower at various times of year as well as staggering the planting period. This is in the hopes that local species will have flowers to feed for the whole year round. This would not only increase the presence of pollinators but would also increase the diversity of flora across the site. Consequently indirectly benefiting other species which also rely on plants. Below are some examples of plants which could be paired together and planted around the site to provide pollen and nectar sources.

Plant species	**Flowering period**
Lavender	June and July (summer)
Viper's bugloss	May to September (spring + summer)
Mahonia	November to February (winter)
Pussy willow	February to June (winter +spring)

Plants are also important to butterflies in other ways, for example when butterflies emerge from their chrysalis during spring they require sunlight to warm up their wings. Therefore, you often find butterflies sitting on plants opening and closing their wings slowly. Therefore a way to aid this is to ensure that any plants invested in on the site are planted in areas across the site which get a lot of sun exposure.

Another important way to help bees is providing a safe space to hibernate during winter. Most bee species queens hibernate during winter periods before building a nest during spring and summer. However due to rise in human populations the areas for bees to safely hibernate are rapidly decreasing, so providing this is important. One popular way to do this is by creating a small "house" for them. This can involve using bamboo or other tubular objects attached together to give small spaces for bees to take refuge. This can not only act as a safe place for bees but can also act as a home for other insect species.

https://gardening4kids.com.au/product/bee-and-insect-hotel/

The conservation of pollinator species can also be beneficial for education regarding their behaviour and ecology. Organisations like Dartmoor Zoo hold conservation and education as some of their core values so having an area which could benefit this would be a step further towards better the education of the younger generation for a better future. Signs could be implemented around the site highlighting the benefits and roles played by the different plants and structures present. They could also be used to highlight the vital role bees and other pollinators play in the maintenance of the natural environment.

Species List

Below is a list of the species found across the park, but this is not intended to be a static list and should not be seen as a complete list. This shows the taxa found in a study done across the park. In the future more surveys would need to be done to get a more accurate and a more complete list of the species found across the park. The table shows data from a study undertaken by Hollie Campbell with; common names, latin names and family names.

Latin name	**Common name**	**Family name**
Bombus hypnorum	Tree Bumblebee	Apidae
Bombus terrestris	Buff-tailed Bumblebee	Apidae
Apis	Honey Bee	Apidae
Bombus pascuorum	Common Carder	Apidae
Pieris rapae	Small White	Pieridae
Pieris brassicae	Large White	Pieridae
Pararge aegeria	Speckled Wood	Nymphalidae
Maniola jurtina	Meadow Brown	Nymphalidae
Lycaena phlaeas	Small Copper	Lycaenidae

Mammal Bioplan

Introduction

Mammals play an important and large part in most ecosystems as both predators and prey. The presence of mammals in any food chain is important as it will help with the regulation of most other species in other trophic levels. Mammals make up a substantial portion of the secondary and primary predators found within a food chain and therefore are important in the control of populations of all species. This consequently means that the stability of mammal populations should be maintained to regulate and control the populations of other species, especially those that could be considered pests. This section aims to outline the best methods to promote and even possibly increase the numbers of native mammal species.

Issues

As with most native species around the zoo, the key issues that faces mammals on the site is habitat and food availability. As the zoo expands and builds new enclosures and buildings, much of the habitat once occupied by native mammals is removed. This can cause a reduction in the populations of native mammals, which in turn can have a detrimental effect on populations of other species. This can mean some species' population are no longer regulated by mammal predators and consequently

their numbers can increase and they become pests. Mammals such as mice can become pests if their populations become too large.

Conservation Objectives

- Regulate and/or increase the size and stability of local mammal populations around the zoo site
- Increase the access to and the amount of available habitat for native mammal populations for safe refuge and hibernation
- Allow for better protection of local ecosystems which act as habitat for mammals

Current Measures

There are few measures in place around the zoo to help conserve native mammal species. One measure put in place currently is small pieces of refugia scattered around one area in the park which has been left untouched in recent years. These act as small areas of shelter for small mammals such as mice and voles to hibernate during winter or live during summer. Another current minor measure put in place is the prevention of any development on an area where badgers are known to live. Their sets are located at the bottom of an enclosure which has been left untouched in recent years. However there could be more measures put into place across the zoo.

