Tayside Beaver Study Group

Final Report

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Executive summary

Background

The Tayside Beaver Study Group was established in 2012 by Scottish Natural Heritage (SNH) in response to a decision by the Minister for Environment and Climate Change to tolerate the unlicensed beaver population in Tayside. The Minister decided that the Tayside beaver population should be allowed to remain in place and be subject to appropriate study for the duration of the official Scottish Beaver Trial (SBT) in Knapdale, Mid Argyll. At the end of the trial reporting period in 2015, the Minister will take a decision on the future of beavers in Scotland, including those in Knapdale and Tayside.

The Group was chaired by the SNH Area Manager for Tayside and Grampian. It comprised a range of partners; National Farmers Union of Scotland, Royal Zoological Society of Scotland, Scottish Environmental Protection Agency, Scottish Government, Scottish Natural Heritage, Scottish Land & Estates, Scottish Wild Beaver Group, Scottish Wildlife Trust, Tay District Salmon Fisheries Board and the Confederation of Forest Industries.

The group had two principal aims:

- To gather information about the Tayside beavers and monitor impacts on local wildlife and land uses in the area;

- To help identify a variety of means to resolve any conflicts between beavers and land uses in the area; provide advice and practical help to land owners at a local level, and to consider how these means could be used more widely in the future.

The information gathered from Tayside will complement information recently gathered from the SBT and will be used by SNH to report to Scottish Ministers in May 2015. This information will aid the decision making process as to the desirability of beaver reintroduction to Scotland.

Key activities undertaken during the monitoring period included;

- gathering information on the health and genetic status of the population
- understanding breeding success to aid with population modelling
- recording impacts on land use
- investigating and trialling methods to minimise negative impacts
- establishing the current and future requirements for advice

The work of the group did not extend to the study of the ecological effects of the beaver population, including any ecosystem services/dis-services that may result from their presence.

A part time Project Officer (PO) was employed from April 2013 until December 2014 to progress and co-ordinate these activities.

This report summarises the findings from previously published works on the Tayside beaver population, and presents detailed accounts of the rest of the work undertaken by TBSG. Discussion of each set of results is presented, together with an overview discussion of the findings for the Minister's consideration.

Key findings

21 beavers were sampled as part of the veterinary health screening programme and 25 as part of the genetic screening. All were Eurasian beavers (*Castor fiber*) and all tested negative for an extensive range of significant diseases. These sample results indicate that the Tayside beavers pose no current health risk to other wildlife, domestic animals, livestock or the public. All beavers displayed good body conditions and no concerns were raised regarding the beavers ability to survive in the wild in Tayside. These results are subject to a separate published report.

Observations at a number of beaver lodges found that beaver group sizes, the group composition (adults, sub-adults and kits) and average the average litter size of 1.9 kits, all fall within the ranges expected of Eurasian beavers. It appears that beavers are thriving within a diversity of land use types within the Scottish environment, and that the Tayside population is currently within a phase of growth and expansion.

A total of 56 beaver sites across Tayside were brought to the attention of the Project Officer. These included sites visited at the request of land managers to provide advice; sites identified as suitable for trapping to support the programme of live capture and release for genetic and health studies; and sites reported in completed questionnaires targeted at landowners and managers in Tayside experiencing beaver activity on their land. Of this 56, 50% (28) reported negative impacts, 2% (1) reported positive impacts and 41% (23) reported no impacts. There was insufficient information provided to categorise 7% of the sites. Negative impacts ranged in severity from gnawing on a tree to more major impacts, such as repeated damming in drainage networks servicing productive arable fields, and burrowing into flood defence banks.

The majority of negative impacts were recorded in the more intensive lowland agricultural areas at sites directly adjacent to watercourses and where actively functioning field drainage is necessary to maintain commercially viable crop yields. Of those experiencing negative impacts, 70% stated a financial cost as a consequence.

The record of positive impacts related to habitat creation and diversification in a loch as a result of several years of beaver activity. The ecological effects of beavers in Tayside were not monitored in detail. This was because it was not possible to establish appropriate baselines against which to measure any changes, and also because a range of ecological effects were the subject of focused quantitative studies at the SBT. The TBSG instead made an early decision to maximise opportunities to complement the SBT by prioritising the documentation of land use issues and conflicts as these were likely to be more diverse than

at Knapdale. As a result the ecological impacts of beavers across Tayside have not been recorded beyond the one anecdotal example.

The 41% of sites where no significant impacts were reported as a result of beaver activity were usually associated with areas of semi-natural/non-commercial riparian woodland, or other non-commercial land adjacent to watercourses. The land managers at these sites did not seek any form of mitigation or management.

Several forms of mitigation were trialled during the Project. Tree protection and dam management were carried out with success in suitable situations. Fewer trials were undertaken than hoped, with a significant number of land managers being reluctant to implement mitigation for a variety of reasons. These included concerns over the cost and time required to install and maintain mitigation; an absence of practical and affordable measures being available in a number of situations and an expectation of failure. Some also expressed a reluctance to put in place measures which aimed to minimise impacts as opposed to having the beavers removed. The removal of beavers was not an option on offer by TBSG in line with the Ministerial decision to allow the beavers to remain in Tayside for study purposes until the future of beavers in Scotland has been decided.

The Project identified a range of advice requirements in Tayside. The managers of sites with negative impacts all desired advice on minimising/eliminating beaver impacts, including removal (which, as stated above, was not a practical option available to TBSG) and/or mitigation methods. The managers of several sites, where there was no experience of negative impacts, stated an interest in receiving advice on realising the potential benefits of beaver activity in terms of tourism and conservation.

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Acknowledgements

We would like to thank all those landowners and land managers who engaged with TBSG and assisted with monitoring, trapping, impact recording and case study work. Particular thanks to those who gave permission to trap and re-release beavers on their sites and gave up their own time to assist on the ground during the trapping and screening programme. Thanks also to Roisin Campbell-Palmer (RZSS) and Neil Mitchell (SNH) for their time and advice assisting with practical elements of the project and beaver ecology training. Thanks also to Scottish Land & Estates and NFUS for their active encouragement of local members and others, to engage with the work of the TBSG. We are also grateful to those who voluntarily assisted with various survey works. The work of Helen Dickinson as Project Officer has been essential in being able to achieve the work set out in this report, and we are grateful for the management provided by Simon Jones of SWT and James Scott of SNH. Finally, gratitude is expressed to all past and present members of the TBSG, who set aside their differences to devise, steer and support a series of objective studies of the Tayside beaver population.

1. Introduction

From 2006, Scottish Natural Heritage and other agencies became aware of a wild living population of beavers distributed across a broad section of the Tayside catchment, and along the River Earn. It is believed that this population originated from escapees, or animals released illegally, from private collections. A survey commissioned by Scottish Natural Heritage (SNH) in 2012, and reported separately, established there were approximately 38-39 beaver groups resident in the Tay catchment (Campbell *et al.,* 2012). In the same year, a decision was made by the then Minister of Environment and Climate Change to allow the Tayside beavers to remain in place until 2015, but be subject to various studies. The information gathered in Tayside complements that gained from the government licenced Scottish Beaver Trial (SBT), which took place in Knapdale, Mid Argyll between 2009 and 2014, and will help to inform the Minister's decision on the future of beavers in Scotland due to be made in 2015.

The Tayside Beaver Study Group (TBSG) was formed in 2012 by SNH on behalf of Scottish Government (SG) to undertake monitoring across Tayside. The TBSG is made up of interested parties that direct the Group's activities. Members are National Farmers Union of Scotland (NFUS), Royal Zoological Society of Scotland (RZSS), Scottish Environmental Protection Agency (SEPA), Scottish Government, Scottish Natural Heritage, Scottish Land & Estates (SLE), Scottish Wild Beaver Group (SWBG), Scottish Wildlife Trust (SWT), Tay District Salmon Fisheries Board (TDSFB) and the Confederation of Forest Industries (ConFor).

1.1 Objectives of TBSG

The principal aims of the group were set out in the agreed terms of reference:

- To gather additional information and monitor impacts of the Tayside beavers on other wildlife and land uses in the area, to help inform Ministers' decision on the future of beavers in Scotland in 2015; and
- To help identify a variety of means to resolve any conflicts between beavers and land uses in the area and provide advice and practical help to land owners at a local level.

The remit of the group did not extend to:

- Promotional work designed to increase support for beaver reintroduction
- Compensation to landowners and land managers for any loss incurred as a result of beaver activity
- Monitoring and regulation of private collections
- Running or monitoring the Scottish Beaver Trial
- Investigation and management of any beavers found out with the Tay and Earn river catchments
- Decision on any licence applications for the release of beavers in Scotland

Key activities covered during the monitoring period included:

- Lodge productivity surveys to establish information on breeding success rates (SNH commissioned report CR802)
- A trap and re-release (at point of capture) programme to facilitate veterinary health screening and DNA sampling (SNH commissioned reports CR681 and CR862)
- Monitoring impacts on land uses
- Investigating and trialling potential measures to reduce and resolve beaver-land use conflicts
- Documenting the range of experiences of landowners and land managers with beaver activity and identifying the current needs in terms of advice
- Responding to reports of beaver activity, confirming and documenting locations

Although included within the Terms of Reference, the TBSG made an early decision not to undertake monitoring of the ecological effects of beavers on other wildlife (and habitats) in Tayside. This was partly because it was not possible to establish appropriate baselines against which to measure changes, but also because, within the time and resources available, greater value could be achieved by complementing the research efforts of the SBT rather than duplicating them. Accordingly, priority was given to the documentation of land use issues and conflicts as the diversity of potential experiences was much greater than available at Knapdale.

1.2 Objectives of the report

This report provides an overview of the activities undertaken by the TBSG. It summarises the findings of studies commissioned by, or on behalf of, the TBSG and have been subject to separate publication, and provides detailed findings of the rest of the projects undertaken by the group but not published previously. The latter includes detailed documentation of impacts and presents the results of various monitoring work. It provides information on the range of experiences of beaver activity encountered by landowners and land managers gathered from the results of a targeted questionnaire and site visits. It also provides details on the implementation and outcome of mitigation trials used to minimise negative impacts resulting from beaver activity. A record of, and any outcomes from engagement activities are also included.

2. Beaver distribution and activity reports

In 2012, in order to provide some basic information to support the work of the TBSG, SNH commissioned a survey of the extent, distribution, population size and activity of beavers across the Tay catchment and the River Earn. The results are detailed in SNH's Commissioned Report No. 540 'Distribution, Population Assessment and Activities of Beavers in Tayside'. The survey report estimated that 38-39 beaver territories were present in the Tay catchment and the River Earn at that time. Beaver activity was present at low levels on the Tay and Tummel, and the majority of activity was evident on the Earn and also the Isla and its tributaries including the Ericht, Dean Water, Kerbert Water and the Lunan (Fig. 1) (Campbell *et al.,* 2012).

The TBSG decided against commissioning of a full resurvey for autumn 2014. This was because it would have been only just over 2 years since the full survey, so there would have been little opportunity for a significant enough change to justify the expenditure. Furthermore, the extensive effort to make contact with land owners/managers experiencing beaver activity across the catchment was in itself likely to identify new beaver sites. Between April 2013 and November 2014, 38 cases of beaver activity were reported to the Tayside Beaver Project Officer (PO). Eleven of these reports were in areas not previously identified within the 2012 survey.

The areas of new activity recorded in this period have been added to the 2012 distribution map and are indicative of some further expansion of range in Tayside to the south, west and east (Fig. 2).

