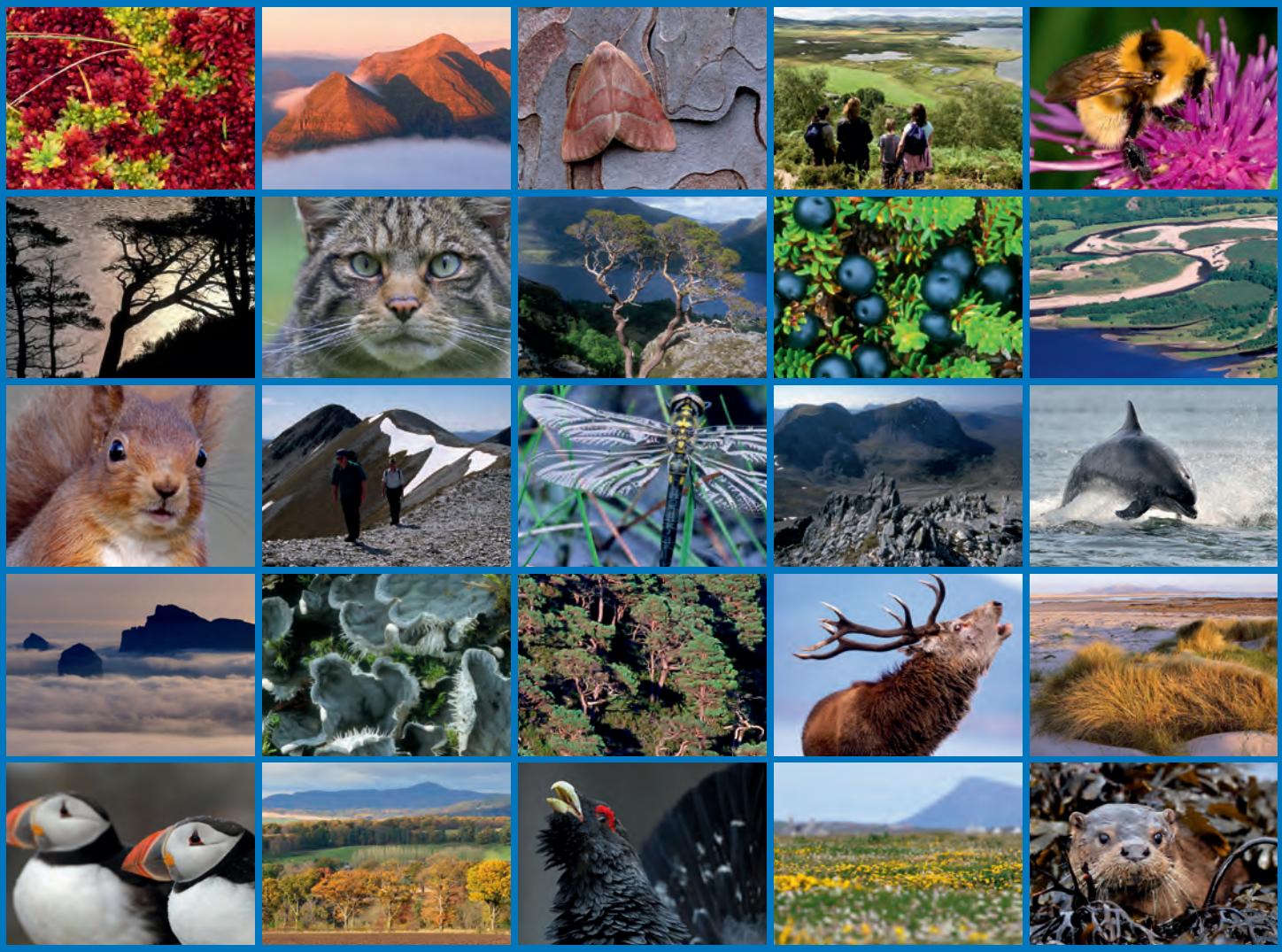
Scottish Natural Heritage
Commissioned Report No. 802

Group size and reproductive rates within the Tayside beaver population, Perthshire



Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad

COMMISSIONED REPORT

Commissioned Report No. 802

Group size and reproductive rates within the Tayside beaver population, Perthshire

For further information on this report please contact:

James Scott
Scottish Natural Heritage
Great Glen House
INVERNESS
IV3 8NW
Telephone: 01463 725363
E-mail: james.scott@snh.gov.uk

This report should be quoted as:

Campbell-Palmer, R., Dickinson, H., Wilson, K. & Rosell, F. 2015. Group size and reproductive rates within the Tayside beaver population, Perthshire. *Scottish Natural Heritage Commissioned Report No. 802.*

COMMISSIONED REPORT

Summary

Group size and reproductive rates within the Tayside beaver population, Perthshire

Commissioned Report No. 802
Project No: 13810
Contractor: RZSS/TBSG
Year of publication: 2015

Keywords

Beavers; Tayside; Tay; reproductive rates; population; kit; emergence.

Background

The Tayside Beaver Study Group identified the need to gather more information on the lodge productivity of beaver families residing within the Tayside catchment. We determined this by observing group size, age composition and reproductive rate at a sample of active lodges within the River Tay catchment. This data will supplement information gathered through the Scottish Beaver Trial on beaver reproduction in the Scottish environment. Eurasian beavers live in family units based around a breeding adult pair and their offspring from multiple generations (typically from the previous and current year). It has been estimated that 38-39 active beaver territories are present in this area and 25 lodges have previously been located (Campbell *et al*. 2012). Group composition is typically assessed through culling (Hay 1958), mark and release studies (Busher *et al*. 1983), or through repeated lodge observations (Rosell *et al*. 2006). The latter method was employed in this study.

