# Lactating Soprano Pipistrelle, Pipistrellus pygmeaus, use of coniferous pine plantations in south-west Scotland

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people's trust for endangered species

## Abstract

Coniferous pine plantations have historically been considered to have little biodiversity and the general consensus has been that UK bat species avoid this habitat. Recent studies, however, show that soprano pipistrelles, *Pipistrellus pygmeaus*, are using these areas for commuting and foraging and so the aim of this study is to understand how lactating females in particular interact with the Galloway Forest plantation, especially as the Forestry Commission Scotland is looking to develop plantations as a source of renewable energy. Bats were caught using mist nets and a harp trap with the aid of a Sussex Autobat lure. Suitable individuals had their morphometric measurements taken and radio tags attached and were tracked for five nights with their location being determined through homing in, triangulation and GPS. Results were mapped and visualised using QGIS. Overall, the results showed that the majority of radio-tracked individuals used the Galloway Forest for foraging and commuting with greater numbers found along watercourses and water bodies. This is most likely due to the linear features of the trees making commuting easier and the greater density of invertebrates found around the waterbodies.

## **Introduction**

Coniferous plantations are areas of afforested woodland, typically planted for the purpose of commercial timber production (Lake et al. 2015), which were first established in the UK during the early 20<sup>th</sup> century (Mason 2007). They are located throughout the UK (Lake et al. 2015) and now cover approximately 7% (1,516,000 ha) of Britain, with 993,000 ha located in Scotland (Dumfries and Galloway Council 2009). These Scottish forests typically consist of fast growing non-native larches, *Larix*, Sitka spruce, *Picea sitchensis*, and Norway spruce, *Picea abies* (Barsoum et al. 2016) which are harvested and sold for commercial uses such as telegraph poles (Connolly et al. 2007) and paper pulp (Cheu Peng et al. 2013). The Forestry Commission has been responsible for maintaining forestry in the UK since 1919 (Pringle 1994) with 59% of the commercial plantations in Scotland being owned and managed by the Forestry Commission Scotland (FCS). The trees are typically felled on a rotation of between 60 – 80 years (Connolly et al. 2007).

This habitat, however, has always been considered a type of ecological desert (Bonet et al. 2009) due to the plantations traditionally being situated on degraded agricultural lands, the tree monoculture (Elliot & Sayer 2005) and the fact that they are harvested through clear-felling large expanses which can influence hydrological and erosion patterns of the land (Brockerhoff et al. 2006). In recent times, they have also been under much criticism for being planted on environmentally important habitats. This was the case in the 1980s when areas of the Flow Country in Northern Scotland were afforested in order for individuals to gain tax breaks and forestry grants but which destroyed internationally important peatland and wetland habitats (Warren 2000).

Bats make up 20% of all classified mammal species in the UK (Hales 2014). There are 17 species (Battersby & Greenwood 2004) all of which have been designated by the UK government as indicator species (those fortunes reflect the health and status of their surrounding environment (Brotons et al. 2012)) (Aguire et al. 2015). Bat species in the UK have been declining since the 1980s (Harris et al. 1995) with the general consensus being that anthropogenic activities such as habitat destruction and fragmentation, urbanisation (Barlow et al. 2016) and the effect of roads and traffic (Altringham & Kerth 2015) as the main causes. They are therefore protected under the amended Conservation (Natural Habitats & C) Regulations 1992 (Rodgers 2013) meaning that it is a criminal offence to deliberately or accidentally disturb individuals and roost sites (Brooks et al. 2014).

Some bat species have been shown to actively select against pine plantations, preferring to utilise broadleaved plantations instead, as was found by Jones & Russo (2003) with Savi's Pipistrelle, *H.savii*, in Southern Italy and by Racey & Smith (2008) with Natterers bats, *Myotis nettereii*, on the English-Welsh border. Despite this however, bats have been shown to use pine plantations in some parts of Europe, which was the case with Brown long-eared bats, *Plecotus auritus,* in Central Spain (Benzal 1990). This pattern would not be surprising as it has been shown that plantations can contain a diverse range of

invertebrates (Ferris et al. 2002) and roost spaces (Cavin et al. 2013) as well as providing linear rows of trees which all bat species utilise when commuting and foraging (Downs & Racey 2006).

Ever since conifer plantations have become a part of the British landscape there has been increasing pressure to manage them to produce a wider range of benefits for society (Kerr 1999). As a result, FCS intend to install 2GW of renewable energy capacity through wind and hydro power in order to contribute to the Scottish Government's objective of producing 100% of Scotland's electricity from renewable resources by 2020 (Forestry Commission Scotland 2016). As well as being sensitive to general disturbance (Thomas 1995), recent studies have shown that bats are particularly affected by onshore wind farms (Kramer-Schadt et al. 2012) and environmental developments (Lane et al. 2015) meaning it is important to understand how these protected species interact with and use the conifer plantations in which these new technologies may be situated.