TAYSIDE BEAVER STUDY GROUP

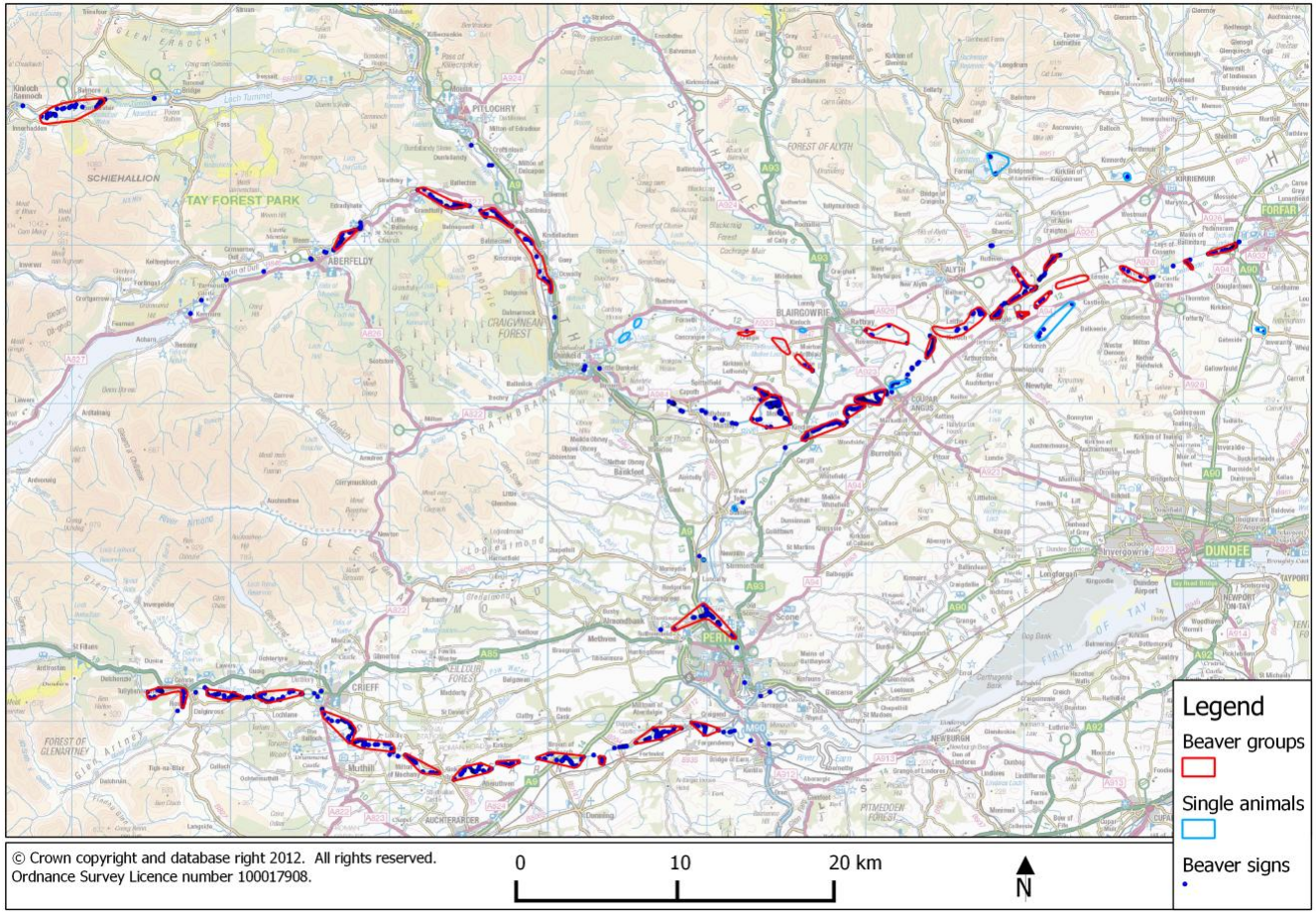

Figure 1. 2012 beaver distribution map

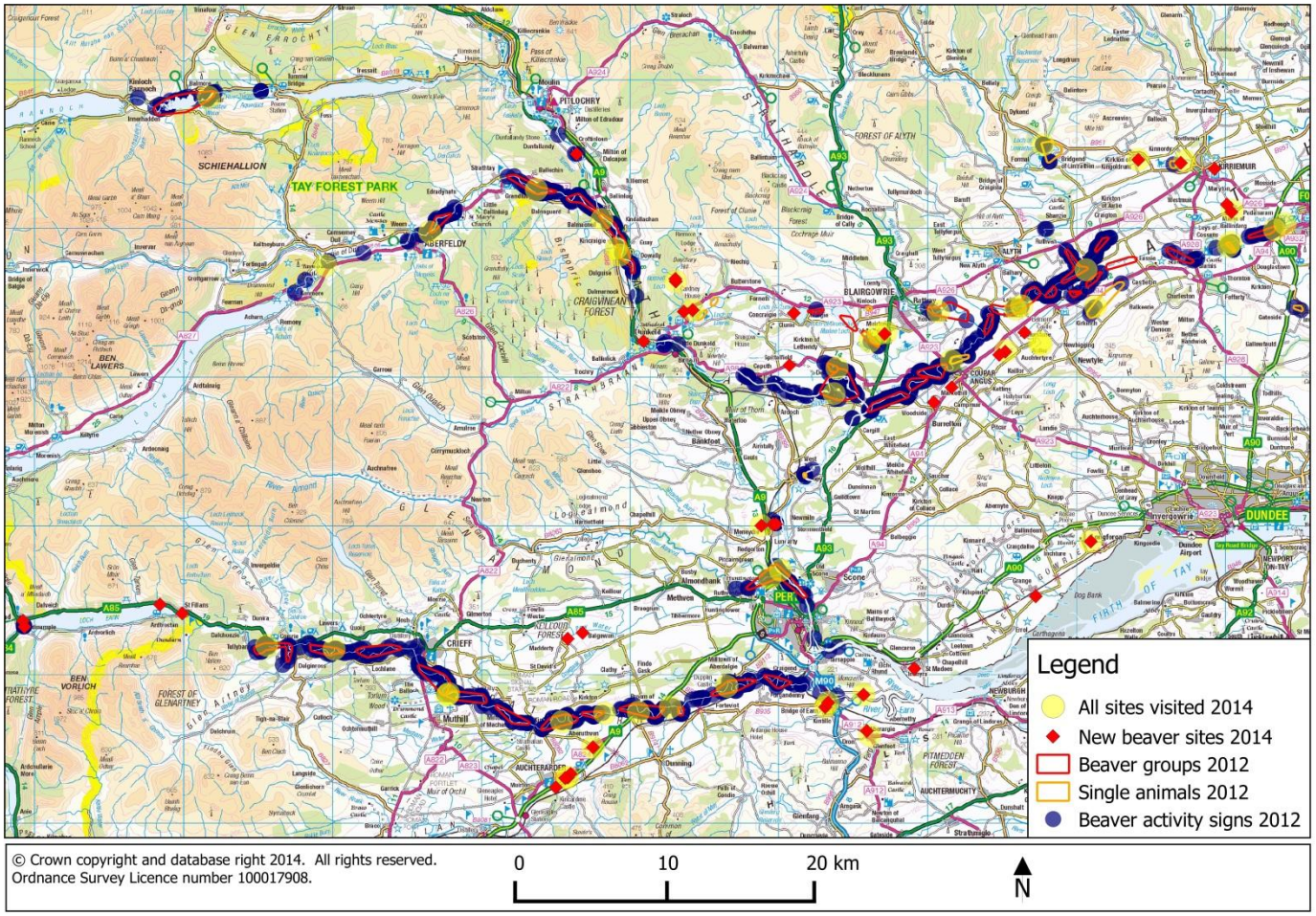

Figure 2. 2014 beaver distribution map (updated from activity reports)

3. Trapping and health and genetic screening

These two pieces of work were commissioned at the behest of the TBSG. Once suitable trapping sites were identified and permission to set traps was gained, traps had to be set and checked regularly and caught animals processed rapidly by the RZSS veterinary team. We are grateful to the land owners who gave permission for traps to be placed on their land for live capture and release.

Each study is the subject of a separate detailed report published on behalf of the TBSG by SNH. The summaries of both are reproduced below.

3.1 Health screening

Commissioned Report No.: 681
Project no: 013810
Contractor: Royal Zoological Society of Scotland
Year of publication: 2015
Title: 'Trapping and health screening of free-living beavers within the River Tay catchment, east Scotland'. (Campbell-Palmer *et al*., 2014).

Background

Since 2006 Scottish Natural Heritage (SNH) has been aware of small scale evidence of free-living beavers in and around the River Tay catchment. A distribution survey undertaken by Campbell *et al*., (2012) determined that a sizeable population was established within this area, outside of the official Scottish Beaver Trial (SBT). In March 2012, the Minister for the Environment and Climate Change announced that the presence of these beavers living in Tayside would be tolerated until a decision on the future of beaver reintroduction to Scotland is made in 2015. Information gathered from SBT, from this Tayside population and from experiences of European counterparts already living with the presence of beavers will be presented to the Scottish Government by SNH to aid in this final decision-making process.

Potentially 38-39 groups of free-living beavers have been identified within the catchment of the River Tay east Scotland (Campbell *et al.,* 2012). The origin and health status of these animals are unknown and may be of concern, particularly if they carry non-native parasites (such as *Echinococcus multilocularis)* or diseases (such as Tularaemia). There is also a need to clarify that the non-native North American species (*Castor canadensis*) has not been released and that any trapped beavers are Eurasian (*C. fiber*). Species identification was recorded here through the colour and viscosity of anal gland secretions, however, further information on species and population identification was undertaken through genetic analysis and will be reported separately (McEwing *et al*., 2014). Reported here are the findings from a beaver trapping and health screening programme which occurred within the Tayside catchment over October 2012 to April 2014.

Main findings

- There is an identified need to assess any disease risk posed by the free-living population of beavers that has become established throughout the River Tay catchment, east Scotland.
- Sampling was undertaken through live-trapping and post-mortem examination. The 21 individuals screened were relatively evenly distributed across the current suspected range.
- The non-native, host specific beaver fluke parasite was present in the majority of individuals (70%).
- No evidence of *Echinococcus multilocularis* or Tularaemia was determined in any live-trapped or post-mortem examined beavers.
- All screened beavers displayed good body conditions, had no physical abnormalities, displayed haematological values within normal ranges and tested negative to all diseases screened.
- Individuals did not display any adverse effects of the live trapping, although minor abrasions to nose, mouth and forepaws were displayed in a minor number of animals on removal from the trap. One beaver had a chipped incisor tooth which may have been caused by biting on the trap. Elevated creatine kinase levels were evident in six individuals, hypothesised to be to be due to increased activity levels from trying to get out of the traps. No individuals displayed any adverse effects during the health screening process itself, although one individual died on recovery from the required general anaesthetic. All other beavers made a full recovery and were released in the late afternoon on the day and at the point of capture.
- One individual was recaptured five months later, ~24km from the previous capture point. This beaver had put on weight and showed no negative effects of previous trapping and health screening procedures.
- From a health and body condition perspective there is no evidence that beavers are failing to cope in a Scottish environment or are suffering from compromised welfare. There is evidence that beavers are subject to mortality from vehicle collisions, and some shooting of individuals is occurring.

3.2 Genetic Screening

Commissioned Report No.: 682
Project no: 013810
Royal Zoological Society of Scotland
Year of publication: 2014
Title: 'Genetic assessment of free-living beavers in and around the River Tay catchment, east Scotland.' *Scottish Natural Heritage Commissioned Report No.* 682. (McEwing *et al.,* 2014).

Background
There is an estimated minimum of 38 active beaver groups identified within the River Tay catchment, in east Scotland (Campbell *et al*., 2012). These beavers are of unknown species

and geographical provenance, and there is therefore a requirement to provide basic information on this 'population' so that information can be provided to aid the upcoming Scottish Government decision on beaver reintroduction and to advise any relevant management plans regarding their future. The findings from the Scottish Beaver Trial (SBT), along with information gathered through the Tayside Beaver Study Group (TBSG), and experiences from European counterparts living with beavers, will all be considered by the Scottish Government to determine not only the future of the SBT and Tayside beaver populations, but also the future of beaver reintroduction to Scotland.

RZSS has developed a suite of genetic markers to be used for identifying individuals for beaver reintroduction and post-release monitoring, as advised by the IUCN Reintroduction Guidelines (IUCN 2013). RZSS was asked to utilise these new genetic tools to investigate the identity and origins of the beavers now resident on the River Tay catchment.

This report highlights the findings of the genetic analysis from blood samples collected from live-trapped individuals and tissue samples from collected cadavers of beavers living within the River Tay catchment. More detailed descriptions of the genetic markers, methodology and analytical techniques implemented here can be found in Senn *et al*. (2013, 2014) and McEwing *et al*. (2014).

Main findings

- Twenty-five Tayside beaver samples were analysed. All individuals were genetically determined to be the Eurasian beaver species (*Castor fiber*).
- All beaver samples were genetically tested to ascertain the origin of their source population; all had a German (most likely Bavarian) provenance.
- The beaver samples were consistent with the Tayside population originating from three distinct lineages of *C. fiber* from Germany.
- If treated as a single biological population, a high degree of genetic diversity (measured as allelic richness and expected heterozygosity) was evident in comparison to other sampled beaver populations across the Eurasian range. Such an observation is expected, given the likely admixed population origin (Bavarian) of the beavers on the Tay catchment.
- Evaluating the relatedness among the twenty-five samples indicated the likelihood of there being approximately three parent / offspring relationships; eleven full sibling relationships; ten half sibling relationships and twenty-two first cousins relationships.
- From a genetic perspective, as many of the beavers within the Tayside catchment are closely related the degree of inbreeding in the future could be a cause for concern, particularly if dispersal becomes limited.
- The extent to which the beavers in the River Tay catchment are acting as a biological (freely breeding) population is yet to be determined. This requires consideration when assessing levels of genetic diversity, relatedness and therefore their genetic health. The genetic data provided here should be considered a baseline measure of genetic health and we advise future replicated studies to monitor genetic health effectively over suitable time scales i.e. in one generation.

4. Lodge productivity

Commissioned Report No.: - 802
Project no: 013810
Contractor: RZSS/TBSG
Year of publication: 2015
Title: Group size and reproductive rates within the Tayside beaver population, Perthshire.Scottish Natural Heritage Commissioned Report No. 682 (Campbell-Palmer R, Dickinson H, Wilson K, Rosell F. 2015).

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.

5. Socio-economic study

The SBT included a socio-economic study of the effects if the trial in Argyll. In order to provide complementary information to the Minister, SNH contracted a similar report for Tayside. The findings can be obtained from the following report, entitled: Tayside Beaver Socio-economic Impact Study, *SNH Commissioned Report No. 805 (Hamilton, A., & Moran, D., 2015.*).

6. Public engagement

Public engagement was undertaken to raise awareness of the TBSG and the purpose of its work, and also to encourage contact over beaver activity.

6.1 Press coverage

2013

Five pieces relating to TBSG were published in local newspapers, including the Angus Courier, Perthshire Advertiser, Blairgowrie Advertiser and the Highland Perthshire Comment. Reports included general overviews of the TBSG and their activities and more detailed reports on the trapping and health and genetic screening programme. Member specific magazines also covered details of TBSG in 2013, including the NFUS Scottish Farming Leader and Scottish Land & Estates Members Magazine. Online coverage was provided by SLE to promote the landowner/land manager questionnaire. A televised report on the BBC One Show detailed the RZSS work on trapping and health screening programme.

2014

Three BBC television pieces aired; Countryfile and Landward produced reports looking at the work of TBSG and the potential benefits and costs of beavers, BBC Breakfast News reported on the activity of beavers in Tayside. Two radio pieces were aired, BBC Radio Scotland Out of Doors programme broadcast an audio version of the Landward piece and Radio Tay produced a brief item to promote the landowner/land manager questionnaire. Online coverage included a report in an SNH E-Newsletter on the progress of the Project and an SLE article documenting the occurrence of a Beaver Information Session attended by several TBSG representatives. A similar report was published in the Scottish Farmer following from the SLE event and encouraging completion of the landowner/land manager questionnaire.

6.2 Community engagement

Over the course of the Project contact was made with 15 community councils across Tayside, via email or phone call. All councils close to, or having beaver activity in their area were offered the option of the PO providing further details on TBSG to display or to book a

talk at a community council meeting. Three councils responded and displayed details about TBSG on local notice boards and a community website and Facebook page.

Eleven fishing clubs were contacted and provided with details on the work of TBSG and offered a talk by the PO. There was no uptake of the offer, but the groups were made aware that TBSG would like to receive any reports of beaver activity, potential issues, and general concerns associated with fish and fishing. One group posted this request on their website. No subsequent reports from fishing groups were received. This may be because most angling takes place on the larger water courses where beavers are less likely to pose any issue for the activity. Furthermore, a specific study of the potential effects of beavers upon Atlantic salmon, sea and brown trout was undertaken by the Beaver Salmonid Working Group on behalf of the National Species Reintroduction Forum. Fishing interests may have been more inclined to engage with their work and saw no need to also make contact with the TBSG.

General Project talks were provided to five local natural history interest groups across Tayside.

The PO attended the 2013 Scottish Game Fair (held annually at Scone Palace) and was located within the SLE marquee. This provided an opportunity to meet with landowners with beaver activity on their sites and to promote the landowner/land manager questionnaire. At the 2014 Game Fair a joint marquee was held between the SBT), TBSG and the Beaver-Salmonid Working Group (BSWG) to raise awareness of the various aspects of their work on beavers in Scotland. Again this provided an opportunity to meet with those with experience of beaver activity, to disseminate the landowner/land manager questionnaire and to provide updates as to the Projects progress. Interest in the TBSG was much higher at the 2014 event and a larger proportion of individuals reported activity and were keen to receive further information on the work of the group.

6.3 Website emails and general enquiries

Emails received via the TBSG website were minimal, between 20 and 30 between April 2013 and November 2014. Emails included students wishing to undertake project work, offers of volunteer assistance with monitoring work, general sightings of beaver activity, requests for press pieces and requests for information on opportunities to watch beavers in the wild. General enquiries directly to the PO were of a higher volume, with a variety of emails and calls received on a monthly basis, including offers of voluntary assistance, general sightings of beaver activity, student research projects and requests for further information on the legal status of beavers.

6.4 Volunteers

Volunteers were required predominantly to assist with lodge productivity survey work over the summer periods and to assist with trapping work as required. A total of 20 people volunteered to assist and of these, six regularly undertook lodge watches and two helped

with checking traps. Two students also assisted with lodge watches in 2014 and one student assisted with both trapping and mitigation trials.

At several trapping sites landowners and land managers also provided voluntary assistance in setting and checking traps.