Main findings

- Active breeding lodges are evident throughout the River Tay catchment and can be readily identified. This study was limited in scope, given time and resources available, but was also restricted through accessibility and land owner permission.
- The earliest kit emergence dates observed were the 10th (n=1) and 24th (n=2) of June.
- Average group size for both years was 5.0 (SD±1.60) individuals. This falls within expected ranges for Eurasian beavers, although higher than previously published figures. This is likely to be reflective of a rapidly growing population which still has significant scope for growth and spread.
- Group composition of observed lodges in 2013 (n=6) was 36.7% adult, 26.7% sub-adult, and 36.7% kits. Group composition of lodges observed in 2014 (n=9) 40.0% adult, 20.0% sub-adult and 40.0% kits.
- This study (combined 2013 and 2014 observations) found an average litter size of 1.9 (SD±1.1), which falls within the limits from previous studies.
- This study determined that Eurasian beavers are successfully reproducing throughout the area of the River Tay catchment which was sampled. Beavers appear to be adapting and surviving to the Scottish environment, particularly in a modern landscape with varying land-use practices. Resources for survival and active reproduction do not appear to be

limiting as yet and it is estimated that this population is not near carrying capacity, and currently in a growth and expansion phase.

For further information on this project contact:
James Scott, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725363 or james.scott@snh.gov.uk
For further information on the SNH Research & Technical Support Programme contact:
Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725000 or research@snh.gov.uk

Table of Contents **Page**

Acknowledgements

We wish to thank all those who volunteered their time to take part in the lodge watches, in particular Alex Rigby who undertook all of the June 2014 watches to determine earliest emergence dates. We also thank those land owners whom gave us permission to undertake field work on their land and providing valuable information on lodge location and site access. In particular we are grateful for Scottish Wildlife Trust and Royal Society for the Protection of Birds staff, and to Scottish Wild Beaver Group for given up their own personal time to assist us. Funding and resources used were provided by Tayside Beaver Study Group and Royal Zoological Society of Scotland.

1. INTRODUCTION

Eurasian beavers (*Castor fiber*) are highly territorial and live in family groups. Beaver territory and group or family size can vary (Nolet & Rosell 1994; Rosell & Parker 1995; Herr & Rosell 2004). A family is typically composed of a breeding adult pair, with kits from that year and offspring from the previous year (yearlings) and potentially older offspring that have not yet dispersed (sub-adults) (Wilsson 1971). Sub-adults may be sexually mature but do not breed, only the adult pair produce kits (Wilsson 1971). Typically sub-adults will remain within the family unit for their first two winters before dispersing (Wilsson 1971; Hartman 1997). All family members participate in territory defence, predominantly in the form of scent marking, but beavers will actively fight off beavers from other families (Aleksiuk 1968; Wilsson 1971; Rosell *et al.* 1998). Both parents and older offspring will assist in providing food and defending any kits (Wilsson 1971).

On average Eurasian beavers tend to produce two to four kits per year, in one single breeding season. Beaver kits first emerge from their natal lodges approximately two months after birth (Wilsson 1971). During this first summer they can be quite visible in and around the lodge area, whilst it is still daylight. Findings from the Scottish Beaver Trial report that Scottish born kits have first been observed in mid-July (Harrington et al. 2015). In south-eastern Norway parturition begins from the end of April/ early May with kits tending to first be seen emerging from the natal lodge before the end of July (Parker & Rosell 2001), whilst in Bavaria kits have been observed before the end of June, as have captive Bavarian animals in private collections in Scotland (A. Leow-Dyke, pers comm., 2015). Free-living beavers in the Tayside region are predominantly assumed to be Bavarian in origin (McEwing et al. 2015, hence may display slightly earlier kit emergence times than Norwegian beavers.

Group size and composition in beavers are typically assessed through one of three methods: removal and culling (Hay 1958); mark and release studies (Busher *et al*. 1983); or through repeated lodge observations (Rosell *et al*. 2006). The first two methods are resource intensive and time consuming, and outwith the scope of this study. The culling of beavers for monitoring purposes was not deemed acceptable or necessary. Live beaver counts, including the assignment of age class to individuals viewed through night scopes and binoculars have been reported in several studies (Svendsen 1980; Easter-Pilcher 1990; Osmundsen & Buskirk 1993; Rosell *et al.* 2006). McTaggart & Nelson (2003)raise concerns about confidently assigning age class at night. Distance, observer experience and environmental conditions such as wind, can all impede beaver observation and age class assignment, especially in swimming beavers (Rosell *et al*. 2006). To address some of these issues this study was undertaken during daylight to dusk, using binoculars and trained personnel. As beavers cannot be sexed through external morphological characteristics (unless nipples of heavily pregnant or lactating breeding females are seen) (Wilsson 1971), group composition in this study was determined through age class and not by sex of individuals observed. Observations were also initially undertaken during dawn, but proved less productive and reliable so are omitted from this report.

