

Morgan Hughes, 30039123

Annotated bibliographies have been organized into groups of different topics and within each topic the articles have been organized by importance. This was completed to help organize ideas for the reader and make the topics of each article clear.

### **Effects that environments have on badger habitat selection**

Apps, C. D., Newhouse, N. J., & Kinley, T. A. (2002). Habitat associations of American badgers in southeastern British Columbia. *Canadian Journal of Zoology*, 80(7), 1228–1239.  
<https://doi.org/10.1139/z02-119>

Before this research, little was known about the different associations between badger habitat selection and landscape conditions. Previous research had been completed on badger habitats in open as well as shrub-steppe habitats but not many other types of landscape variables have been considered. The main behavior that is being described is habitat selection behaviors and what influences this in North American badgers.

The research question was to look at how different abiotic, biotic, and anthropogenic factors affect badger habitat selection and to develop a model of these relationships that can be utilized in conservational planning.

20 badgers were equipped surgically with tracking implants and their location was obtained each week from April through to September and once monthly from October to March. Data about the soil characteristics as well as vegetation/overstory type was also collected at each site. Varying statistical methods were then used such as univariate differences and multiple logistic regression to compare different factors.

Badgers were found to select habitats with glaciofluvial soil types with a fine sandy soil texture. They also preferred areas that were open and clear of large amounts of overstory plants as well as areas that were on a slope. This is likely due to ground squirrels being more likely to inhabit open areas and these soils allow for easy digging but also stable burrows.

This study was significant as previously there was little research into all the different factors that affect badger habitat selections. This research provided really good information about potential reasons that badgers select the areas that they do, and which areas are best to focus conservation efforts on when trying to help badger populations. These findings are important as they inform us that badgers are likely to select areas with appropriate soils and access to prey.

This article was chosen for my literature review as it provides information about badger habitat selection and some of the main drivers in their ecosystem choice. This article advanced

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

knowledge in the field as it provided specific soil types as well as areas that badgers are more likely to choose for burrow sites. Previously, it was mainly known that badgers choose open habitat types but there was not much information about specific factors that affect habitat selection. This study supported previous literature that had been done on habitat selection o regarding badgers increased chance of choosing open habitats.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Duquette, J. F., & Gehrt, S. D. (2014). Badger (*Taxidea taxus*) resource selection and spatial ecology in intensive agricultural landscapes. *The American Midland Naturalist*, 171(1), 116–127. <https://doi.org/10.1674/0003-0031-171.1.116>

Before this study, most of the research on badgers had been completed in one area that the literature refers to as the “core area” which is in the Western United States. There have been a few studies outside of this area that concluded badgers like well-draining soil and open habitats. Further research was required in areas outside of this core range specifically on how fragmented ecosystems affect habitat and resource selection in North American badgers. The behavior studied in this paper was habitat selection of badgers and different factors that can affect their selection such as land fragmentation, availability of prey, and soil types.

The author's objectives were to assess resource and habitat selection of badgers in areas mainly used for agricultural purposes to determine how different environmental factors and human disturbances affect the species.

Badgers were captured using snares placed outside of the burrows in Ohio and Illinois. The badgers were then sedated, transferred to a veterinary clinic, and then surgically implanted with radio tracking devices. Badgers were sexed, aged, weighed and their ears were tagged. After being released, Illinois badgers were tracked daily and Ohio badgers were tracked twice weekly to determine their location and which burrows they were utilizing.

Badgers in Illinois were found to select mainly for croplands and prairies as habitats whereas badgers in Ohio were found to mainly select pastures, upland forests, and roads. Pastures were likely selected because prairies were less abundant and pastures mimic prairies ecosystems. Badgers were also found to have higher home ranges than expected likely do fragmented ecosystems causing limits in habitat and food availability. These are highly significant findings as it provides a large amount of knowledge about space and resource use in badgers and how fragmented ecosystems affects their behavior.