7. Professional engagement

7.1 Site visits

Conservation organisations:
There was a large amount of interest in the Tayside beaver population and a desire to understand the variety of experiences encountered as a result of beaver activity. Groups from several conservation organisations were taken out to see this first hand. Groups from the Royal Society for the Protection of Birds and Scottish/North of England Wildlife Trusts were taken out by the PO to look at both the potential positive and negative impacts arising from beaver activity and to discuss the issues and possible mitigation and management options.

Landowner organisations:
With the support of SLE and NFUS, the TBSG members visited a number of farms and estates over the period of its work to inspect beaver activity, and discuss implications directly with the land managers.

The Chair of TBSG attended a meeting organised by NFUS to discuss beaver activity and impacts on farmlands in Tayside and answer queries around the work and progress of TBSG. Over 30 farmers attended the meeting from Perthshire, Angus and Fife and then visited 2 sites with beaver activity and management issues for agriculture.

The PO, an SNH and SG representative from TBSG attended an SLE organised beaver information session held on a Tayside estate. Over 30 landowners and managers attended and representatives from TBSG were able to answer queries and offer advice regarding mitigation and management. They were also able to hear the concerns of those experiencing negative impacts as a result of beaver activity. The same representatives also attended a site visit/meeting organised by SLE to another site with beaver activity.

Government agencies:
Two groups from SNH visited sites in Tayside with an aim of gaining an understanding about the range of impacts being experienced in the area.
Liaison with SEPA has resulted in site visits with two staff members to look at specific issues on the ground. Guidance of an Environmental Protection Officer was sought on a site where damming activity had previously caused blockages in a culvert. The options around the licensing system for in-stream work were discussed in relation to a potential method of mitigation in the form of culvert protection fencing (see section 10).

Experience of Beaver activity and Management in another EU country

The PO, the TBSG Chair and the Scottish Government representative, took the opportunity to visit Bavaria to see first-hand the approach adopted to the management of beavers by another country subject to EU legislation. Beavers were first reintroduced to Bavaria in the

1960s and have expanded and consolidated their range and population to occupy a diversity of landscapes and land uses similar to those in Tayside. The visits were led by the lead beaver advisor/manager from a Bavarian NGO and investigated a range of land management issues and management techniques. They were also able to discuss issues with land owners, other advisers from a range of interests and backgrounds, and with local politicians.

7.2 Training

A day's training event was held with assistance from Roisin Campbell-Palmer (RZSS) and James Scott (SNH) in December 2014. This day was aimed at key members of relevant organisations, to provide training on basic beaver ecology, field signs, potential management issues, mitigation options and current legal and welfare advice regarding protection and control. The aim was to establish key points of contact within groups with land management interests in Tayside. These contacts will have some level of knowledge to be able to deal with beaver related queries from organisation members and members of the public. As a result of the training, these points of contact should be able to identify if it is beaver activity that is being reported; advise if there are any mitigation options that would be suitable and provide advice on the current legal situation and welfare issues related to mitigation/management options where applicable.

The day was split into a series of presentations on beaver ecology, management issues, mitigation options and legal and animal welfare issues. This was followed by site visits to see beaver field signs and mitigation options in practice at two sites within Tayside.

This training was attended by members of Angus Council, Forestry Commission Scotland, National Trust for Scotland, Perth and Kinross Council, RSPB, SEPA, SLE, SNH, Scottish Society for the Protection of Animals, TDSFB and Tayside Police.

8. Landowner/land manager engagement

8.1 Landowner/land manager questionnaire

A questionnaire was developed by TBSG which was targeted at Tayside landowners and land managers who have beaver activity on their land. The purpose was to document the range of experiences and opinions resulting from actual beaver activity across Tayside. It also sought to identify the range of support requirements and management options that land managers might desire to help with the implications of beaver activity now, and possibly in the future if beavers are allowed to remain beyond 2015.

Questionnaires were provided directly to individuals when undertaking site visits; sent to individuals who had been, or were in contact with the PO regarding beaver activity on their site; it was also distributed to visitors to the Scottish Game Fair who had beaver activity on their land. SLE made the questionnaire available via their website and the questionnaire was also distributed at the SLE organised beaver information session held in March 2014. Representatives of both SLE and NFUS sitting on the TBSG encouraged their members to complete the form and report any beaver activity directly to the PO. NFUS conducted their own survey and in this process advised people to complete the TBSG survey or report impacts directly to the PO.

The questionnaire was limited to obtaining information from people with practical experience of beavers on their land. Accordingly it was not made publically available via the TBSG website nor through the general press. Those who requested a copy were asked to confirm that they had genuine experience of beaver activity before the questionnaire was issued to them. In this way there was a good degree of confidence that forms were not completed by those without actual experience of beaver activity. Gauging public opinion based on theoretical notions was not the aim of this exercise and beyond the capacity of the TBSG.
A total of 31 completed questionnaires were received.

Twenty three of the respondents were visited either before or after the completed questionnaire was received to validate the experiences reported, gather more information and offer advice. Eight sites were not visited: two because no contact address was provided on the completed forms; two did not respond to follow up contact from the PO, and the remaining four did not desire a site visit. It is likely that a number of land managers remain unaware of the presence of beavers on their land so did not think the questionnaire could be relevant to them.

8.1.1 Results

Q1. Would you like to be kept informed of the activities of TBSG?

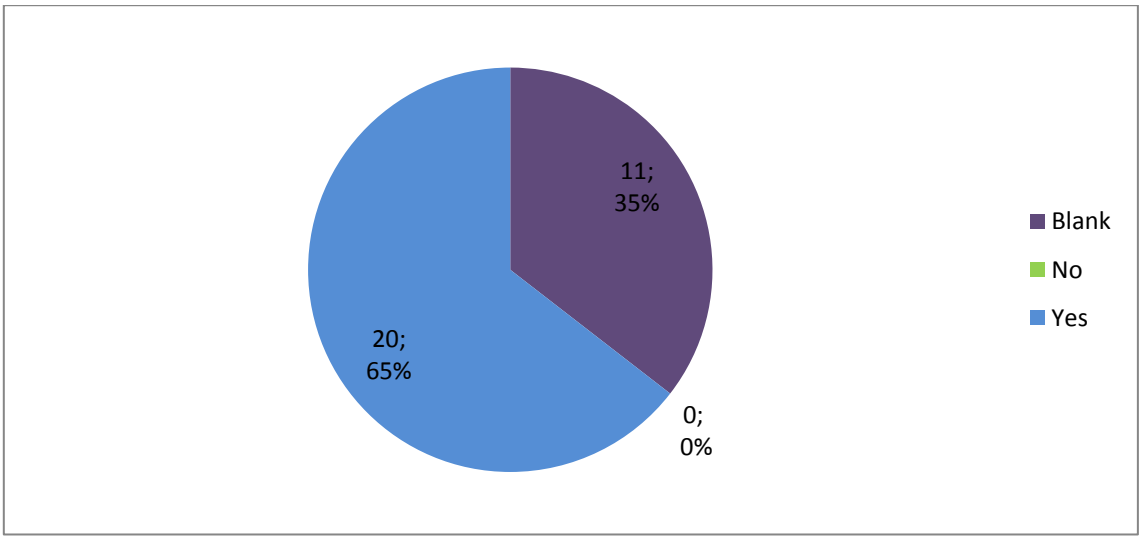

Figure 3. Kept informed of the activities of TBSG

Those who wished to be kept informed received several updates on progress with the work of the TBSG between October 2013 and December 2014, either via email or post.

Q2. Would you like to receive a visit from the Project Officer?

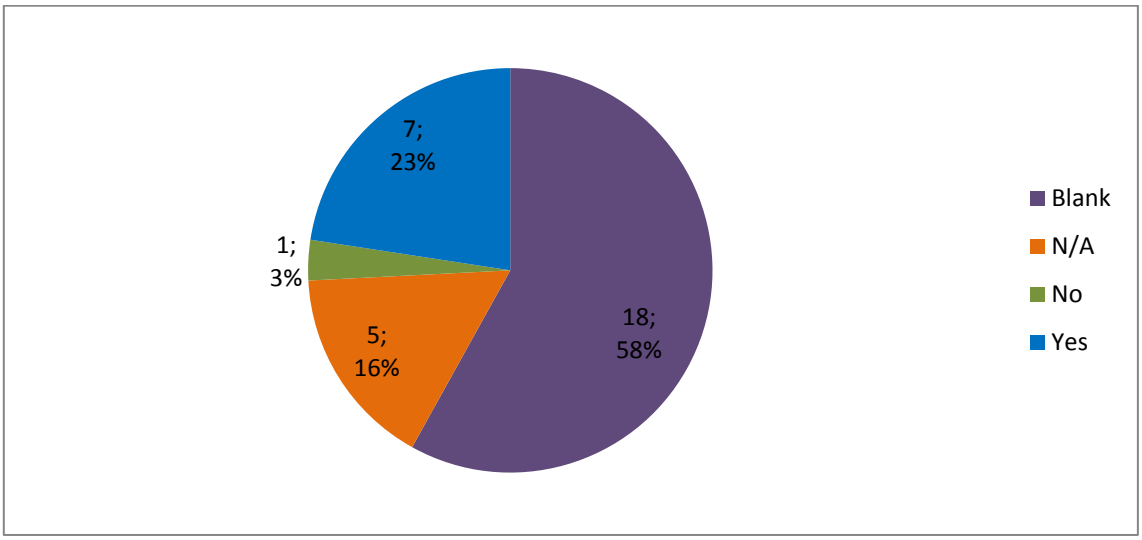

Figure 4. Receive a visit from the Project Officer

Contact was made with all individuals who requested a site visit after they had completed the questionnaire. Four out of the seven respondents had already been visited. Two sites were visited following receipt of the questionnaire. One individual did not respond to enable a site visit to be arranged but the site was visited after the estates gamekeeper made contact.

The individual who requested no site visit had already been visited as part of the trapping programme.

All five n/a individuals had received a site visit prior to completing the questionnaire.

Of the 18 blank responses nine had already received a site visit and two did not respond to requests to a visit.

Q3. Would you be willing to participate in a more detailed case study to follow up your responses to this questionnaire?

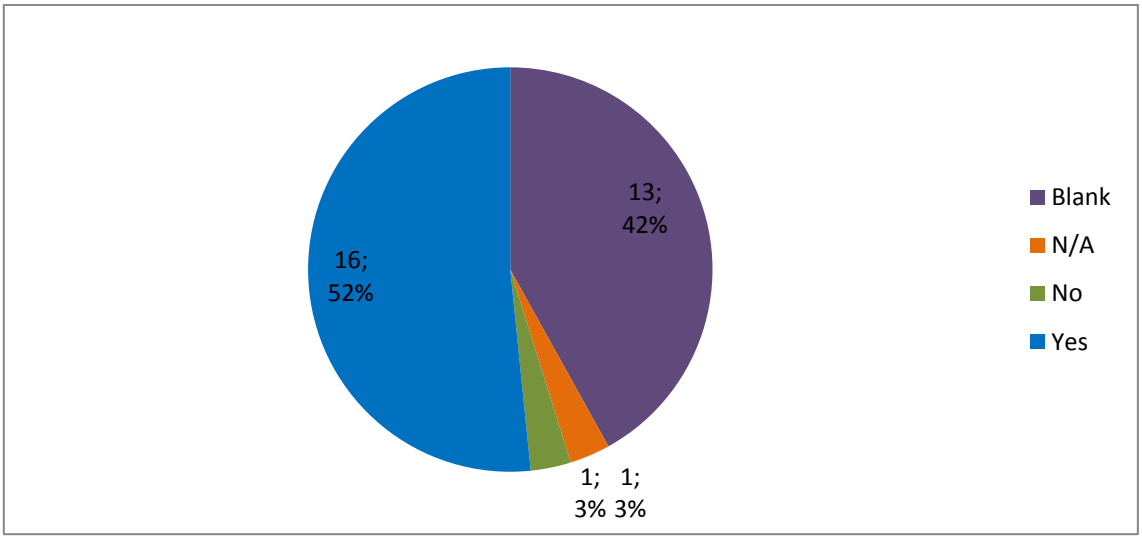

Figure 5. Participate in a more detailed case study

16 individuals were willing for their experiences to be used as a case study. From these, four sites were used as examples of negative impacts arising from beaver activity (see section 9.2). The rest of the offers were not taken up, either because the experiences duplicated those found on the chosen case study sites, or because they did not exhibit any significant impacts, either positive or negative, that would provide an informative case study. The single n/a return was for a site already in use as a mitigation trial site.

Q4. Please provide us with a brief description of your land management interest

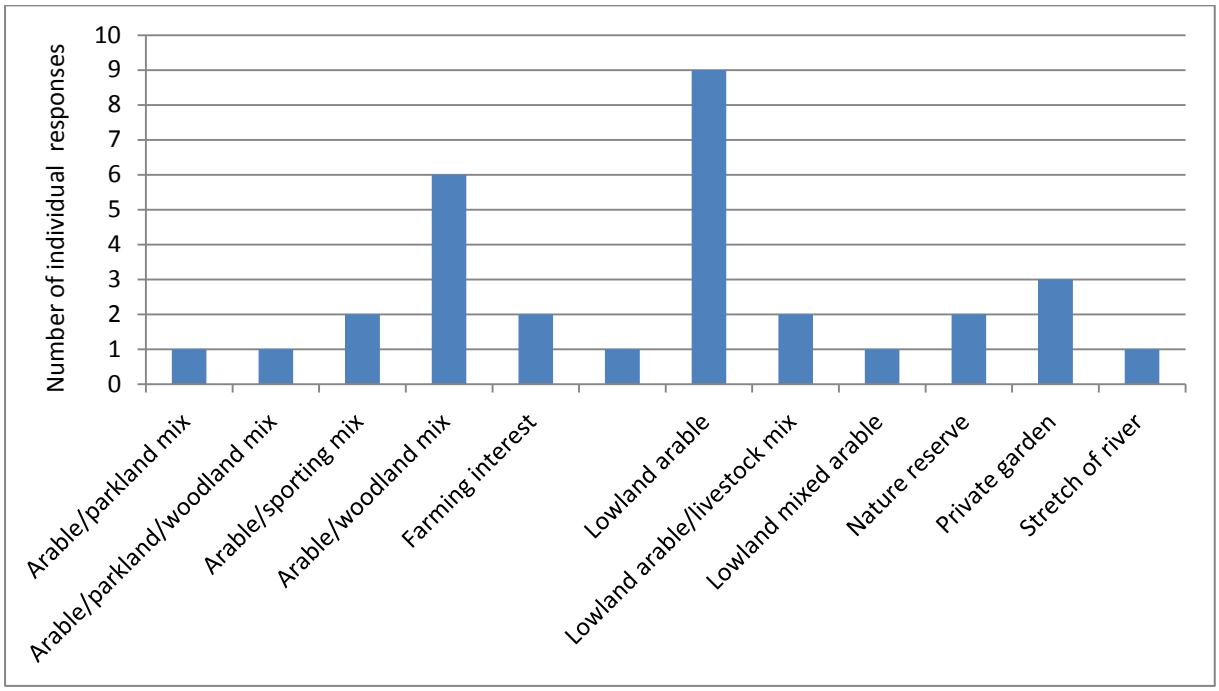

Figure 6. Land management interest

81% (25) of respondents classed their land management interests as arable/farming, either wholly or mixed. 10% (3) covered private gardens and 6% (2) nature reserves.