1.1 Background to study

The Tayside Beaver Study Group identified the need to gather more information on the lodge productivity of beaver families residing within the Tayside catchment. This was determined by observing group size, age composition and reproductive rate at a sample of active lodges within the River Tay catchment. This data supplements information gathered through the Scottish Beaver Trial on beaver reproduction in the Scottish environment. Eurasian beavers live in family units based around a breeding adult pair and their offspring from multiple generations (typically from the previous and current year). It has been estimated that 38-39 active beaver territories are present in this area and 25 lodges have previously been located (Campbell *et al*. 2012). Group composition is typically assessed

through culling (Hay 1958), mark and release studies (Busher *et al*. 1983), or through repeated lodge observations (Rosell *et al*. 2006). This study used animal observations from repeated lodge watches on a selection of active beaver lodges within the River Tay catchment to determined productivity.

1.2 Objectives of study

i. To identify active beaver lodges where breeding was occurring within the River Tay catchment.
ii. To provide an assessment on group size and composition.
iii. To gather information on kit emergence, including litter size, emergence date and times.

2. METHODS

Active beaver lodges potentially suitable for observation were identified from previous surveys conducted by Campbell *et al*. (2012), those revealed from recent beaver trapping work (Campbell-Palmer *et al.* 2015) and those identified by the Tayside Beaver Project Officer through landowner engagement. Lodges were assessed for recent activity through the presence of fresh field signs including feeding stations with freshly browsed vegetation, freshly cut woody material and evidence of recent substrate manipulations in the immediate lodge vicinity. Reports of recent beaver sightings prior to onset of the observation period were also taken into consideration. The study aimed to observe 10-15 lodges, undertaking a minimum of 4 observation sessions per lodge, with each observation session lasting approximately four hours under natural light conditions.

Group size involved the identification of the number of beavers within each age class (adult, sub-adult or kit). Yearlings and older offspring were all classified as sub-adults as in some instances it was not possible to confidently determine a yearling from a potential two year old offspring, whereas the identification of kits was more obvious. This was based on body size and length, head width and the amount of body visible above the water line whilst an individual was swimming. If kits were present at any given lodge then it was presumed two breeding adults were also present, even if not directly observed. Individual beavers were counted as they emerged (or on some occasions as they returned to the lodge), and/or when they are visible around the lodge area. Observations were undertaken from the opposite river bank. Efforts to avoid double-counting of the same individual were made, with only animals positively identified as different being recorded, so numbers tend to be minimum counts. Any observed differences, particularly in size, were made to try and distinguish individuals when counting. Having more than one observer also assisted in keeping track of where various family members were, direction of travel and timings between observations also greatly assisted in the joint decision on whether an individual had been previously counted or not. Selection of appropriate observation points also enabled a clear view of the water body, so various individuals could be accounted for; additionally beavers could often be heard feeding which also assisted in the collection of count data. Reproductive rate or litter size was determined as the number of kits from that year emerging from the natal lodge (Wilsson 1971).

2.1 First kit emergence

A total of 35 lodge observations were undertaken at ten sites throughout June 2014 to try and determine the earliest kit emergence dates occurring within the Tayside beaver population. These combined both dusk and dawn observations and camera traps. It was not possible to sample randomly due to issues with access and landowner permission.

3. RESULTS

Family members often emerged singly and could be hard to distinguish from each other, particularly whilst swimming and/or from a distance. Only individuals positively identified as different were included to avoid any over-estimates in counts. As previously discussed in Rosell *et al.* (2006), given their size and time of lodge watches, beaver kits are rarely misidentified by observers, though yearlings and older sub-adults, and sub-adults and adults may be confused on occasion. Therefore we used three age class groupings to try and reduce misidentification. It was more important in this study to positively identify kits and then identify any older individuals that represent previous breeding. Two adults were assumed on the few occasions two separate individuals were not positively identified, if kits were present.

A minimum of four observations were undertaken at each active lodge, with at least two of those watches being undertaken by one of three experienced personnel to reduce inter-observer variation and to validate age class assignment. Only lodges with kits present were included, hence some lodges were observed but later excluded if beaver sightings were poor or if kits were not seen. Active lodges are likely to exist within the River Tay catchment that are not actively reproducing and/or include pairs or even single animals. Any future studies should include such lodges. However, time and resource constraints for this study meant a focus on productivity in breeding lodges.

3.1 Pilot study 2013

On observation of 6 different lodges sites across Tayside from July to August 2013, a total of 35 presumed individual beavers were observed. A breakdown of these individuals according to age class is given in Table 1. Eleven newly emerged kits were observed, along with evidence of previous breeding and offspring survival in 67% of lodges watched, indicated by presence of sub-adults/yearlings. Number of animals per lodge ranged from two to seven individuals. The mean group size was 5.0 (±2.07) individuals.

Table 1. Lodge watches 2013. Number of beaver sightings, according to age class, over four observations sessions per active lodge, undertaken between July and August 2013. Unless seen together, two breeding adults were presumed if kits were observed at each lodge.

Lodge site	Group composition			Min. group size
	Adults	Sub-adults/ yearlings	Kits	
Meigle	2	2	3	7
Isla	2	2	2	6
Comrie	2	0	2	4
Loch of the Lowes	2	0	2	4
River Ericht	2	3	2	7
Carsie	1	1	0	2
Total	**11**	**8**	**11**	**30**

Successful breeding in 2013 was evident at five out of the six lodges (83.3%). The mean litter size for 2013 was 1.83 (±0.98) kits. Evidence of previous breeding and kit survival from previous years was present at 66.7% of the lodges in this study, indicating beavers had been present and breeding at these sites for at least three or four years, although this could be longer. The observed lodges at Comrie and Loch of the Lowes could represent expansion zones with beavers more recently dispersing into these areas and starting to reproduce.