This article advances knowledge in the field as it provides extensive knowledge about habitat selection in badgers in areas that have previously not been overly studied. This study also showed how badgers behave in largely fragmented ecosystems which previous research had not described. This article mostly supports previous findings as most research has found badgers prefer open habitats with soils that are easy to dig in. This article was included in the literature review because it provides many good potential reasons for why badgers select habitats the way that they do.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Doyle, J. C., Sample, D. W., Long, L., & Van Deelen, T. R. (2019). Space use and habitat selection of American badgers (*Taxidea taxus*) in southwestern Wisconsin. *The American Midland Naturalist*, 182(1), 63. <https://doi.org/10.1674/0003-0031-182.1.63>

American badgers are a poorly studied species and little information was previously known about their habitat selection. It was known that they are mainly associated with open habitats but have also been known to occur in other areas. Habitat preference was not highly studied previously, and further research needed to be conducted to truly understand American badger threats.

The authors wanted to estimate home range sizes as well as habitat selection of American badgers to assist in conservation efforts.

Authors found burrows, captured 20 badgers, and equipped them with tracking devices. Badgers were then tracked and data on movements were collected using radio telemetry. Minimum convex polygon R statistic package was used to quantify home range estimates and adehabitatHS in R was used to analyze habitat data.

Home ranges varied from 2.4km<sup>2</sup>-541km<sup>2</sup> in males and 1.6km<sup>2</sup>-65km<sup>2</sup> in females. Badgers selected for open habitat types with grassland or cropland being the most chosen for all badgers but one. Badgers were found to be able to exploit many different types of habitats, however, and were able to persist in more than just their preferred habitat types.

The values for home range size are significant because the home range sizes in this study were found to be larger or equal to previous studies that were completed. It is important to understand the home range of a species for conservation efforts, the ability to track the animal as well as determine if disturbances to normal patterns are occurring. The second finding about habitat selection is important as it helps to determine which ecosystems should be of focus when thinking about badger conservation efforts. The study found that conservation efforts should be focused on maintaining large, open habitats for the badgers to be able to utilize.

This article was chosen for my literature review because it provides a general description of habitat selection in badgers and provides some context for why they choose the habitats they do. This article advances knowledge in the field because although basic knowledge about badger habitat selection was known previously, there was little specific knowledge about preferred habitats. This article supports some previous studies regarding habitat range size but had larger values than other studies. Badgers were known to subsist in open habitats previously, but this article proved that they are the top choice for badgers.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Feore, S., & Montgomery, W. I. (1999). Habitat effects on the spatial ecology of the European badger (*Meles meles*). *Journal of Zoology*, 247(4), 537–549. <https://doi.org/10.1111/j.1469-7998.1999.tb01015.x>

Previous studies have been completed on how poor habitat conditions affect the social group size of badgers, the number of badgers in an area as well as their territory size. However, more data needs to be collected on this to determine how habitat quality can influence these factors of badger group living. The behavior that is being studied is how badgers change their group living and the size of their territories depending on the condition of the ecosystem they are living in.

The author's objectives for the study were to determine how different landscapes and ecosystems affect the number of setts<sup>1</sup>, group size, and the size of a badger group's territory.

Three different study sites were chosen for data collection after preliminary sett surveys had been completed. Once the three study sites were chosen, setts were classified on whether they were the main sett or an outlier sett as well as the density of setts in the study area. Habitat surveys were then completed at each location to determine habitat quality. To separate badger groups from one another as well as to quantify territory size, ingestible colored pellets were placed at the entrances of burrows, and then were located in the fecal matter of the badgers. Badgers were also trapped and assessed to quantify the number of badgers in each area.

It was found that the site that was the smallest in total area had the most burrows (44), and the site with the largest area has the least burrows (13). It was found that habitat composition influenced the location of badger burrows, their group sizes as well as their territorial area. These findings are significant because it demonstrates that habitat quality can affect badger habitat selection in many ways as well as other behaviors they exhibit.