Q5. Would you be willing to permit live capture and release for a beaver health and genetic study?

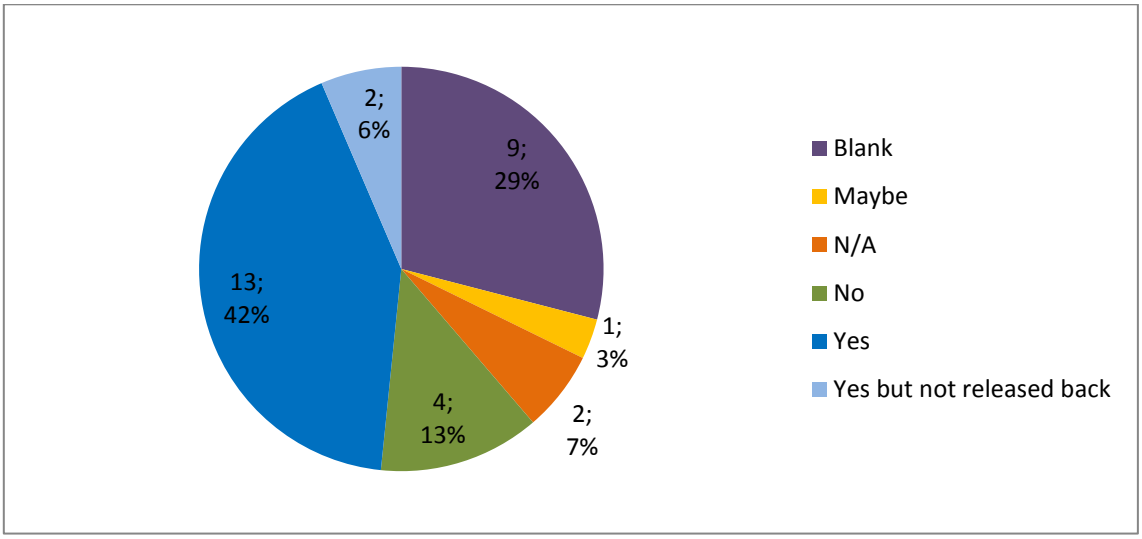

Figure 7. Willing to permit live capture and release for a beaver health and genetic study

Of the 13 yes answers, six replies were received after the trapping programme had ceased; one already had a trap in place; one site was baited subsequently but found to have no contemporary beaver interest; two had no signs of fresh activity to justify trap deployment and three did not have suitable locations to place a trap.

Both the two n/a answers were already in use as trapping sites.

Of the nine blank responses, five were already in use as trapping sites.

Two individuals would have been happy for beavers to be trapped and removed but not released back at their site.

The one “maybe” answer did not have fresh beaver activity on their land.

Q6. Approximately when did you first notice beavers on your land?

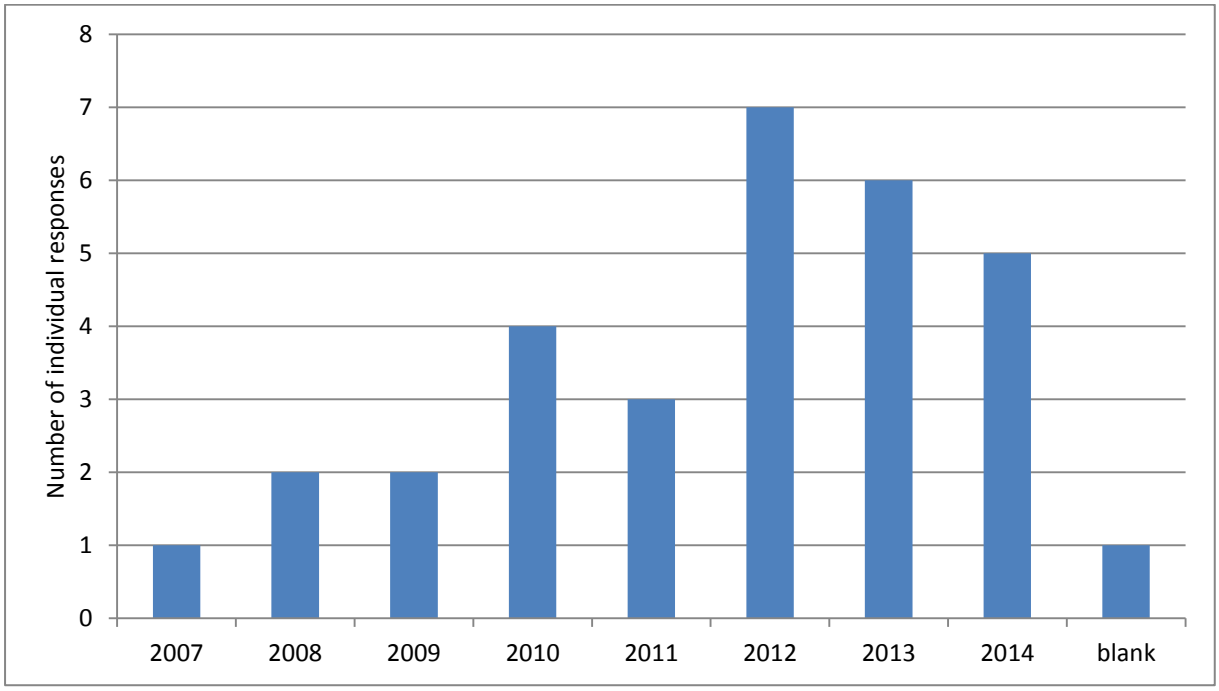

Figure 8. Year first beaver presence noted

The earliest recorded awareness of beaver activity was 2007. The largest proportion of respondents, 23% (7) became aware of beavers in 2012, followed by 19% (6) in 2013 and 16% (5) in 2014.

Q7. What drew your attention to their presence?

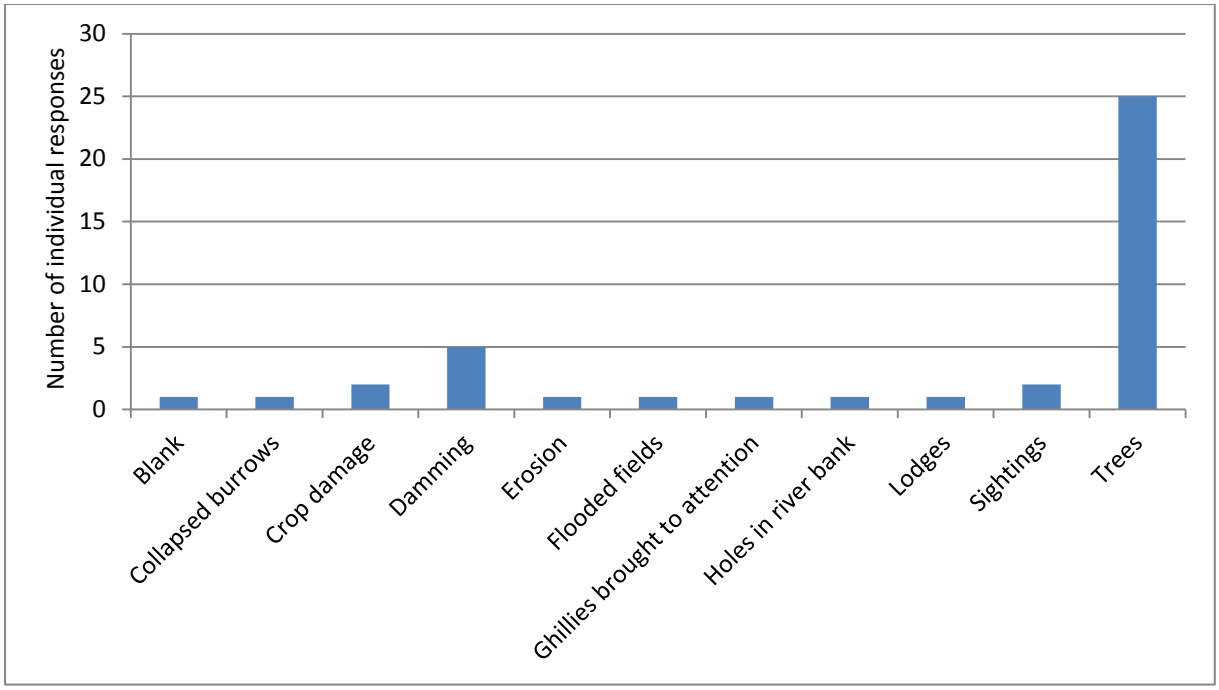

Figure 9. Initial beaver activity

25 respondents first became aware of beavers on their land as the result of the characteristic signs of gnawing and/felling of trees and branches. The next most common cause of awareness was damming, which was first noticed by five respondents.

Q8. What beaver activities have you experienced on your land?

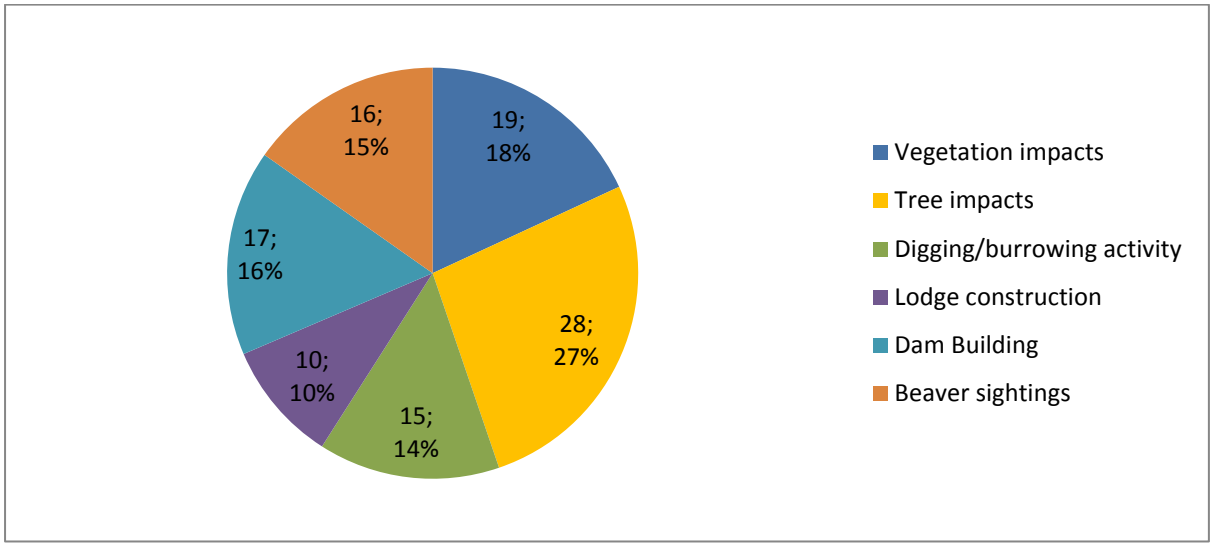

Figure 10. Beaver activities experienced

Impacts on trees were the most commonly stated experience, cited by 28 respondents. 19 individuals stated they had experienced impacts on vegetation, closely followed by dam

building (17), beaver sightings (16) and burrowing activity (15). Lodge construction was the least common activity experienced (10).

Q9. Have any of the following interests been impacted?

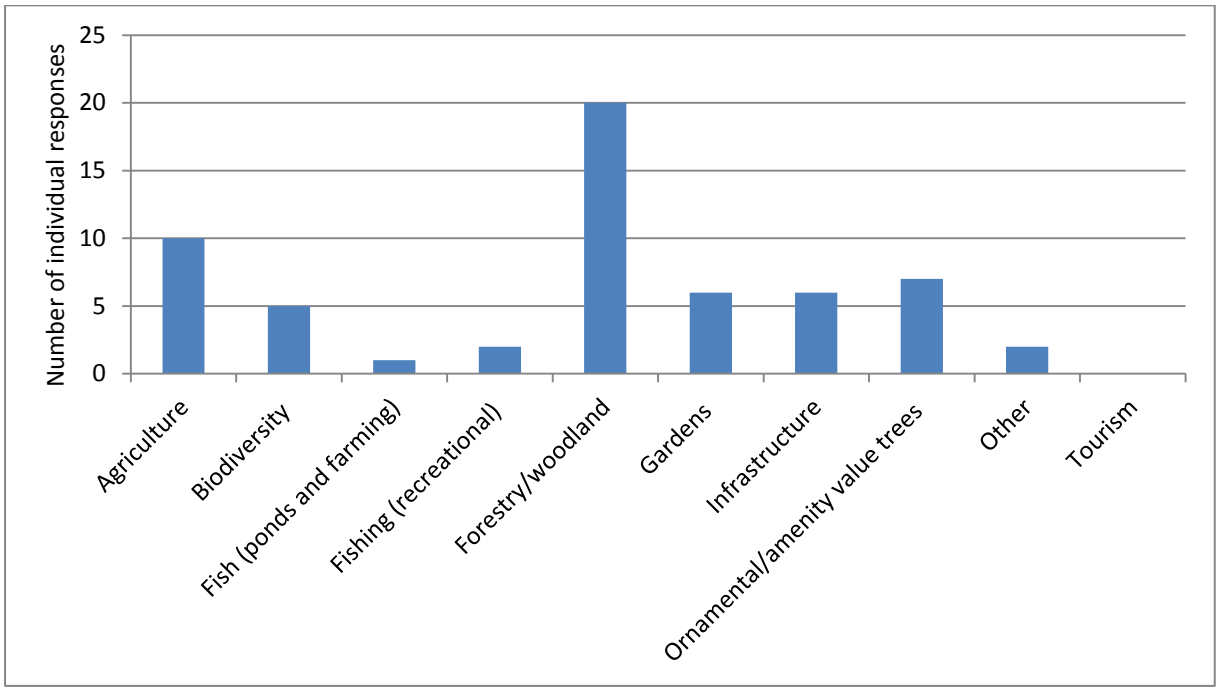

Figure 11. Impacted interests

Forestry/woodland was cited as the most commonly impacted interest (20). Of these respondents, one stated that 70 trees in a mixed broadleaf plantation had been felled over an 18 month period (site not visited to verify due to personal circumstances of landowner). Three stated that impacts were of a small extent and two stated the trees impacted were of no monetary value. Nine respondents stated the trees impacted were bank-side/river-side trees, with the majority being within narrow tracts of riparian woodland not used commercially. Two respondents cited impacts on garden trees of amenity value in this category (despite a separate category being available to record this impact).

Agriculture was recorded as the interest with the second highest incidence of impact (10). Issues cited included damming in drainage ditches and consequential impacts on field drainage; erosion of land due to burrowing and diverted water flows around dams; flood bank damage due to burrowing, and three cases of crop foraging

The third highest recorded impact (7) was on ornamental/amenity value trees. Six of these reports were on trees in gardens (2 also reported this type of damage under the category for forestry/woodland).