Family composition in observed lodges was found to be 36.7% adult, 26.7% sub-adult, and 36.7% kits.

3.2 First kit emergence

Ten active lodges were observed in June 2014 during an additional pilot study in an attempt to establish first emergence dates. Four kits were observed in total. The results of this study showed very few emerging kits with sightings recorded at only two sites: River Earn and Meigle. The first recorded kit sighting was the 10th of June on the river Earn. This kit was observed being carried in the mouth of an adult beaver, thought to be being moved to an alternative lodge due to an increase in river levels following heavy rainfall. The next recorded kit sighting was the 24th of June at Meigle. Observations did not continue on three of these sites due to lack of resources.

Anecdotal evidence of kit emergence dates include the second week of May 2012 on the River Isla, 18th June 2014 on the Dean, with kits in this area usually being first seen around the first week of June (P. Scott, pers comm., 2015). Captive collections of breeding Bavarian beavers in Scotland recorded first emergence dates of 10th June in 2011, with dates of 20 - 23 June observed in 2006 – 2012 breeding seasons (A. Leow-Dyke, pers comm., 2015).

*Table 2. Lodge watches June 2014. Thirty five observations sessions on ten active lodges undertaken in June 2014 found four individual kits at two separate sites. Earliest observation dates presented below. *represents the same Meigle site with a different number of kits observed on different dates.*

Lodge site	Kits	Date first seen
River Earn	1	10/06/14
Meigle	2	24/06/14
Meigle*	3	26/06/14

3.3 Lodge observations 2014

In total fourteen active lodges were originally identified for observation in 2014. Five lodge sites identified for inclusion in the 2014 study were not observed due to several factors including a lack of recent beaver activity or accessibility difficulties. These sites were located on the Ruthven, Earn and at Carsie, Whiteloch and Dunalastair. Additionally, the lodge at one site (Mill Dam) was observed four times yet no beavers were sighted despite the presence of recent feeding and damming activity. Therefore a total of nine active beaver lodges were observed for the minimum of four observations sessions and included in the results below.

At nine different lodge sites across Tayside a total of 45 individual beavers were observed from July to August 2014. A breakdown of these individuals according to age class is given in Table 3. A map showing the distribution of the sites studied across Tayside can be seen in Figure 1. A total of 18 (2014) kits were recorded. The average observed 2014 kits for each family was 2.0 (range 0 to 4). Based on these observations the average family consisted of 5 (±1.41) individuals, ranging from three and seven individuals, across a range of age classes.

*Table 3. Lodge watches 2014. Number of beaver sightings, according to age class, over four observations sessions per active lodge, undertaken between July and August 2014. Unless seen together, two breeding adults were presumed if kits were observed at each lodge. *The lodge located at the Meigle site was only observed twice between July and August and therefore excluded from further data analysis.*

Lodge site	Group composition			Min. group size
	Adults	Sub-adults/ yearlings	Kits	
River Almond 1	2	1	3	6
River Almond 2	2	1	0	3
Battleby Loch	2	0	2	4
Loch of the Lowes	2	2	2	6
River Ericht	2	1	2	5
Meigle*	2	1	3	6
Kinnordy	2	2	1	5
River Earn	2	1	4	7
Comrie	2	0	1	3
Total	**18**	**9**	**18**	**45**

Group size for lodges observed in 2014 ranged from three to seven individuals, with average group size being five (±1.41) individuals. Kits were observed at all lodges bar one site on the River Almond. Litter size ranged from one to four kits, with the mean being two kits (±1.22). Evidence of previous breeding and offspring survival was present at 77.8% of lodges observed. The adult pair at Battleby Loch were known to be a newly established pair through trapping and health screening work undertaken in 2013 and 2014 (Campbell-Palmer *et al.* 2015), therefore this is known to be the first year of breeding for this particular pair.

Group composition for the lodges observed in 2014 was found to be 40.0% adult, 20.0% sub-adult and 40.0% kits.