These results correlate with previous studies as previous research had been completed that also showed that the type of habitat influences the spatial ecology of badgers. These results greatly contribute to the literature because it provides research for how habitat quality affects habitat selection in badgers through many factors. Although previous literature had been completed on the subject, this research included more factors affected by habitat quality than had been previously looked at. This article was included because it provides more insight into badger habitat selection and how habitat quality influences their choices.

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## The function and structure of different burrows

Symes, S. A., Klafki, R., Packham, R., & Larsen, K. W. (2019). Discriminating different-purpose burrows of the North American badger *Taxidea taxus*. *Wildlife Biology*, 2019(1), 1–9. <https://doi.org/10.2981/wlb.00528>

Previous research had been completed on the different characteristics and usage of badger burrows<sup>1</sup>. Research had also been completed on the different purposes of burrows. However, it is still unknown whether burrows that are utilized during different seasons have characteristics that differ between them. The research was required to see if burrows that are utilized during certain seasons have distinct characteristics that make the burrow better for that season. The behavior of interest is habitat selection and what factors may influence the specific burrow choice during specific seasons.

The author's main research objectives were to measure specific burrow characteristics and what these burrows were being used for in cold climates.

To collect data, 16 badgers were captured using traps and then sedated. Body condition measurements were then taken and trackers were surgically implanted. Burrows were then categorized as either summer, winter, or natal. Snow depth, temperatures, vegetation cover, topographic information as well as ecosystem type was also recorded. A linear mixed effect model was then used to statistical test whether the different burrow characteristics differed.

Winter and natal burrows were found to be in forests most frequently whereas summer burrows were found more in open habitats. Winter burrows were found to have increased canopy cover over them which is thought to provide insulation to the burrows. Natal burrows were determined to have increased horizontal cover which is thought to hide or conceal burrows from predators. Burrows used to raise offspring were also found to have more entrances which are believed to provide more opportunities to escape from predators. This suggests that badgers choose different areas and different habitats to place burrows during different seasons. These results are important as they provide suggestions for different factors that badgers look for when choosing which burrow to inhabit during specific seasons.

This article provides a lot of information about potential factors that affect badger habitat selection during different seasons and this is significant as it can be utilized in conservation efforts. This study correlates with previous research that there are different uses for certain burrows and therefore different characteristics but there is not much literature to compare the specific findings with. This article was included in my literature review because it provides insight into how habitat selection may change in badgers depending on the season.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Brøseth, H., Bevanger, K., & Knutsen, B. (1997). Function of multiple badger *Meles meles* setts: Distribution and utilisation. *Wildlife Biology*, 3(1), 89–96. <https://doi.org/10.2981/wlb.1997.011>

It was previously observed that badgers utilize many different setts<sup>1</sup> and that they form social groups within a specific territory. Setts can range in size, the number of openings it contains, and the purpose it holds. However, little was previously known on why badgers have multiple setts and the reason for the different distribution of setts within a territory. The behavior is described in this research is burrow use and selection by the European badger.

The main research question is why badgers use many different setts as their resting sites and how these different setts are distributed within a badger's territory.

The different badger setts were located utilizing tracks throughout March-April and then five female and five male European badgers were captured and implanted with location trackers. These badgers were then located throughout April-September to record which locations the badgers were sleeping in. A simulation test was then used to determine if the sett locations were random or not.

On average, most individuals observed utilized nine different burrows and during certain periods, the number of setts used differed between adults and young. Reproducing females were found to stay in the same setts at a much higher frequency than non-reproducing individuals. It was also found that setts that contained more entrances were utilized more often. The change in sett use may be to avoid ectoparasites and reproducing females are likely limited to one burrow due to the limited mobility of their cubs.

This research was significant as it determined the average number of setts that were utilized by individual badgers. It also discussed some potential reasons for why badgers use many different sets. The research also highlighted the importance of completing more research on sett use in badgers and why their habits are important to learn about.