The fourth highest record of interests impacted was upon infrastructure (6) and gardens (6). Five out of the six respondents reporting impacts on infrastructure specified impacts on flood banks arising from beaver burrows. One individual reported that damming close to a bridge

had altered the flow dynamics of a burn which had then begun to undermine the bridge structure. No details of the type of bridge, its size or the scale of impact were provided.

Other issues raised in response to this question included impacts on biodiversity (5). Of these, 4 reported the potential for negative impacts on biodiversity, including loss of bird breeding sites caused by the felling of trees, loss of bank side plants and changes to the river substrate. The remaining respondent reported that beavers were benefiting open water habitats by feeding on and controlling the extent of aquatic vegetation.

One instance of a fish pond being flooded was recorded. Two individuals stated concerns regarding beaver dams stopping migratory fish movements. One was raised as something they perceived to be a potential issue and one stated a belief that a dam was preventing movement. Impact on fish movement could not be verified from a subsequent site visit.

Other recorded impacts included strain on relationship with neighbouring landowners with differing views on beaver activity.

Q10. What, if any, concerns do you have about the presence of beavers on your land?

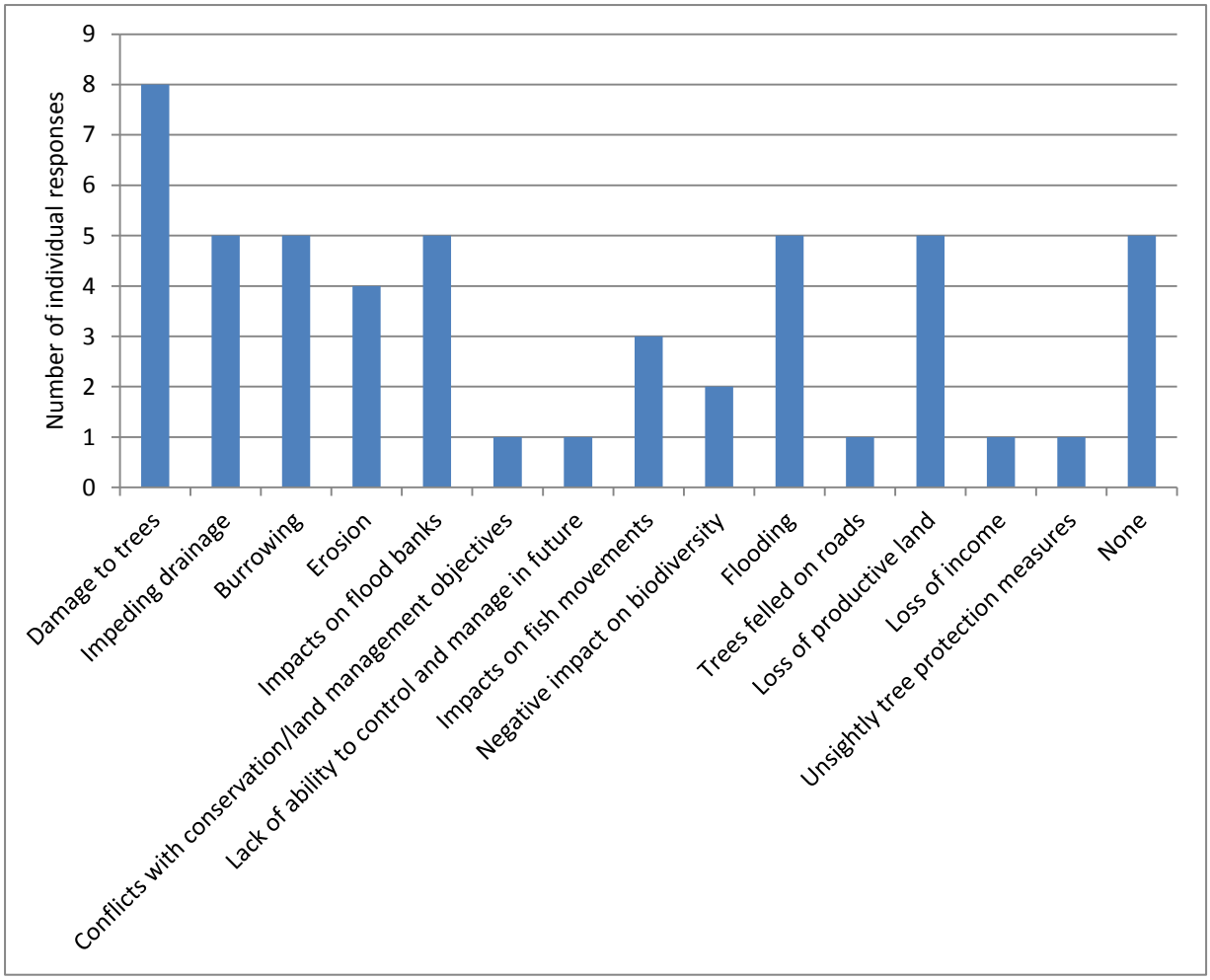

Figure 12. Concerns

Five respondents stated they had no concerns regarding beaver activity on their land. 26 reported concerns, with many of them having more than one (50 concerns reported from these 26 respondents). The most common concerns arose from impacts on trees; impeded drainage; burrowing impacts on flood banks; flooding as a result of dams or from breaches to flood banks, and the potential loss of productive land.

Q11. What, if any, benefits do you anticipate from the presence of beavers on your land?

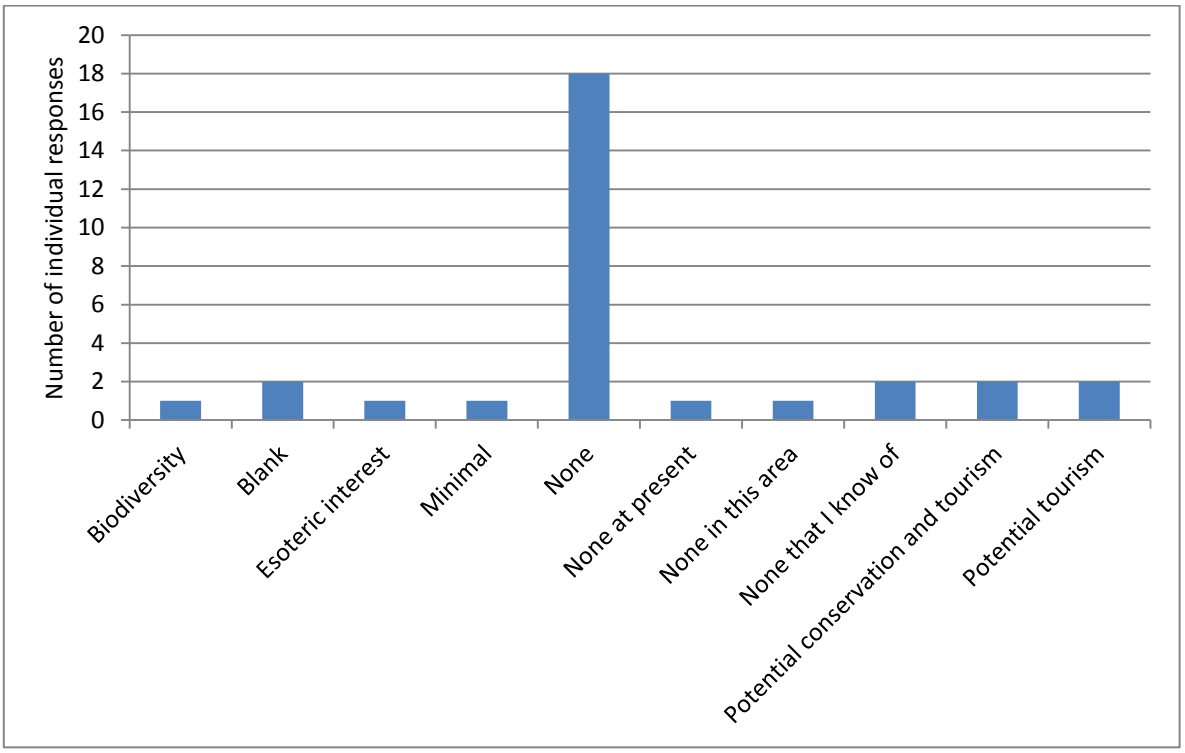

Figure 13. Benefits

Twenty two respondents did not anticipate benefits from beavers on their land. Of these, eighteen gave the firm answer that they anticipated none; one anticipated no benefits at present. Another intimated there may be benefits in other areas but not in arable land. Two were not aware of any benefits. Six respondents anticipated some benefits, one each for biodiversity and esoteric interest, with the other four anticipating a potential for conservation and/or tourism.

Q12. In your experience are there currently any financial costs or benefits to having beavers on your land?

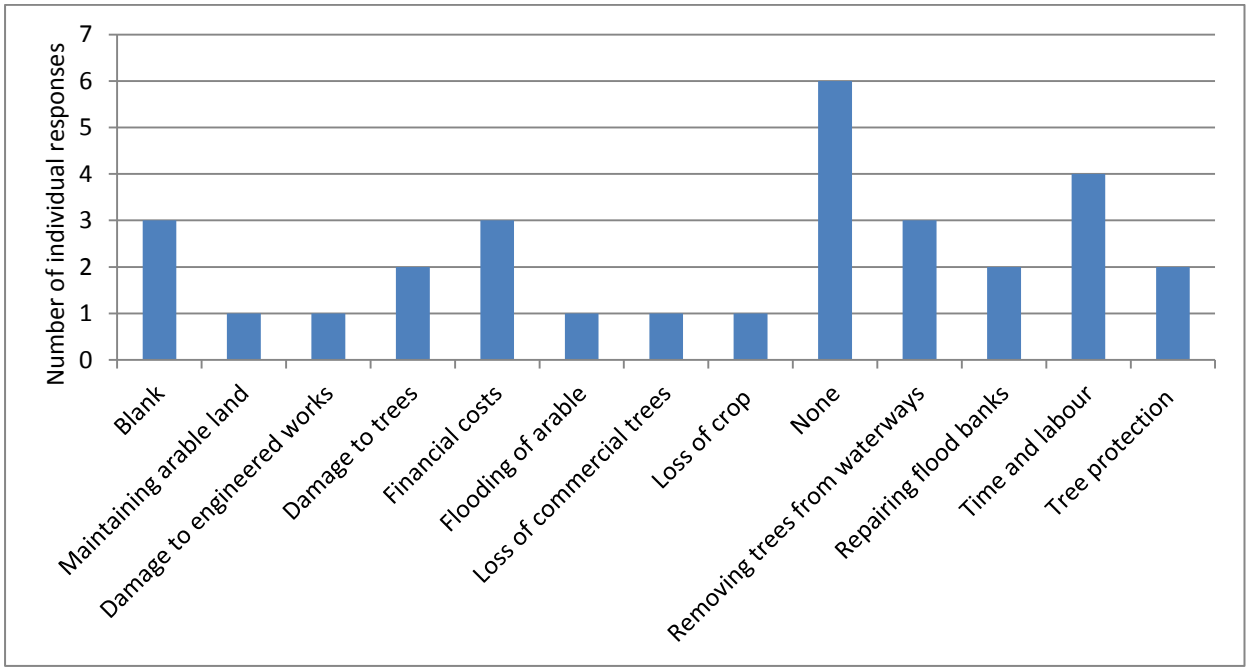

Figure 14. Financial implications

None of the respondents reported financial benefits. Of the 28 that responded to this question, six experienced no financial costs, while 22 reported some form of financial costs from the range of impacts. Three respondents provided supplementary information on the actual financial costs related to beaver activity. One had spent £1,553 over nine months to deal with dam removal and associated flooding. Another stated a figure of £10,000 to repair damage to flood defence banks, although no detailed breakdown of the costs was provided, and no visit was possible to verify the costs or find out more. Another had spent £30 to protect garden trees.

Q13. Have you tried any mitigation or management measures?

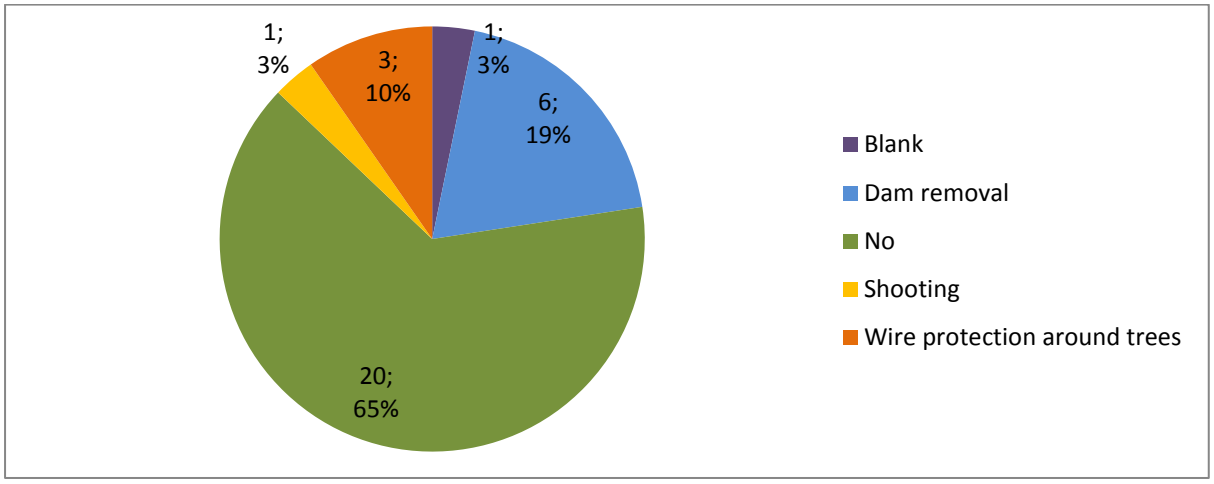

Figure 15. Management and mitigation

65% (20) of respondents have not tried any mitigation methods. Of those who had the majority (6) had undertaken dam removal. One individual had used lethal control to remove a beaver and three had installed wire protection around trees.

Q14. On balance do you feel the presence of beavers is positive or negative?

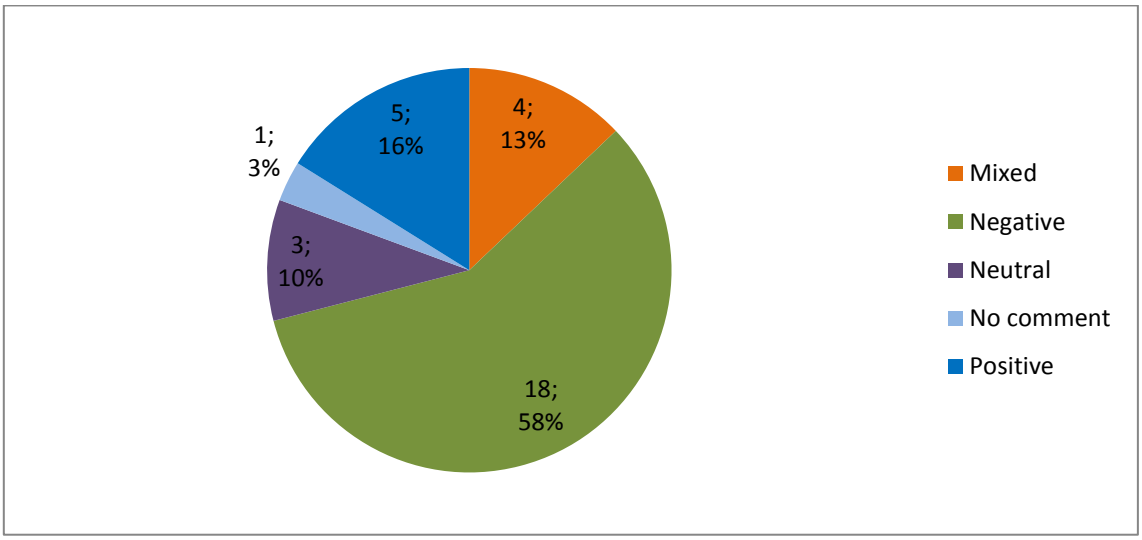

Figure 16. Beaver presence

Five respondents felt the presence of beavers was positive on balance, with one of these also stating they were aware they may not be suitable for all areas. Three were neutral, four were of mixed opinion and eighteen felt the presence of beavers is negative. Of these eighteen one individual was open to being shown the positive impacts and one believed they were negative specifically in arable areas.