Soprano pipistrelles, *Pipistrellus pygmaeus*, are one of the most widespread species in the UK (Barlow et al. 2016) with an estimated population size of 1,300,000 (Battersby 2005). Previous studies in the Galloway Forest in south-west Scotland have shown that Soprano Pipistrelles are using the area during their lactation period, despite being wetland associated bats (Davidson- Watts & Jones. 2005). The lactation period is an important part of their life cycle and producing milk is highly energetically demanding (Briffa et al. 2003) meaning that there are evidently enough food and roost spaces in the plantations to support them during this time. Therefore, the aim of this study is to establish and discuss which parts of the plantations they are using in order to increase understanding of how this species interacts with the coniferous plantation habitat of south-west Scotland.

## <u>Methods</u>

### Study Area

The Dumfries & Galloway region of Scotland (*Figure 1*) was chosen because approximately 23% (145,000 ha) of the land area of the region is conifer plantation which makes up for almost 10% of the UK planting (Dumfries and Galloway Council 2009). The Galloway Forest also provides a wide variety of differing habitats such as plantation forest, ancient oakwood and montane scrub (Forestry Commission Scotland 2016) and rivers and streams (Doughty et al. 2001). This provides a more stable ecosystem which increases biodiversity (Klein et al. 2006) and therefore increasing the likelihood that a substantial amount of bats will be using the area.



Figure 1: Map of the location of Dumfries & Galloway County (Copyright of 'Improvement Service')

#### **Data Collection**

#### Catching

Catching took place at each site for four hours starting thirty minutes after sunset which allowed for individuals to feed before capture and to avoid catching commuting individuals. Three mist nets and a harp trap, all aided on rotation, by a Sussex Autobat lure were used for catching. Individual bats caught were identified to species level, aged, sexed and their reproductive status assessed. The hair of qualifying soprano pipistrelles was clipped in order to attached the radio tag and a faecal sample and morphometric measurements taken. Catching was avoided in late June when the females were less likely to be heavily pregnant.



Figure 2: Mist-netting with the aid of a Sussex Autobat lure



Figure 3: Measuring forearm length



Figure 4: Clipping the hair

#### Tagging

Only adult lactating females over six grams were tagged and only two individuals were tagged at any one time. 0.29g Holohil LB-2X tags were applied to their backs using ostomy glue. The bats were retained in bags for fifteen minutes to ensure that the tag was firmly applied before release. There was no tracking of the tagged bats during the first night as they are unlikely to exhibit normal behaviour.

#### Radio-tracking

The bats were tracked using Sika and Australis receivers and Yagi antennas from dusk to dawn for five full nights. The bats were followed using a combination of homing in and triangulation. Behaviour such as commuting, foraging and resting were determined from tracking as well as the location and direction of the bat in order to assess where the bat was. A GPS was used to plot the point of each recording.

#### Data Analysis

The data from the radio-tracking, homing in and triangulation was uploaded on to QGIS 2.14 where the spacial patterns of the bats was visualised.

## **Results**

The results of the radio-tracking are shown below in *Figures 5* to 15.

All the figures show that most of the individuals which were radio-tracked spent the majority of their time along the rivers and water bodies located within the Galloway Forest. *Figures 5*, *6*, *8*, *11*, *13* and *15* also show several, less frequent, instances of the bats flying and foraging in more open areas and along the roads.

## Table 1: Index for Figures 5 to 15





Figure 5: Bat locations Craiglowrie Burn



*Figure 6*: Bat locations along River Dee



*Figure 7*: Bat locations along Craigshinnie Burn



*Figure 8*: Bat locations along Bow Burn and Loch Ken.



Figure 9: Bat locations along the River Dee



*Figure 10*: Bat locations along Clatteringshaw Loch and Corsland and Green Burns.



Figure 11: Bat locations along Mid Burn



Figure 12: Bat locations along Mid Burn



Figure 13: Bat locations along Palnure Burn



Figure 14: Bat locations along Palnure Burn



Figure 15: Bat locations along Palnure Burn

## **Discussion**

The results show that the majority of the soprano pipistrelles which were radio-tracked were using the Galloway Forest for the majority of their commuting and foraging. Their positioning also appears to be affected by the location of watercourses and water bodies as many of bats were found to be foraging and travelling within close proximity to these areas (see *Figures 5 - 15*).

The fact that the bats were choosing to feed in close proximity to water bodies is not unusual as a higher abundance of invertebrates (Biggs et al. 2004) are found above the water's surface in the summer months. This is beicause insect larvae, such as the Scottish biting midge, *Cullicoides impunctatus* (Blackwell et al. 1992) which is found in abundance within the Galloway Forest (Brodin & Gransberg 1992), are emerging and taking adult form (Barlow 1997 & Byström et al. 2014). However, it is not just the water bodies themselves that makes them such popular places to feed, but the fact that the edges are lined with trees. It has been shown by other studies in the past that pipistrelles actively choose areas of water which are lined with trees, which was the case with Altringham et al. in 2000, as they also attract a certain amount of invertebrate activity (Downs & Racey 2006). This edge habitat also provides shelter from predators (Ekman & de Jong 1996) such as diurnal raptors including a variety of owl species (Speakman 1991) which would be the case in the Galloway Forest which has a high population of raptors (Shaw 1994).