This article was included in my literature review because it provides information about some reasons for badger habitat usage patterns and why badgers have multiple setts. This article advances knowledge in the field because before this, it was highly unknown why badgers constantly rotate the setts they are using. There is little previous research to compare to this paper but does correlate with a previous research project that showed reducing badger ectoparasitic loads decreased the amount of sett changing. Future research could be focused further on the reasons badgers select different setts on different days.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Roper, T. J. (1992). Badger *Meles meles* setts—architecture, internal environment, and function. *Mammal Review*, 22(1), 43–53. <https://doi.org/10.1111/j.1365-2907.1992.tb00118.x>

Before this literature review, research had been conducted on badger setts<sup>1</sup> to determine different structural elements of burrows. However, a literature review compiling all information regarding sett structure had not been completed. The research objectives of the literature review were to compile different studies that researched elements of the structure and environment of burrows. This review was conducted by compiling data about seven main setts and 12 outlier setts from 19 different pieces of literature.

Burrows were found to greatly vary in size and area but setts that were older were often found to be more complex in terms of the tunnel system. Most burrows contained at least one chamber and these chambers are most likely used for resting or raising young. Chambers were also found to sometimes contain bedding material or bones. Temperatures within a burrow were found to be similar to the average ambient temperatures for the area but much about the internal environment of a burrow is still unknown. Main setts were found to be larger and contain more chambers than outlier setts. It is believed that these larger setts may provide more constant internal conditions, increased predator avoidance, and decreased parasites.

New insights from this paper include that main setts are larger than outlier setts, the complexity of burrows often increases with age, and that burrows have many different potential contents. This review highlighted the need for further research regarding the internal environments of setts, how different setts are utilized as well as how the availability of setts affects a social group.

This review is significant as it provides some context for badger setts and some potential reasons for why badgers have different types of burrows. This paper also highlighted important characteristics about burrow structure which helps researchers better understand sett organization. This article was included in my review as it summarizes a lot of key information regarding badger setts. This review advanced knowledge in the field as it summarized previous literature and used this literature to create new conclusions.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Roper, T. J. (1992). The structure and function of badger setts. *Journal of Zoology*, 227(4), 691–694. <https://doi.org/10.1111/j.1469-7998.1992.tb04425.x>

Before this review, the literature discussing main and outlier setts<sup>1</sup> had not been compared to determine if there were similar conclusions about the subject. Research had been conducted on sett use and sett structure but needed to be compiled into one review. The overall research question of the review is the function that main setts and outlier setts serve for badgers. The review was conducted by reviewing the research hypothesis on sett use and differences between main and outlier setts.

It was discussed how main setts are often larger than the outliers which most likely means badgers create different sized setts for different purposes. It was also discussed how larger sets are often found in areas with easier to dig soil as well as how the size of a sett correlates with its age. Setts can be used as safety refuges when foraging, resting/sleeping spots, and breeding spots. The general pattern shows that the main sett is used for breeding/overwintering and outliers are used more in the summer. Larger setts might offer better environmental conditions, smaller chances of parasites, more entrances which means an easier chance of escape from predators and might allow individuals to better avoid antagonistic interactions with each other.

New insights from this paper include that badger outlier sett use may be related to social structures of the badger groups. The potential main reasons for larger sett creation were also discussed which include better environments, predator protection, ectoparasite prevention, and antagonistic interaction avoidance. The review highlighted the need for further research on whether societal structure impacts sett use, the reason for outlier sett use, why differences between individuals/group use of outlier setts exist, and finally the fluctuations of internal sett environment over time.

Setts are extremely important badger habitats and why they utilize different setts as well as have different sett functions are a very important research topic for better understanding badger behavior. Badger habitat cannot be fully understood without large knowledge about setts. Although this is not an extensive research subject, this review summarized previous important findings, suggested potential hypotheses and provided information about what still needs to be researched. This review article provides important background knowledge about badger habitats and the different behavioral reasons for badger sett selection.