Q15. What support do you feel you might need to assist in managing any beaver impacts on your land?

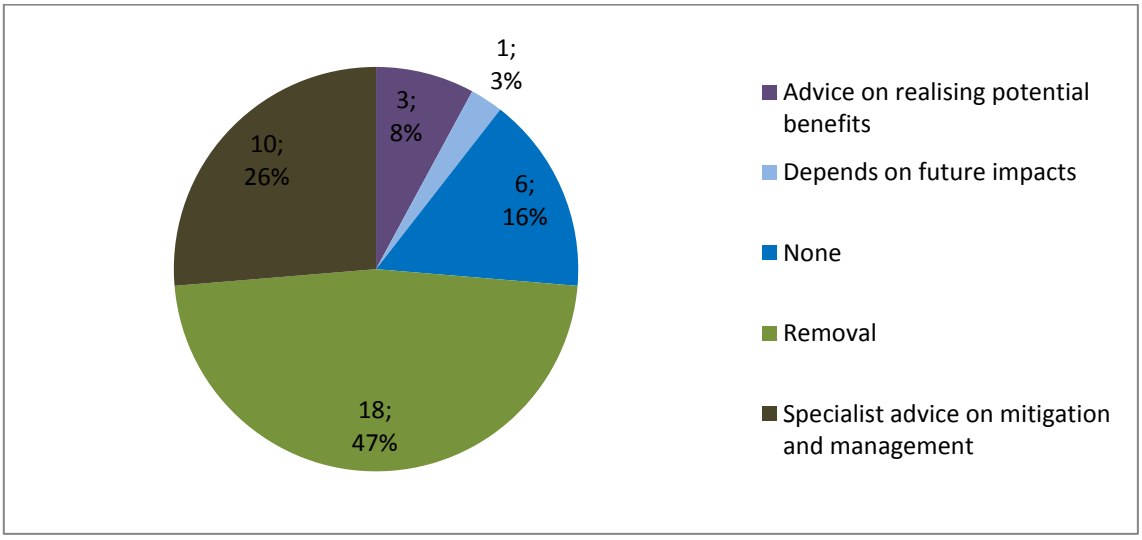

Figure 17. Support required

Eighteen respondents stated they felt they needed support to remove beavers from their land. Ten stated they required specialist advice on mitigation and management. Six individuals felt they did not need any form of assistance and three wanted advice on realising potential benefits.

8.1.2 Discussion of questionnaire responses

The actual number of landowners with beaver activity on their land across Tayside is unknown, and it is likely that a number of owners/managers remain unaware of beaver presence. As a consequence it is not possible to determine what proportion of all Tayside beaver activity is represented by the 31 completed questionnaires. It is accepted, however, that 31 returns is a small sample size so should be treated with caution before trying to extrapolate the findings. The ability to verify 23 of the reports on site does, however, provide confidence that they represent a genuine range of beaver related issues experienced by those who engaged.

26 of the 31 respondents reported concerns arising from beavers on their land. 18 recorded a negative view of beavers, with no benefits anticipated. Five respondents had no concerns and felt positive towards beavers, while seven were neutral or of mixed opinions about them. The questionnaire was restricted to those who, at that time, had direct experience of beavers on their land. Thus, although the questionnaire returns may represent a small sample size, they do indicate that, of those who are currently aware of beaver activity on their land and have also been in touch with TBSG, the majority have concerns.

A closer analysis of the responses found a particularly strong correlation between respondents with negative opinions about beavers and the presence of beavers within arable farming land (25 out of 26 with concerns). The concerns about negative impacts were connected with loss or damage of productive land as the consequence of impeded drainage and flooding/raised water tables caused by dams in drainage networks, or by damage to

flood banks from beaver burrows. The possibility of having to cease use of productive land next to river banks as the result of the risks from collapsing burrows was another expressed concern.

Loss of, or impacts upon, trees was also a common cause of concern for respondents. There were several cases where felled trees have caused damage to fencing and impeded water flow in ditches/ burns. A number of trees of amenity/personal value have also been lost or damaged. Actual or potential loss of trees of commercial value as a consequence of felling or flooding was reported as a concern at two sites. Damage to trees is probably the most obvious of beaver signs, and it is therefore not surprising that it has been cited as the most common sign that first drew attention to the presence of beavers, nor that perceived impacts of beavers upon trees was a common concern. Site visits by the PO to investigate questionnaire returns have, however, found that in the majority of reported cases, tree gnawing and felling has occurred within semi-natural riparian woodland of little commercial value. Furthermore, despite fears to the contrary expressed by respondents, the PO concluded that this was of no significant detriment to the value of the habitat for biodiversity.

71% (22) reported incurring financial costs as a result of beaver activity. Of these, three individuals stated actual figures ranging from £30 to £10,000, although it has not been possible to verify or obtain a breakdown for the higher figure. Respondents regarded such costs, whether high or low to be additional costs which would not have been incurred if beavers had not been present. Amongst the other respondents the cost associated with managing beaver activity arose from the expenditure of time and use of machinery, predominantly in removal of woody debris from water courses.

While there is no evidence to suggest anything other than that all returns to the questionnaire represent genuine perceptions, there was a need to verify matters on the ground wherever possible. This is because some perceived problems arose from a lack of knowledge of beaver activity and its implications.

In light of the above, it is significant that the majority of the land use/infrastructure concerns, highlighted in the questionnaire responses, were verified on site by the PO. In a few instances the recorded concerns related to the potential for impacts which have not actually been experienced in practice in Tayside. Examples are the potential for harm to biodiversity by tree felling; the risk to livestock and machinery from collapsing burrows and impedance of fish passage by dams (the latter is a subject for specific research that is within the remit of the Beaver/Salmonid Working Group).

Despite the expression of concerns, the majority of respondents had not tried any form of management or mitigation for a variety of reasons.

The 9 respondents who had tried mitigation found it to be successful especially for tree protection and for some instances of dam removal. One respondent reported that they had shot a beaver as the result of recurring problems with dam construction. These dams were being constructed in vulnerable drainage ditch networks within arable farmland. Repeated efforts to remove the dams to allow free flow of drainage waters, were being countered by rapid dam replacement.

Shooting of beavers is legal, although it is illegal to possess a dead beaver or parts thereof without a licence. The shot beaver was made available to the PO under licence for post mortem examination to determine its health before death and analyse its genetics. Given uncertainties over the legal status of beavers amongst land managers, despite clear advice on the TBSG web site, it is possible that more beavers have actually been shot but have not reported to TBSG.

25 respondents felt they needed support and advice arising from beaver activity. The majority of these (18) wanted advice on removal, although given the Minister's decision to allow the beavers to remain in place for study until 2015, this was not an option on offer by the TBSG.

From discussion with landowners subsequent to their questionnaire returns, the reluctance to implement mitigation measures was explained more fully. The reasons included concerns over the cost and time required to install and maintain mitigation; an absence of practical and affordable measures being available in a number of situations and an expectation of failure. Some also expressed a reluctance to put in place measures which aimed to minimise impacts as opposed to having the beavers removed. The removal of beavers was not an option on offer by TBSG in line with the Ministerial decision to allow the beavers to remain in Tayside for study purposes until the future of beavers in Scotland has been decided.

Another factor to take into account, when interpreting the findings of the questionnaire, is that negative impacts which could have serious consequences, or could require active management, are much more likely to be reported than examples of positive or no impacts. The willingness to physically complete a questionnaire on beaver activity will often reflect the significance of the individual experiences. Accordingly the returns may not accurately reflect all experiences in Tayside.

Evidence for this arose from the observation that, of those who received a questionnaire during a site visit, most individuals who did not return the form had not reported any concerns with beavers. Conversely, the majority of those experiencing negative impacts did return their questionnaire.

This is stated without underplaying the validity and importance of the negative issue presented but accepting that experiences of positive and no impact may have been under recorded.

8.2 Site visits

Site visits were undertaken across Tayside for a variety of reasons; to identify and establish trapping sites for the health and genetic screening programme; to document land use impacts and offer management advice; to establish sites to be included in the lodge productivity survey; to confirm/validate reports of beaver activity and to establish mitigation trials and document case studies.

52 individual sites with beaver activity were visited (Fig. 18). Of these visited 24 managers reported a negative impact arising from beaver activity, one reported a positive impact, 23 reported no impacts and four were not possible to classify on the evidence available.

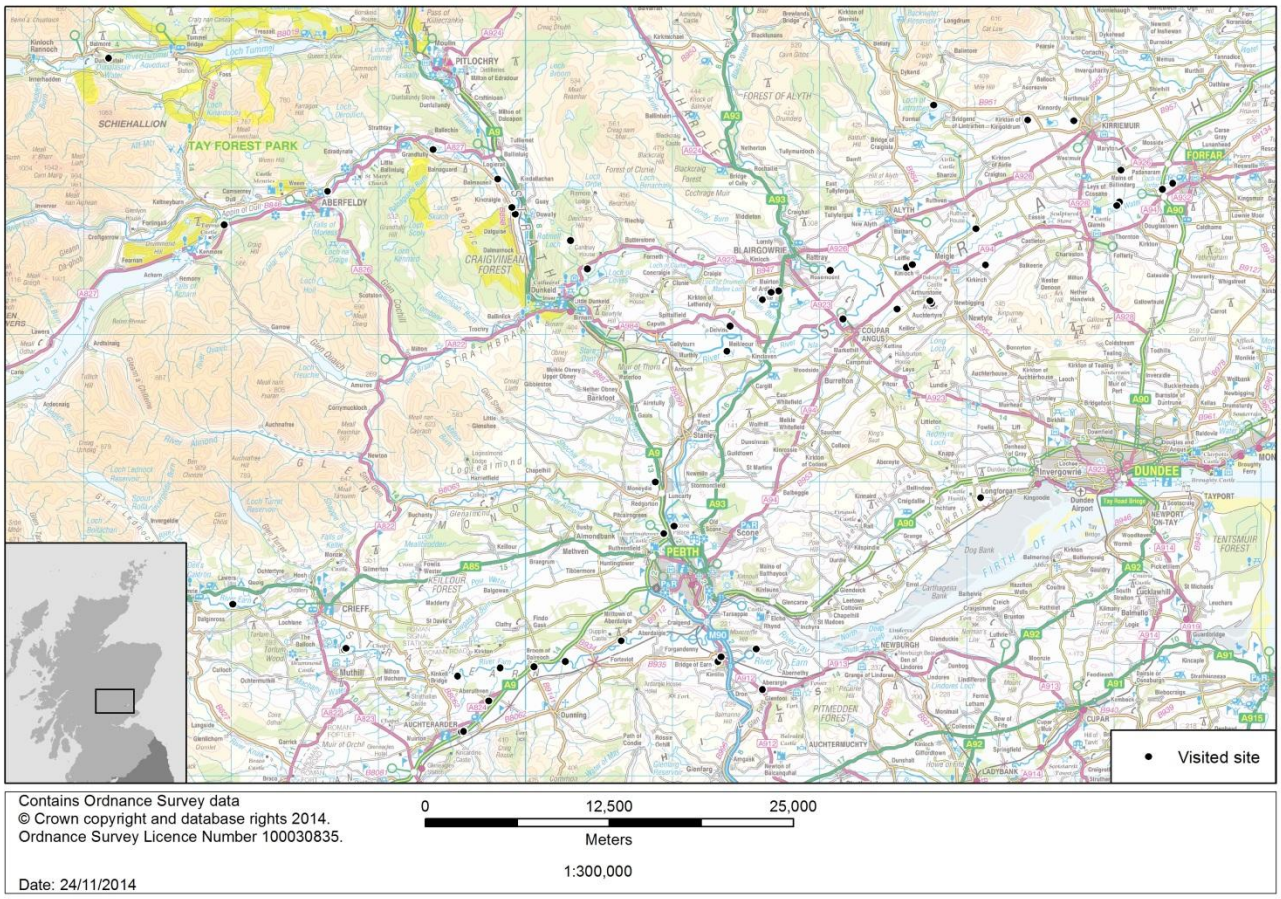

Figure 18. All sites of beaver activity visited

Table 1. Site visit breakdown

Type of visit	Number
Trapping related activities	278
Beaver activity site visits	46
Monitoring (mitigation/case study sites)	22
Lodge productivity related site visits	24

Site visits were made for various reasons:

- Landowner/land manager request:
  - In response to request extended through a questionnaire return
  - In response to report of beaver activity
  - In response to report of impacts resulting from beaver activity
- Project Officer contact
  - Identifying potential trapping and lodge monitoring sites from information of the 2012 distribution maps

General site visits with landowners and land managers focussed on documenting beaver activity and any associated impacts. During the trapping period sites were also assessed for suitability as a trapping site if permission to trap was given. Pictures, grid references and details of activity were recorded alongside any specific comments/concerns of the landowner/land manager. Mitigation options if applicable were explained and any options for trialling methods discussed.

9. Beaver impacts on land use

The recording and assessment of the impacts of beavers on various land uses was a major aim of the TBSG, and took up a large part of the PO's efforts. The results presented below have been derived from all of the contacts made with land owners/manager, including the proactive and reactive site visits and the responses to the landowner/ land manager questionnaire. The overall findings are presented below, supplemented by four case studies to describe a range of the land use issues in more detail.

9.1 Recorded beaver impacts

As the result of contacts made with landowners and land managers, beaver activity was recorded on 56 individual sites. Figure 19 summarises the findings.