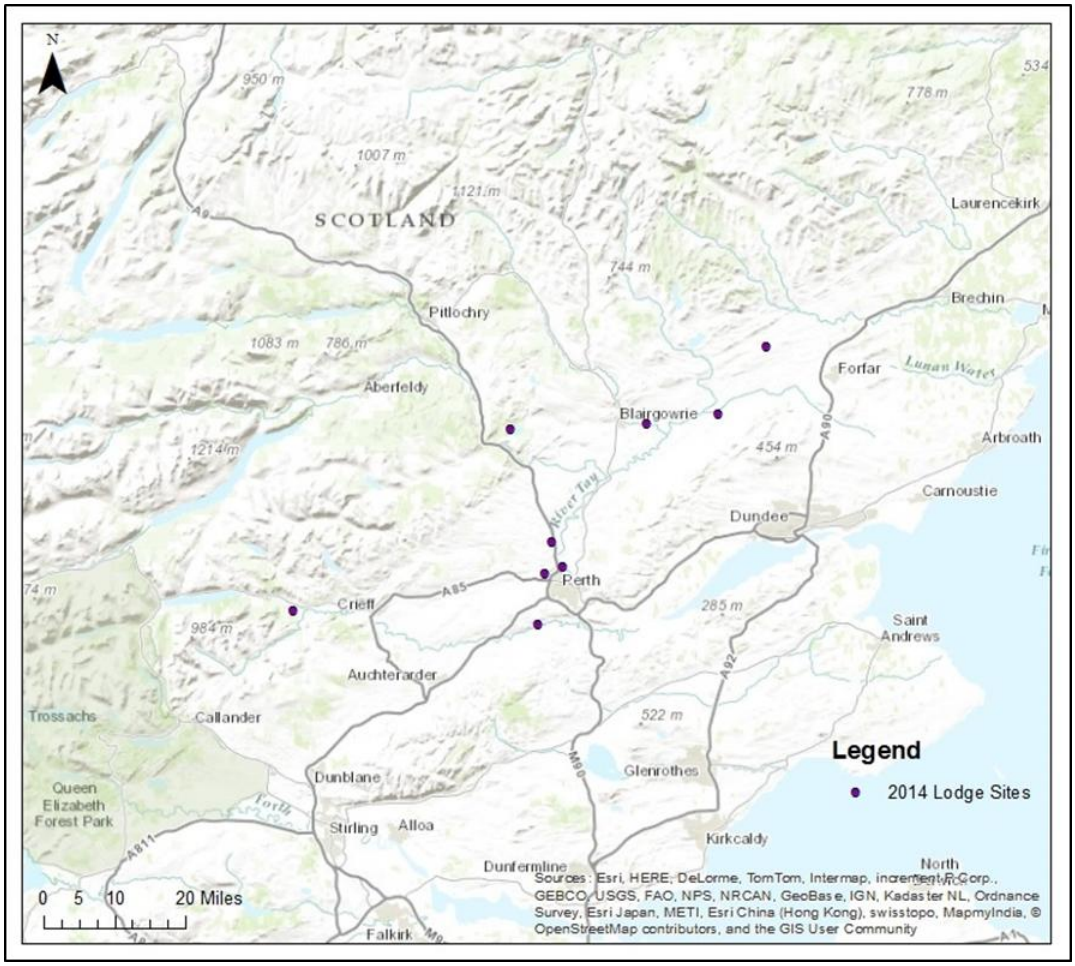


Figure 1. Map displaying the location of the lodges sites observed in 2014. These nine sites are fairly evenly distributed throughout the River Tay catchment, though lodge selection was largely based on site access and land owner permission.

The average number of beavers sighted with each consecutive watch decreased for both sub-adults/yearlings and kits with the most individuals on average being sighted in the first two watches. The sightings for adults remained relatively constant with each of the four watches as can be seen in Figure 2. Most beavers per watch were sighted in the month of July between the hours of 18:00 and 22:00.

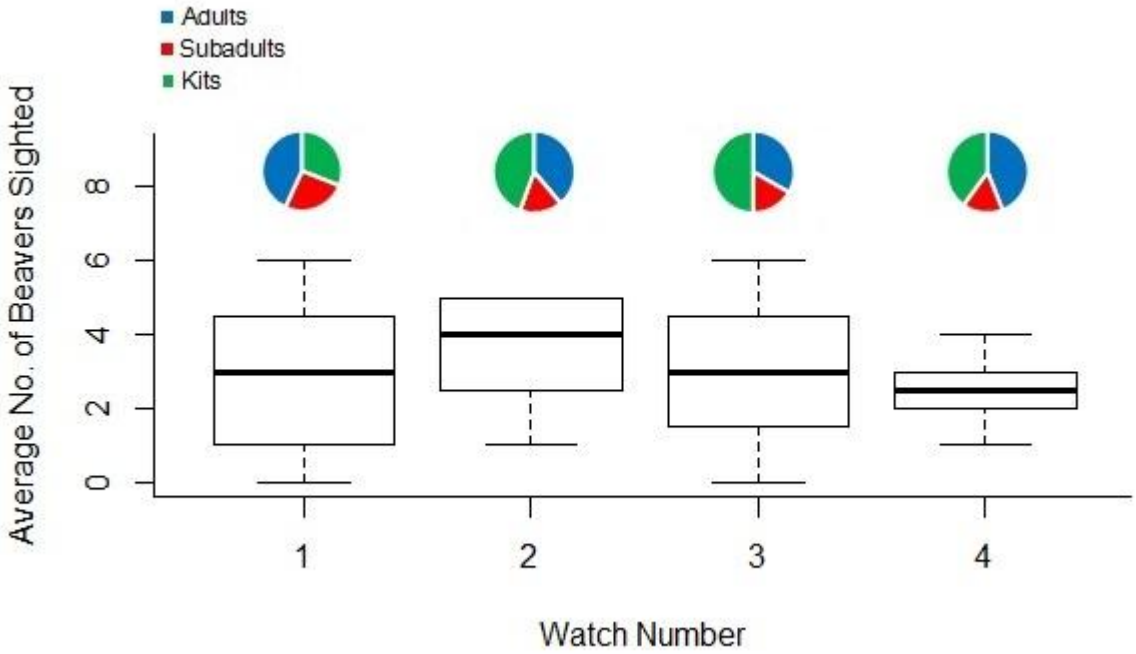


Figure 2. Box plots displaying the mean number of beavers sighted per lodge according to each consecutive watch (over four watches per lodge). Pie charts above depict percentage of beaver age class observed with each watch number.

A total of 13 newly emerged kits were sighted in the month of August and 5 were sighted in July. No kits were recorded to newly emerge in September (Figure 3). Kits tended to be first sighted around 20:00, with some kits emerging as early as 18:46 and others as late as 21:10. When adjusted for time of emergence from sunset, kits were recorded emerging from the lodge for the first time on average around 1 hour and 18 minutes before sunset. Kits tended to first emerge almost an hour closer to sunset in August than July (Figure 4).