All bat species use linear, recognisable features for navigation (Downs & Racey 2006) meaning the pine plantations, where the trees are planted in straight rows, provide the perfect paths towards the water bodies found within. Flight is also made easier because there is little understorey growth found in plantations when compared to broad-leaved woodlands due to the tree variety being less species rich and increased outshading from the canopy (Balandier et al. 2008). During the lactation period of soprano pipistrelles, the females travel shorter distances from their roosts to forage, as they are un-willing to leave their offspring for extended periods or to use too much energy (Racey & Swift 1985). Therefore as the Galloway Forest provides straight and clear courses from the roost to the feeding areas, this is the ideal environment. The water courses themselves also act as wildlife corridors (Puth & Wilson 2001) and provide navigable paths into the plantation (Cole et al. 1998) which was also seen by Aihartza et al. (2012) when studying Mehely's horseshoe bats, Rhinolophus mehelyi, in south western Spain. The water courses within the Galloway Forest were less cluttered with vegetation, compared to the surrounding forest and so are perfect for the soprano pipistrelle which is an 'edge-space' species. This means they are not as well adapted to flying in cluttered environments when compared to Natterer's, Myotis nattereii, or Brown-long eared, Plecotus austritus, bats (Abbott et al. 2012). Echolocation uses a lot of energy (Dechmann et al. 2013) and flying in cluttered areas means the bats have to use a higher frequency (Kalcounis-Rueppell et al. 2010). However, if the bats can fly in more open areas, they can lower the frequency which focuses the energy which results in more efficiency (Jakobsen et al. 2012). This is vital during the lactation period when the majority of energy is needed to create milk and feed young (Barclay et al. 2012).

However, the fact that they are foraging over the water does not prove that the Galloway Forest is a rich habitat for bats, but instead because these areas are the only source of water and food within a desert environment (Adams et al. 2015). There have been many discussions as to the ecological benefits of plantations with many arguing that this habitat type can be an 'ecological desert' and have a detrimental effect on biodiversity, especially if they were planted in places which are naturally not areas of woodland (Bremer & Farley 2010). This is the case with south west Scotland as this was historically an area of agriculture (Elliot & Sayer 2005). Because of the monoculture of pine plantation woodlands (Elliot & Sayer 2005), it has also been discussed that their comparatively little understorey variety can have an effect on the invertebrate diversity (Scrosati & Cortney 2013) which could currently be having an unknown effect on the bat population numbers.

The data gained from radio tracking could be inaccurate as radio tracking is very variable and there are several environmental and physiological factors which can affect its accuracy. Environmental effects such as weather (Garrot & White 2012) and terrain (i.e. a stronger signal will come from the top of a hill compared to within a dense forest) (Göktogan et al. 2010) can affect the strength of the radio tag signal. It

is also not possible to tell whether the tag itself has been damaged by the bat flying through dense vegetation (Göktogan et al. 2010), grooming itself (Lučan & Radil 2010) or low battery life and temperature (Garrot & White 2012), all of which can affect the accuracy of the tag's signal. The tags used in this study did not automatically download via GPS meaning that the locations were determined by the surveyor from the strength of the signal which means there could have been an unknown amount of human error when interpreting the signal (Crofoot et al. 2011).

In order to improve the survey method in the future, an estimation of height should also be noted. This is because the environmental conditions such as temperature, which can affect invertebrate numbers as is the case for midges, *Corynocera*, can change significantly from just a few meters in elevation (Haskett 2004; Adamson et al. 2010). And so, if the bats were foraging at a greater height, there could be a variety of unknown factors which were affecting the distribution seen in the figures in the Results section of this report.

When considering the long term management of the Galloway Forest, consideration needs to be given to the management of rivers and water bodies found within, especially as these habitats are important for promoting general biodiversity (Biggs et al. 2004). Deforestation has been proven to have detrimental effects on water bodies as it results in increase runoff creating more flooding (Bruijnzeel et al. 2008) and less soil stability (Sagar 1984). Pine plantations have been shown to provide a fantastic mosaic of habitats for the bats to use so whilst deforestation is inevitable, more should be done to ensure the stability and presence of the waterbodies; especially if the FCS looks to include on-shore wind turbines within the Galloway Forest. Whilst deforestation can be detrimental for bat populations, clearing of small spaces can have a positive effect as seen by Kurta & Tibbels (2003). Therefore, future studies should focus on how big an area of clear felling has to be before it becomes detrimental to bat species.

Overall, the Galloway Forest pine plantation provides an important habitat for lactating soprano pipistrelles which use it for both foraging and commuting. Given the national and international decline of all bat species through anthropogenic causes (Barlow et al. 2016), it is imperative that FCS preserve this significantly important habitat and look to increase its biodiversity and to encourage bat populations.

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