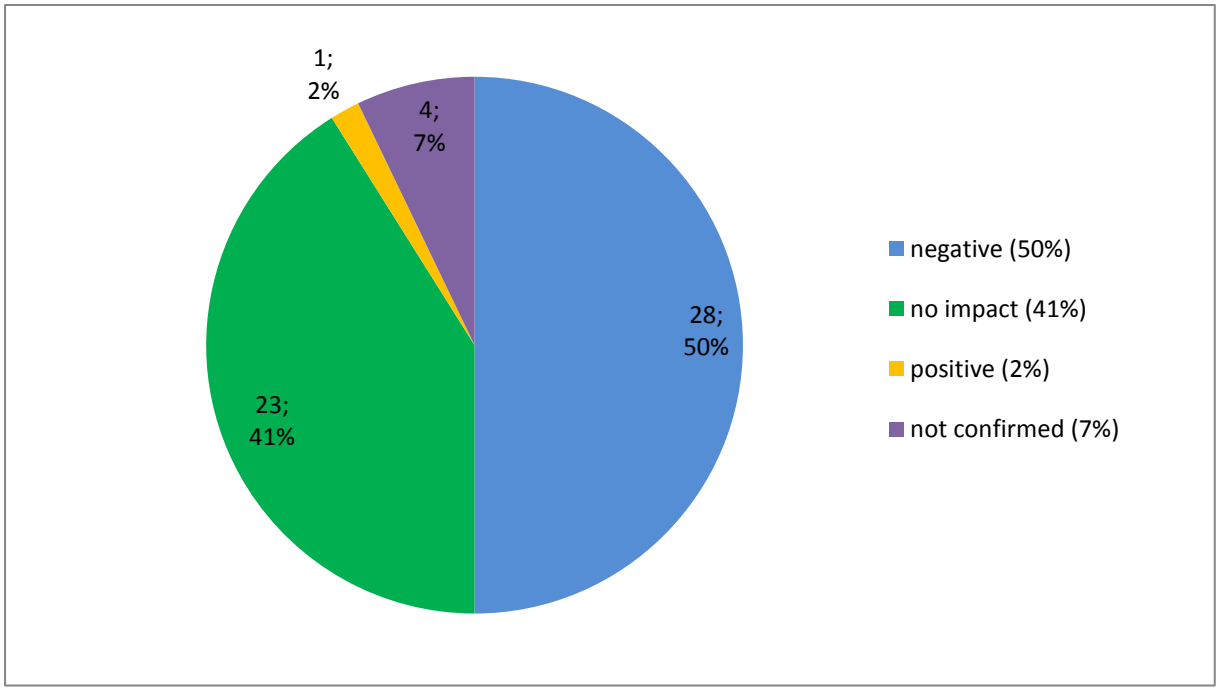

Figure 19. Beaver impacts

Of the 56 recorded sites, no impacts of concern were reported for 23 (41%) of the sites. Negative impacts were reported from 28 (50%) sites. Positive impacts were reported on one site as a result of beaver activity. For four reports, it was not possible to categorise impacts from the information provided, and the PO was unable to arrange a site visit to gain more information.

Of the 28 sites where negative impacts were reported (Fig. 20), the majority reported more than one issue. Of these 28, issues were resolved using mitigation on 5 (tree protection and dam removal) and on four sites he impact was classed as minor.

The PO visited 25 of these sites, four were not visited for various reasons and details rely upon those provided in the questionnaire.

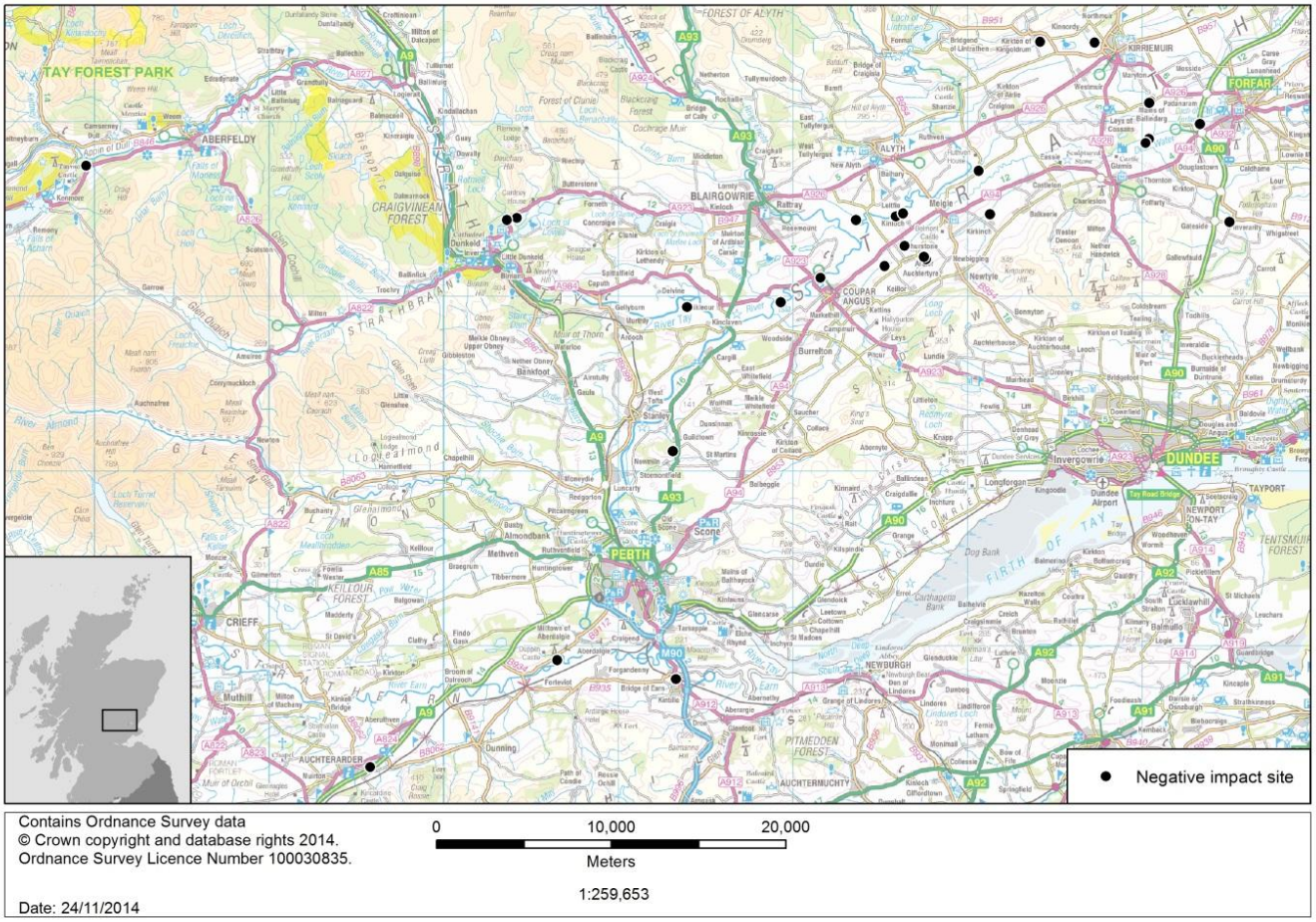

Figure 20. Distribution of sites with reports of negative impacts

9.1.1 Types of impacts recorded arising from of beaver activities

- Burrowing into banks and increased erosion:

  The managers at eight sites reported concerns regarding increased erosion of river banks as a result of burrowing/digging activity. Beavers burrow to gain access from below water level to rest sites or lodges in/on a bank, and sometimes to gain safe access to food sources.

- Burrowing into banks and resulting collapses:

  Issues associated with the collapse of burrows were recorded at four sites next to river banks. At three of the four sites, there were a number of burrows that has collapsed leaving deep holes in the bank (up to 1.5m in depth). At one of these there were 10 collapsed burrows over a distance of approximately 1.6km (about 1 mile). At one site the landowner was aware of burrowing due to entrances being observed at low water, but had not come across any actual collapses. Specific concerns included the potential hazard to livestock grazing and people walking by the river. During one site visit a burrow collapsed under the land manager and the PO experienced two instances of burrows collapsing under them whilst on site visits. No serious injuries to people or livestock have been sustained or reported as a result of collapsed burrows.

- Burrows in flood banks:

  Issues/potential issues arising from beaver burrows in flood defence banks were recorded on five sites. At two sites beaver burrowing activity had resulted in several breaches (see section 9.2.2). No actual breaches were recorded on the other three sites, but concerns were raised about increased risk due to burrowing activity in the area.

- Crop foraging:

  Beaver foraging on crops was reported as an issue on three sites, (wheat, barley and carrots). In discussion with the farmers concerned, they were of the opinion that the amount of crop foraged was of low concern as it was minimal. The greater concern was shown to be with other risks of impacts arising from beaver activity in arable areas, particularly the flood risks associated with burrows and dams in drainage channels.

- Damming and associated erosion:

  Erosion of banks was reported as an issue at four sites associated with redirection of water flows around a beaver dam. At two sites, a section of bank had been eroded due to water flowing round a dam during high flows. At a third site, access for farm machinery had been impeded as the result of erosion caused by diverted flows (Fig. 21). At a fourth site, there was a report of damming causing erosion next to a bridge. No site visit was possible to establish any more details of this report, nor to assess its seriousness.

Figure 21. Land erosion associated with of diverted water flows around a beaver dam

- Damming and associated flooding:

  Damming and associated flooding were reported as issues at nine sites. At six of these, concerns arose from damming in drainage ditches within intensively farmed lowland areas. These concerns related to the

actual/potential flooding of arable fields caused by impeded drainage from field drains resulting in a rise in water table (see section 9.2.1).

At one site, 150 metres of an access track next to a burn, leading to a small area of residential housing, was flooded during a period of high rain fall. The flow patterns of the burn had been affected by the raising of the water table on adjacent land caused by beaver damming.

One dam at the outlet of a pond had caused a diversion of flow resulting in flooding of the margins of the adjacent wheat field.

The flooding of a small area of conifer plantation was reported at one site due to damming activity in an adjacent drainage channel.

- Damming and fish passage:

  There were two sites where damming activity was reported to be blocking fish passes. In both instances the TDSFB Operations Manager believed that the fish passes would not be able to function unless the dams were removed. In one of these sites, the dam was built against a fish counter. The manager cleared the dam but then had to remove more debris from the counter every morning over a number of weeks, because the beavers rapidly started to rebuild the structure during the course of the following day and night. The debris prevented the counter from working and the manager eventually decided to remove the counter to discourage further dam building.

  A site was visited after receiving a report of a dam on a tributary burn of the river Tay used by migrating salmon. On visiting the site the dam was no longer intact and most evidence washed away following high rainfall. The landowner advised that high water flows were frequent in this burn, and it was concluded that it is highly unlikely that any dam would remain in place for any prolonged period. This dam was reported in mid-August 2014 and no further damming activity has occurred since.

- Ecological and land management benefits:

  At one site biodiversity and habitat improvements were reported as a result of beaver activity with a reduction in the need for planned management activities (see section 9.2.4).

- Amenity trees:

  Impacts on amenity trees were reported at four sites, all within 5m of a watercourse. At one site one tree was gnawed and the owner had proactively protected the tree with mesh tree before making the report (Fig 22). At another site, four planted willows that were felled by a beaver (Fig 23). At a third site the questionnaire response stated that beavers had stripped bark from several large willow trees which the landowner had then protected with wire mesh. At the fourth site a large willow tree was gnawed before the owner fitted wire mesh around to protect it.

Figure 22. and Figure 23. Garden trees impacted by beaver activity

- Impacts on commercial trees:

  Impacts on commercial trees were reported at two sites. At one, the questionnaire return reported a loss of approximately 70 trees of commercial value in a mixed broadleaf plantation with a burn running through the site, including 15 mature trees (site not visited) and one indicating a potential issue due to dams flooding a small area of conifer plantation (Fig. 24).

Figure 24. Dam in drainage channel close to conifer plantation

- Loss of trees:

  Loss of trees in general was reported as a concern at six sites. Investigation indicated that this concern arose from the perception that the felling of trees by beavers is negative.

- Trees and road safety:

  At two sites, beavers felled trees in close proximity to a road, one being a major dual carriageway. This led to concerns for driver safety if trees fell onto the carriageway (see section 9.2.3).

9.2 Beaver impact case studies

The following accounts provide more detail on a range of the beaver impacts experienced within Tayside, summarised in the previous section. We are grateful to the land managers for their permission to feature their issues in these case studies.

9.2.1 Damming

- Drainage impacts

This case study was on a farm of 445 hectares of lowland arable land situated close to Meigle. The farming system includes 13.8km (8.5 miles) of actively managed burns and drainage ditches, either manmade or heavily modified to facilitate agriculture. The landowner first became aware of beaver activity on his site in August 2013 when beaver dams were identified in several stretches of burn.

Between September 2013 and November 2014, 32 dams were built/in the process of being built by beavers. These varied in size depending on the stage of construction, (Figs. 25 and 26). A maximum length of 2m (from one side of the burn to the other), a maximum breadth (from front to back) of 1m and a maximum height of 0.75m was recorded. Damming occurred in seven stretches of burn/drainage ditch (Fig. 27). Dams are regularly removed, by the landowner, mainly by hand, due to the potential for serious impacts on field drainage. Monitoring established that dams in two of the seven locations were being rebuilt within one day of removal and at another two locations, removed dams were rebuilt weekly.

Before beavers started to occupy the area, farm staff carried out walked inspections of burns and ditches twice a year to monitor for blockages. In the light of the speed with which beavers can (re)build a dam, the frequency of inspection has been increased to weekly, requiring a day's activity on each occasion. Approximately 4 hours per week have been spent removing dams.

Figure. 25 and Figure. 26 Beavers dams in burn

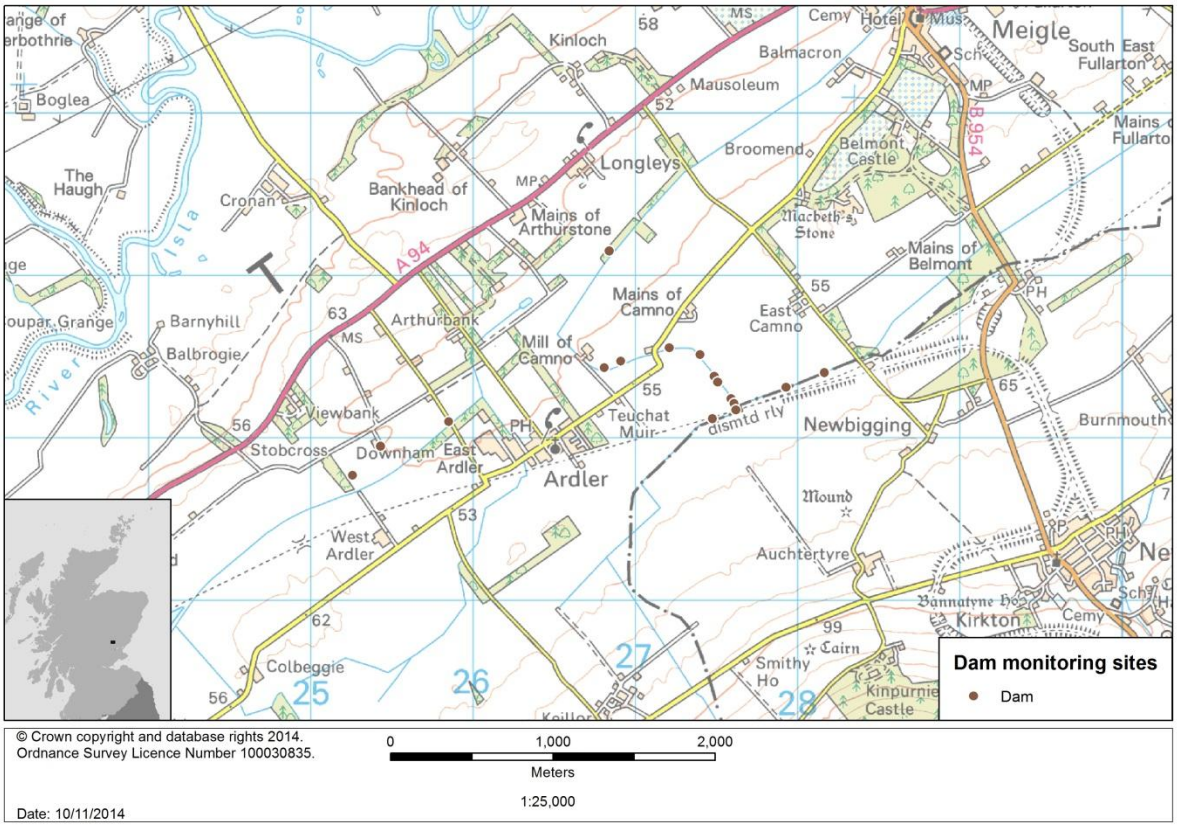

Figure 27. Dam monitoring site

The particular issue at this site was the potential impact on field drainage as a result of water backing up behind a beaver dam and the consequent time and resources taken to monitor

and remove dams. Sub-surface field drainage pipes are used throughout this site to avoid water logging of the ground which would cause difficulties for cultivation, crop growth and harvest.