Proposed Measures

One of the main measures that could be proposed, as with most other native taxa, would be the better planning and consideration for local mammals when developing on the zoo site in the future. For example where there are known populations around the site, more consideration for maintaining these areas should be upheld when developing. This could involve leaving patches and corridors of native vegetation to aid the movement and living spaces available for local mammals. This protection of local mammal habitat would not only support the living space for them but would help increase their food sources. A further measure which could be put in place would be to increase the refugia available to local mammals. Refugia could simply be pieces of scrap metal, wood or other material placed around the zoo site which would allow for more hiding places and hibernation areas for local mammals. This would help increase the mammal populations and therefore help to regulate the numbers of other species in local food chains.

Species List

Below is a list of the species found across the park, but this is not intended to be a static list and should not be seen as a complete list. This shows the taxa found in a study taken across the park. In the future more surveys would need to be done to get a more accurate and a more complete list of the species found across the park. The table shows data from a study undertaken by Hollie Campbell with; common names and latin names.

Common Name	**Species Scientific Name**
Field vole	*Microtus agrestis*
Common shrew	*Sorex araneus*
Eastern grey squirrel	*Sciurus carolinensis*
European rabbit	*Oryctolagus cuniculus*
European badger	*Oryctolagus cuniculus*
Red fox	*Vulpes vulpes*
Common pipistrelle	*Pipistrellus pipistrellus*
Daubenton's bat	*Myotis daubentonii*
Soprano pipistrelle	*Pipistrellus pygmaeus*
Brown long−eared bat	*Plecotus auritus*

Serotine bat	*Eptesicus serotinus*

Reptile and amphibian bioplan

Introduction

Due to the weather conditions which occur on Dartmoor zoo, many species of reptile and amphibian can be found around the site. Reptiles and amphibians make up only a small portion of the native species found on Dartmoor and in the UK and for this reason many of these species are sensitive to change. Reptiles and amphibians, due to their physiology, are sensitive to most changes in their environment. This consequently means that any changes to the park and its local ecosystem can have drastic impacts on the populations of reptiles and amphibians. Therefore it is important to invest in measures to help protect and promote these species as they play an important part in most food webs.

Issues

As mentioned in the previous section, reptiles and amphibians as species can be sensitive to changes in their environment. Especially species such as newts, which require a specific set of conditions to properly inhabit an area. Therefore one of the major problems faced by these taxa and relevant to the zoo, is the removal and disturbance of the local environment. As with most other taxonomic groups, reptiles and amphibians are heavily affected when the zoo develops on its site, building on and removing local habitats. Some species can also be affected by chemical changes to their environments,for example all amphibians spend some part of their life cycle in water. If any local water systems such as streams and ponds become polluted due to the zoos activities, this can mean they are no longer suitable for these species.

Current Measures

There are many water bodies scattered around the zoo site, but very few of them have measures put in place to look after them and keep them habitable. Many areas are left undisturbed by keepers and other staff which means many areas are suitable for reptiles and amphibians to inhabit. Reptiles are cold blooded which means during sunny periods they will bask to heat up their bodies. In one area of the park left untouched in recent years, pieces of refugia have been left to not only allow reptiles to bask on and underneath but to also allow both amphibians and reptiles to hide under.

Proposed Measures

As stated, most amphibians require a clean water system to thrive. One measure to help support amphibian populations in the future would be to test the local water systems compositions, for example oxygen and CO_2 levels and other physico chemical elements of a water body. This will give a good indication of the health of any local water bodies and therefore whether they are suitable for amphibians. Once an assessment like this is done it will allow for other measures to be put in place which could help clean water systems, such as the prevention of runoff from the zoo site. Another measure would be to increase basking and hiding/hibernating places across the site. There are places left untouched around the zoo and these would be perfect to implement these refugia. This could involve placing rocks, logs, and other material to act as refugia for reptile and amphibian species, which would not only give them more habitat but prevent these taxa from hiding/hibernating where they can cause problems, such as under houses in enclosures of zoo animals.

Species List

Below is a list of the species found across the park, but this is not intended to be a static list and should not be seen as a complete list. This shows the taxa found in a study taken across the park. In the future more surveys would need to be done to get a more accurate and a more complete list of the

species found across the park. The table shows data from a study undertaken by Hollie Campbell with; common names and latin names.

Common Name	**Species Scientific Name**	**Reptile or Amphibian**
Common frog	*Rana temporaria*	Amphibian
Common toad	*Bufo bufo*	Amphibian
Smooth newt	*Lissotriton vulgaris*	Amphibian
Palmate newt	*Lissotriton helveticus*	Amphibian
Grass snake	*Natrix natrix*	Reptile
Slow worm	*Anguis fragilis*	Reptile