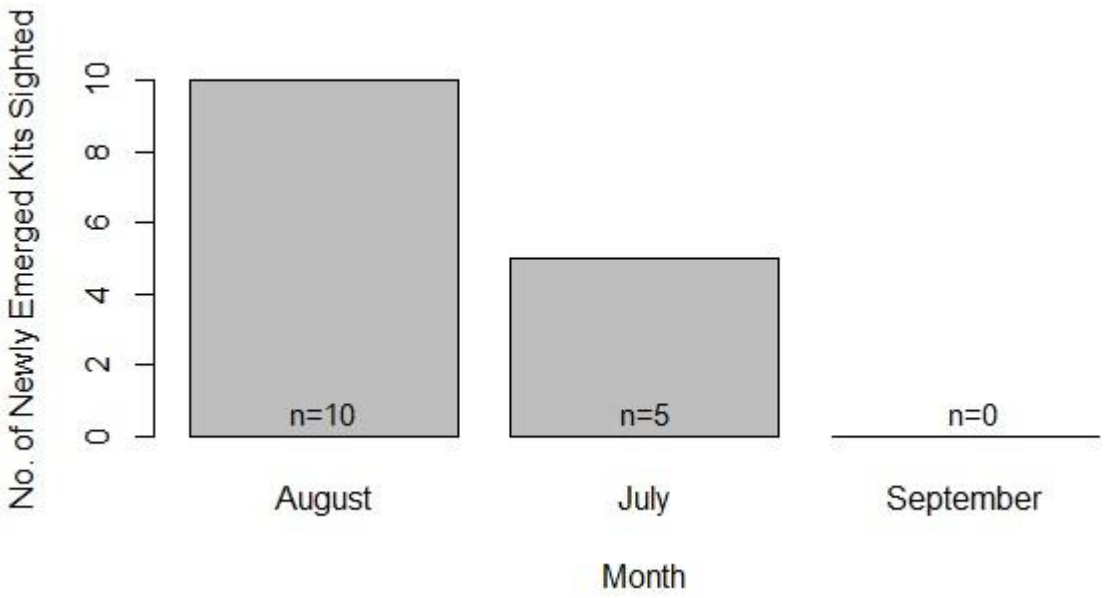


Figure 3. Number of newly sighted kits per month of lodge watches.

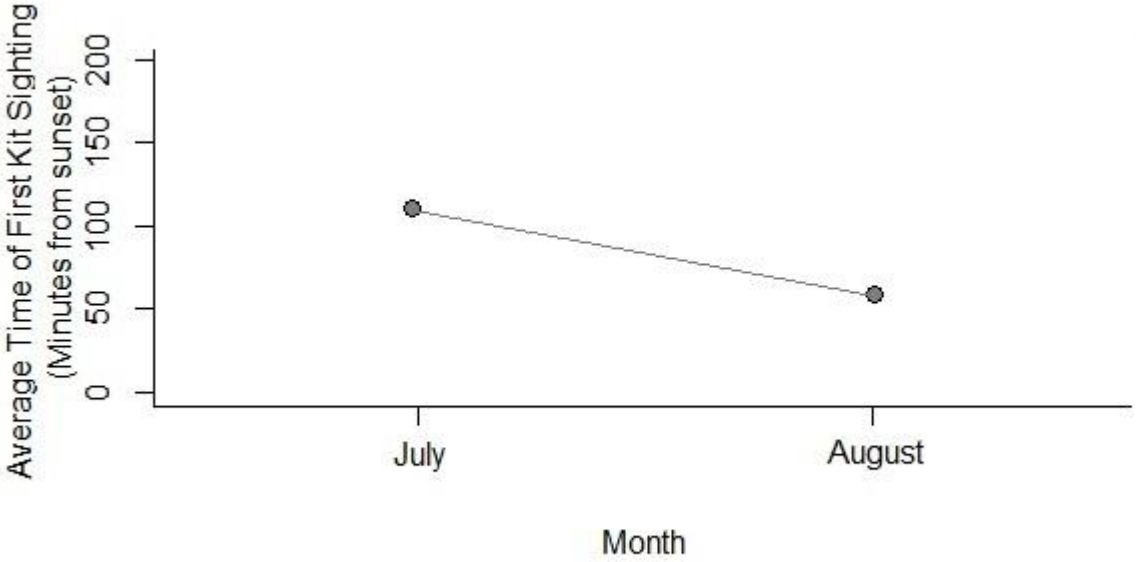


Figure 4. Line graph displaying the average time of minutes from sunset newly emerged kits were first seen during lodges watches undertaken in July and August.

4. DISCUSSION

The beaver population within the River Tay catchment is still in its growth phase, with numerous unoccupied territories available. This population has plentiful opportunities for growth and expansion, both in distribution but also in population densities. Beaver kit emergence and survival also appear to be good, suggesting resources are not limiting and kit mortality is not particularly high. It is sometimes presumed that beavers will not experience significant predation pressure in Scotland, however kit predation by red foxes has been recorded at the Scottish Beaver Trial (Goodman 2015). It is well documented that at normal densities beavers from non-related families can impose significant influence on the survival of other beavers through their highly territorial behaviours. Dispersing offspring in particular are often subjected to repeated territorial disputes as they pass through occupied areas in search of a territory and partner of their own. Mortality can be caused directly through fighting, more often mortality may result after a series of encounters, infection from wounds and the stressors associated with dispersal from the natal territories, including shelter and food acquisition.