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## Badger behaviors and interactions with other species

Symes, S. A., Klafki, R., Packham, R., & Larsen, K. W. (2020). Winter activity patterns of the North American badger (*Taxidea taxus*) at its northwestern periphery. *Journal of Mammalogy*, 101(1), 199–210. <https://doi.org/10.1093/jmammal/gyz171>

Some previous research studies have suggested that badgers reduce their activity during the winter but other experiments have observed badger's active outside of their setts<sup>1</sup> during the colder seasons. Further research was needed to determine badger winter behavior and the different adaptations they have for dealing with colder seasons. The specific behavior that is being explored is badger movement patterns.

The main research objectives of the experiment are to determine if North American badgers change their activity level during winter and if they exhibit torpor.

16 badgers were captured and surgically implanted with GPS trackers. During the summer, badgers were often located once per day whereas, in the winter, badgers were often located once per week. Cameras were also placed outside of burrows to watch whether badgers were leaving their burrows. It was then determined how long a burrow was used for and what type of burrow it was. Ambient temperatures were also recorded. The relationship between how often a badger left a burrow and the outside conditions was determined using a general linear mixed-effect model.

Daily movements were found to be decreased in the winter compared to the summer. The average number of burrows utilized by an individual badger during the winter was two. Body temperatures were also found to be decreased in some individuals suggesting that badgers may undergo torpor. These findings are significant as they suggest that populations of badgers in Northwest British Columbia are likely more active during the wintertime than populations of badgers farther south. It also suggests that badgers alter their behavior during the wintertime by decreasing their ranges and number of burrows they utilize.

This article advances knowledge in the field because it provides more information about the behavioral adaptations that badgers have to survive in harsh climates. Previous literature has also found similar activity levels in badgers in eastern areas but lower levels compared to these findings in southern populations. This review was included in my literature review because it provides some context for badger activity during winter and how their habitat selection may change by decreasing the number of setts they utilize.

<sup>1</sup> Setts, burrows and dens are words utilized interchangeably throughout this literature review that describe the underground habitat of a badger.

Andersen, M. L., Bennett, D. E., & Holbrook, J. D. (2021). Burrow webs: Clawing the surface of interactions with burrows excavated by American badgers. *Ecology and Evolution*, 11(17), 11559–11568. <https://doi.org/10.1002/ece3.7962>

Previously, a lot of research had been completed on species of woodpeckers and the relationship between their tree cavities and other species. Despite badgers being similar ecosystem engineers, little research had been completed on the connection between badger burrows<sup>1</sup> and other animals. Further research was required to determine the importance of badger burrows in ecosystems. The behaviors that were being observed in this research were species interactions that were occurring at the badger burrow holes and how these burrows are being utilized by many species.

The author's objectives were to identify which species utilize burrows that have been abandoned, how these different species are using the burrow and which of these species are frequenting the burrows most often.

Two study sites in Wyoming, USA were examined for abandoned badger burrows. Ten cameras were set up in one site and 13 in the other. Images were then sorted by different species and categorized as either entering or exiting, inspecting, foraging, bathing, or moving in or around the burrow. Data was summarized as the frequency of detection of a specific species as well as the frequency of each behavior observed around the burrows.

The study captured 12 mammal species, 18 bird species as well as one reptile utilizing the abandoned burrows. The most frequent behaviors for mammals recorded were being in and foraging around the burrows. Birds were found primarily to be foraging around the burrows and were found to utilize the burrows more often than other groups.

These results are important as it was originally thought that more mammals would be observed using the burrows than other groups of organisms. This was one of the first pieces of literature that discussed species utilizing badger burrows and is important as it demonstrates the major role that Badgers play in an ecosystem.

This article was chosen for my literature review as it provides information on some other species that utilize burrows and why badger burrows are so important. This article advances knowledge in the field as before this paper, the importance of burrows to other species was not known. Since little work had been completed, there is little literature to contrast it to. A more in-depth and large-scale project is required to truly determine if the findings in this report are accurate.

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