The use of lodge counts to estimate total population size should be viewed with caution. Beaver lodges can be alternatively occupied and abandoned, additionally males and/or older offspring may use alternative lodges and burrows within a territory during the summer months, so there is a potential to over-estimate (Parker *et al.* 2002a). The type of lodge and hence its visibility has been demonstrated to affect counts, e.g. natal burrows / bank lodges where tunnelling can occur far back from shoreline are less likely to be observed (Gustavsen 1996; Parker *et al.* 2002b), and hence may lead to under-counting. In established populations it has been estimated that 25-75% of visible lodges are actually occupied (Dennington & Johnston 1974; Slough & Sadleir 1977; Slough & Jessup 1984; Parker *et al.* 2001). Additionally the time of year lodge at which counts occur will impact upon accuracy of counts with lodge visibility improving in the autumn when vegetation has died back.

Rosell & Parker (1995) reviewed group size in Eurasian beavers from several studies and determined a mean group size of 3.8 (±1.0) individuals, with a range of 2.4 to 5.5. This was below the findings in this study which found an average group size of 5.2 (SD±1.66) (2013 and 2014 combined). However, lodges were not randomly selected in this study, depending greatly on landowner permission and observability of lodge, in previous studies beaver count data were also collected from boats and canoes, which was not an option here.

Previous studies on Eurasian beaver family composition found adults represented between 54-64%, sub-adults 22-26% and kits 14-20% of animals at natal lodges observed (Kile & Nakken 1995; Parker *et al.* 2002a; Rosell *et al.* 2006). The figures determined in this study were different, with a greater overall percentage of sub-adults and kits. Again this is probably due to non-random sampling of observed lodges but it should also be noted the previous studies were sampling within a beaver population at normal carrying capacity, therefore a relatively stable population.

Average litter sizes vary in beaver populations across Europe, and it has been proposed that this may be as a result of inbreeding depression shown in refugia populations (Halley 2011). Refugia population average litter sizes have been recorded as 1.9 kits in the Elbe (Nolet *et al.* 1994); 2.5 kits in Sweden (descended from Norwegian stock) (Rosell & Pedersen 1999); 2.8 kits in Pripet and 2.9 kits in Voronezh, Russia – whereas mixed beaver populations from these two origin stocks display a higher litter size of 3.4 kits (Saveljev & Milishnikov 2002). Campbell *et al*. 2005 found average number of kits per territory in any year was 0.9 ±0.8 for Norwegian beavers, this was within a population determined to be at carrying capacity (Rosell & Hovde 2001; Parker *et al.* 2002). It has therefore been proposed that beavers from mixed refugia stock will display increased fecundity (Halley 2011). This study (combined 2013 and 2014 observations) found an average litter size of 1.9 (SD±1.1), which falls within

the limits from previous studies, but higher than western refugia populations. This would seem to be representative of the Tayside population being of mixed origin stock, which is supported by recent genetic studies identifying this population being Bavarian in origin (McEwing *et al.* 2015.

5. CONCLUSIONS

The findings of the three main objectives concluded:

i) Active breeding lodges are evident throughout the River Tay catchment and can be readily identified. This study was limited in scope, given time and resources available, but also restricted through accessibility and land owner permission. Any future studies could expand on sample size and distribution. Greater consideration to non-biased sampling should be given, along with a focus on counts at non-breeding lodges to gain more representative data on total population size and composition.

ii) From those lodges sampled, group size lay within expected ranges for Eurasian beavers, although higher than previously published figures. It should be noted this is likely to be reflective of a rapidly growing population which still has significant scope for growth and spread. There was good evidence of offspring survival between years and that multiple years of breeding have occurred. Individuals observed appeared to be in good body condition and surviving well in the Scottish environment.

iii) Kit emergence was relatively straightforward to observe and we are confident the majority of kits were seen at each lodge. There was no evidence that kits were only emerging after nightfall as they were often seen between 60-110 minutes before sunset, and appeared undisturbed by presence of observers and exhibited normal behaviours. The earliest recorded sighting kits were 10th and 24th of June. The 10th June sighting was a kit observed being carried in the mouth of an adult, possibly being moved to an alternative lodge due to river level rise. Litter size ranged from one to four kits, with the mean observed being two kits.

This study determined that Eurasian beavers are successfully reproducing in the area of the River Tay catchment which was sampled. Beavers appear to be adapting and surviving to the Scottish environment, particularly in a modern landscape with varying land-use practices. Resources for survival and active reproduction do not appear to be limiting as yet and it is estimated that this population is not near carrying capacity, and currently in a growth and expansion phase.

6. REFERENCES

Aleksiuk, M. 1968. Scent mound communication, territoriality, and population regulation in beaver (*Castor canadensis* Kuhl). *Journal of Mammalogy*, **49**, 759-762.

Busher, P.E., Warner, R.J. & Jenkins, S.H. 1983. Population density, colony composition, and local movements in two Sierra Nevadan beaver populations. *Journal of Mammalogy*, **64**, 314-318.

Campbell, R.D., Harrington, A., Ross, A. & Harrington, L. 2012. Distribution, population assessment and activities of beavers in Tayside. *Scottish Natural Heritage Commissioned Report No. 540*.

Campbell-Palmer, R., Pizzi, R., Dickinson, H. & Girling, S. 2014. Trapping and health screening of free-living beavers within the Tay catchment, east Scotland. *Scottish Natural Heritage Commission Report No. 681.*

Dennington, M. & Johnston, B. 1974. Studies of beaver habitat in the Mackenzie Valley and Northern Yukon. Report 74-39, 1-172. Canadian Wildlife Service, Department of the Environment, Ottawa, Ontario, Canada.

Easter-Pilcher, A. 1990. Cache size as an index to beaver colony size in Northwestern Montana. Wildlife Society Bulletin, **18**, 110-113.

Goodman, G. 2015. The Scottish Beaver Trial: Veterinary monitoring of the Knapdale beaver population 2009-2014. The University of Edinburgh.

Gustavsen, P.Ø. 1996. Effektiviteten av elgjaktlag for taksering av beverbestanden i Bø commune, høsten 1995. Hovedoppgave, Høgskolen i Telemark, Bø i Telemark, Norge (In Norwegian).

Halley, D.J. 2011. Sourcing Eurasian beaver *Castor fiber* stock for reintroductions in Great Britain and Western Europe. *Mammal Review*, **41**, 40-53.

Harrington, L.A., Feber, R., Raynor, R. and Macdonald, D.W. 2015. The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals 2009-2014, final report. *Scottish Natural Heritage Commissioned Report No. 685.*

Hartman, G. 1997. Notes on age at dispersal of beaver (*Castor fiber*) in an expanding population. Canadian Journal of Zoology, **75**, 959-962.

Hay K.G. 1958. Beaver census methods in the Rocky mountain region. *The Journal of Wildlife Management*, **22**, 395-402.

Herr, J. & Rosell, F. 2004. Use of space and movement patterns in monogamous adult Eurasian beavers (*Castor fiber*). *Journal of Zoology London*, **262**, 257-264.

Kile, N.B. & Nakken, P.J. 1995. Colony and brood size of beaver (*Castor fiber*) in the Gautestad region of Evje-Hornes Township, Aust Agder County. BSc thesis, Høgskolen i Telemark, Bø. pp 1-28 (In Norwegian).

McTaggart, S.T. & Nelson, T.A. 2003. Composition and demographics of beaver (*Castor canadensis*) colonies in central Illinois. American Midland Naturalist, **150**, 139-150.

Nolet, B.A., Dijkstra, V.A.A. & Heidecke, D. 1994. Cadmium in beavers translocated from the Elbe Riverto the Rhine/Meuse estuary, and the possible effect on population growth rate. Archives of Environmental Contamination and Toxicity, **27**, 154-161.

Nolet, B.A. & Rosell, F. 1994. Territoriality and time budgets in beavers during sequential settlement. *Canadian Journal of Zoology*, **72**, 1227-1237.

Parker, H., Rosell, F. & Gustavsen, Ø. 2002a. Errors associated with moose-hunter counts of occupied beaver *Castor fiber* lodges in Norway. *Fauna Norv Series A*, **22**, 23-31.

Parker, H., Rosell, F., Hermansen T.A., Sørløkk, G. & Stærk, M. 2002b. Sex and age composition of spring-hunted Eurasian beaver in Norway. *The Journal of Wildlife Management*, **66**, 1164-1170.

Rosell, F., Bergan, H. & Parker, H. 1998. Scent-marking in the Eurasian beaver (*Castor fiber)* as a means of territory defense. *Journal of Chemical Ecology*, **24**, 207-219.

Rosell, F. & Hovde, B. 2001. Methods of aquatic and terrestrial; netting to capture Eurasian beavers. *Wildlife Society Bulletin*, **29**, 269-274.

Rosell, F. & Parker, H. 1995. Beaver management: present practice and Norway's future needs. Telemark College, Bø, Norway: 1-137 [In Norwegian with an English summary].

Rosell F., Parker H. & Steifetten Ø. 2006. Use of dawn and dusk sight observations to determine colony size and family composition in Eurasian beaver *Castor fiber*. *Acta Theriologica,* **51**, 107-112.

Rosell, F. & Pedersen, K.V. 1999, *Bever*. Landbruksforlaget, Oslo.

Saveljev, A.P. & Milishnikov, A. 2002. Biological and genetic peculiarities of cross composedand arboriginal beaver populations in Russia. *Acta Zoology Lituanica*, **12**, 397-402.

Slough, B.G. & Jessup, R.H. 1984. Furbearer inventory, habitat assessment, and trapper utilization of the Yukon River Basin. Yukon River Basin Study Project Report, Wildlife No. 1, 1-87, Yukon Department of Renewable Resources, Whitehorse, Yukon, Canada.

Slough, B.G. & Sadleir, R.M.F.S. 1977. A land capability classification system for beaver (*Castor canadensis* Kuhl). *Canadian Journal of Zoology*, **55**, 1324-1335,

Wilsson, L. 1971. Observations and experiments on the ethology of the European beaver (*Castor fiber* L.). *Vitrevy*, **8**, 115-266.

ANNEX 1: LODGE OBSERVATION RECORDING SHEET

Lodge Observation Recording Sheet

OBSERVER/S	
DATE	LOCATION (site name and grid ref)
START TIME	END TIME

INDIVIDUAL	TIME SEEN (00:00)	AGE CLASS (kit/subadult/adult)	NEWLY SEEN (yes/no/unsure)	INTERACTING WITH OTHERS

Notes

www.snh.gov.uk

ISBN: 978-1-78391-203-2

Policy and Advice Directorate, Great Glen House,
Leachkin Road, Inverness IV3 8NW
T: 01463 725000

You can download a copy of this publication from the SNH website.

recycle

Scottish Natural Heritage
Dualchas Nàdair na h-Alba
All of nature for all of Scotland
Nàdar air fad airson Alba air fad