Field drain outlets at this site vary in height from 0.2m to 0.5m above the water course into which they discharge (Fig. 28). They also have a very shallow drainage gradient owing to the flatness of the ground so that the backup of water could potentially affect a large area. Compared to these measurements, a dam of 0.75metres in height could readily cause a rise in water level sufficient to cover a field drain, impede drainage and in turn raise the ground water table. Hence the much increased monitoring and regular removal of dams.

Figure 28. Field drainage pipes

9.2.2 Burrowing

- Flood defence banks

This case study was on a farm of 320 hectares of lowland arable land situated along the banks of the River Isla. The farm includes 4.5km (2.8 miles) of river banks, of which 3.2km are reinforced by flood defence banks varying between 2m and 4m in height. Approximately 0.8km of the bank is situated less than 2m from the river's edge, 1.6km lies between 2m and 4m from the edge with around 0.8km located over 4m away from the river's edge. The landowner became aware of beaver activity along this stretch of the Isla in 2011.

Two breaches in the flood defence bank occurred in late 2012 and were attributed to points weakened by beaver burrowing activity. These were repaired at a cost of £5000 in 2013. Crop damage did not occur due to the time of year but breaches resulted in flood debris

being deposited in the fields requiring removal by the landowner. Early in February 2014 the landowner reported a further breach in a flood defence bank. On inspection it was observed that at the base of the breach there was a beaver burrow entrance measuring approximately 0.75m across, indicating that a burrow had been constructed at this point (Fig. 29). The original size of the breach covered 10m by 12m (Fig. 30). The landowner expects to pay £2000-£3000 to repair this breach.

Figure 29. Beaver burrow entrance

Figure 30. Flood bank breach

The landowner's principal concern at this site was the increased risk of a serious breach in the flood defences caused by beaver burrowing, and the potential for the future loss of productive land by flooding. Flooding could damage crops from sowing to harvest, and prevent/disrupt cultivation.

Hydromorphological advice was sought from SEPA regarding the implications of beaver burrows in flood banks. They concluded that flood defence banks could be impacted by beaver burrowing activity in two ways. Partial collapses due to burrowing would cause an increase in soil pressure meaning further collapse is more likely. This could create a low point which is more vulnerable to being overtopped during high water flows. This overtopping leads to severe scouring of the river side, which is likely to lead to a breach in the flood bank and subsequent flooding of the land behind. If burrows pass through a flood bank and break the surface on the flood plain side, a channel is created through which flood water passes, scouring out the flood bank and again leading to a potential complete breach.

Flood banks located greater than 20m from the river bank are unlikely to be impacted by this type of activity.

- Collapsed burrows

This case study was on a farm of 200 hectares of mixed lowland arable and livestock situated south of Alyth along the river Isla with approximately 1.6km of river bank. Beavers were first noticed on this site in 2010 when signs of beaver feeding and tree felling were identified.

Along this 1.6km stretch of river bank, sections of which are used for summer cattle grazing, ten collapsed burrows were identified (Figs. 31 and 32).

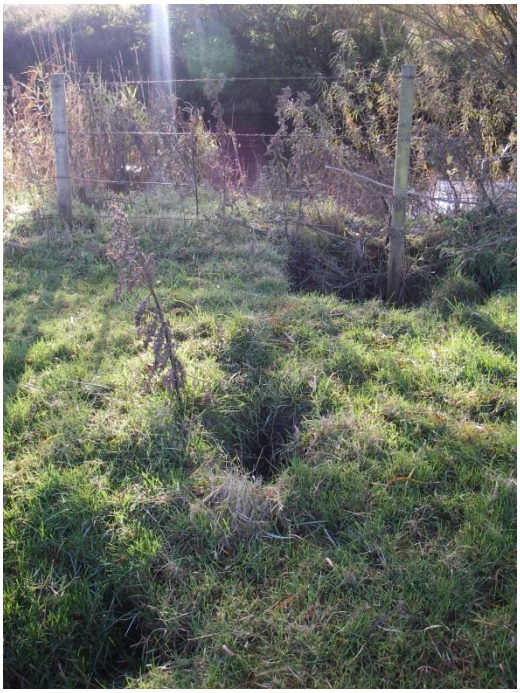

Figure 31. and Figure 32. Collapsed beaver burrows

As this area is used for livestock grazing, the landowner was concerned about the potential hazard if livestock fell into burrows that collapsed under them or fell into holes already present. No actual occurrences of injuries have been reported during the study period.

9.2.3 Tree felling and road safety

- Trunk road

A small section of land near Forfar approximately 200m by 20m situated between a water course and the A90 trunk road was being utilised by a group of beavers for foraging and collecting material for their construction purposes. It was noticed in March 2013 that three large poplars in a small plantation had been felled (Fig. 33) and others showed signs of beaver gnawing. Due to the height of the trees and proximity to the dual carriageway, there was a serious risk to drivers if a beaver felled tree reached the road.

Figure 33. Beaver felled trees close to dual carriage way

Transport Scotland and their contractors, BEAR Scotland, were informed of the situation, and proactively felled the trees believed to pose a risk to the dual carriage way. The remaining trees adjacent to the road were protected with wire mesh and fencing as part of a mitigation trial (see section 10.1.1). Two poplar trees were left bare as a control for the trial process. One of the controls began to show signs of beaver gnawing late 2013 and was then protected to avoid the possibility of it being felled onto the road.

The protection of the trees by a mesh fence was successful and since the end of 2013, there have been no further reports of beaver damage and consequent risk to the A90.

- Roadside lochs

Loch of the Lowes includes a narrow strip of riparian woodland alongside approximately 1.6km of a well- used road and within 10 metres of its edge (Fig. 34). Beavers became resident in the area in 2012. Before beavers arrived, the Ranger staff carried out weekly road-side checks by vehicle to check any issues with trees and road safety.

Figure 34. Beaver activity close to road

During October 2013 one tree was felled across a well-used section of road by a beaver. This was removed by staff. As a result road side checks were increased in frequency, as staff time allowed and were carried out on foot to identify signs of beaver activity not always visible from a vehicle. During a routine check in July 2014, a number of trees were found that had been partially gnawed through by beaver. These were felled proactively by hand to avoid the risk of the beavers felling them onto the road. In September 2014 a large willow was proactively felled by chainsaw and specialist team after being deemed a risk to the road following beaver gnawing. Also in September a large rowan was found felled onto the road and was then sawn into smaller pieces to allow removal off the road by hand.

The obvious concern at this site was that beaver activity had increased the risk of trees falling onto the road and causing a safety hazard to vehicles and their occupants. There was also concern about the drain on staff time associated with the need to increase the frequency of routine checks on foot.

9.2.4 Biodiversity and habitat management

The group did not have sufficient resources to study the ecological impacts (either positive or negative) of the beavers on Tayside, and therefore the report below is a reflection of observations at a single site. It will certainly be the case that there are many other un-recorded ecological effects of this population.

- Amenity loch

Forfar Loch sits within central Angus and is a site used by a large number of the local public and visitors to the area. Beaver activity was first identified in 2012 by site Ranger staff and activity extends to an area approximately 225m x100m.

At the point where water drains from the loch, dense reed growth required annual clearance to prevent back up of water and flooding elsewhere on and around the site. Over the last 2 years the density of the reed bed has been reduced as a result of beavers regularly swimming through it with tree material. Beavers have also been feeding in the area, creating further clearings (Fig. 35). This activity has reduced the need for personnel to clear the area saving time and cost. This beaver activity has also diversified the reed bed structure with a combination of new and old growth which has created a more varied habitat. Beaver felling and feeding activity has also provided effective management of areas of willow, which had been identified for coppicing for habitat management purposes

Figure 35. Beaver cleared area of reed

Beaver activity has resulted in a more diverse habitat with areas opened up and new reed growth established. A mix of old and new growth of willow and reed has created additional habitat diversity for feeding and breeding birds. Beaver activity at this time has supplanted some staff effort associated with the clearance of the outflow and the control willow growth.

10. Mitigation

In areas of Europe with large beaver populations such as Bavaria, mitigation techniques are frequently used to reduce negative impacts from beaver activity (Schwab and Schmidbaue, 2003). There are a range of mitigation options available with some of the most common including individual tree protection using wire netting, exclusion fencing to protect stands of trees, electric fencing to dissuade beavers from foraging on crops and flow control devices to reduce flooding behind a beaver dam.

The identification and trial of mitigation options was an important aspect of the work of the TBSG. Accordingly, the PO has as a matter of course, used the opportunity presented by site visits to discuss potential mitigation options (where appropriate), and sought the opportunity to trial any suitable techniques. Offers were made for the following:

- Trialling of electric fencing to limit crop foraging was offered at three sites, but no one took up the offer. One believed it would be ineffective; one advised they would report any foraging activity but did not make further contact, and the other felt it would be too difficult to undertake due to the need to keep the wires free of vegetation contact.
- One site was identified as being suitable for a flow control device. The landowner did not want to put something in place which would allow beavers to stay in the area. He favoured removal of the dam and possible lethal control of beavers if damming continued.
- Culvert protection by in-stream fencing was identified as an option at a site where twice, during one year, beavers had built a dam which blocked a culvert draining a small artificial pond. On investigating the site in preparation for trialling mitigation, the PO found no further beaver activity, so no mitigation was required.
- Prevention of damming using electric fencing at site where a dam was being rebuilt repeatedly. Preparatory monitoring found that damming activity had discontinued and no mitigation was required.

Advice was sought from a SEPA Officer regarding the statutory regulation requirements connected with any proposals to place mitigation structures in a water course. Structures which could be classed as temporary (ie. not permanently fixed as with concrete) could be installed without specific licence under the General Binding Rules (GBR) of the Controlled Activities Regulations. Temporary structures included the installation of wire fencing fixed to hand driven posts. Flow control devices could also be put in place under the GBR provided they were installed in a temporary manner with minimal disturbance to the substrate. This advice was current as of December 2014, and could be subject to change.

There was a general lack of interest in mitigation methods being trialled by the majority of landowners. In particular, there was reluctance to have something in place which may encourage beavers to remain. There were also concerns over maintenance and a perception (untested) that most would be ineffective, despite evidence from other parts of the world.

There were also instances during site visits where no suitable mitigation technique was available, or those suggested were too costly to justify. Examples of such situations are:

The potential use of flow control devices in dams in narrow drainage channels receiving water from networks of field drains in farm land. The use of flow control devices requires the acceptance in principle of the presence of a beaver dam and the raised water level behind it. It then allows the maximum water level to be managed within an acceptable limit related to the on-site issues. The tolerance thresholds for any increase in water level in these types of drainage ditch, are so small that the principle of a beaver dam being left in situ is not acceptable.

Options for the protection of flood banks from beaver burrows would be large scale and require significant resources to undertake. The standard mitigation advice in other parts of Europe, is reinforcement of banks (eg.with sheet piling) or relocation of the flood banks to an ideal distance of 20 metres away from the river edge.

Protection of extended stretches of trees – individual tree protection would be impractical and expensive. Exclusion fencing can be appropriate depending on the value of the trees compared to the cost of the fencing. There may be instances where the cost of fencing may outweigh the value of the trees being protected.

10.1 Mitigation Trials

The results of a number of trials are presented below. The costings associated with these trials are presented in Annex 3.

10.1.1 Tree protection

The small poplar plantation next to the A90, referred to in section 9.2.3 above, was used to trial 2 individual tree protection measures. Eight trees were wrapped individually with standard chicken wire which was secured to the trunk with fencing staples. A further eight trees were protected individually with rylock stock fencing, secured 15-20cm away from the trunk using wooden posts (Fig. 36).Two poplar trees were left bare as a control. The remaining trees on site consisted predominantly of alder, which are not attractive to beavers, and were not protected due to the low likelihood of these trees being felled onto the road.

Figure 36. Wire tree protection

Since these mitigation methods were installed, none of the protected trees have been gnawed by beavers, despite the beavers still being on site. Conversely, ten trees without protection have been targeted by beavers, with eight being felled. This included one of the large poplars left bare as a control, and which had showed signs of light gnawing.

Both methods have been successful at this site, as of December 2014 no protected trees had been gnawed by beavers. Standard wrapping of trees with chicken wire is the most common form of tree and protection, and compared to the fencing method, is cheaper and quicker to install.

Protecting trees against beaver damage with standard chicken wire mesh wrapped around the tree, is a well-tried method across Europe, with a high success rate when installed correctly to a height of 1m on the trunk (leaving around 10-15cm gap between the wire and the trunk to prevent beavers gnawing through the wire and to allow room for tree growth). It is found to be the quickest and easiest form of mitigation against the felling of individual trees of value. Wrapping trees in mesh was a form of protection put in place by at least six landowners in Tayside. Subsequent discussion from individuals with experience of mitigation in Europe, has established that if trees are wrapped with a double layer of wire and secured with spring fastenings, the wire can be adjusted as the tree grows and puts on girth. This prevents the need for periodic removal of old wire and replacement as trees grow.

10.1.2 Tree protection paint

Trees along a stretch of burn were being felled by beavers and used for dam building at the same location. 40 trees along a 40m length of the burn side were painted to a metre in height with one of two abrasive protective paints. One of the paints was a German brand “anti-game” product ‘Wobra’. This is advertised as suitable for preventing beaver gnawing on trees. The paint contains quartz sand and dries clear. The second was a DIY abrasive tree paint. This was created by mixing masonry paint with sharp sand (140g sand to 1l paint) based upon a method utilised in America. Alternate trees adjacent to the burn were painted with Wobra, DIY paint and left bare as a control (Fig. 37).

The paint was applied in July 2014 and to date no painted trees have been subject to beaver gnawing. In contrast, five trees left bare have been gnawed and/or felled. Construction of dams continued in this stretch of burn for two weeks following the paint application, but after that period was only seen outside of the trial area. This suggests that the paint protection may have prevented trees being targeted and may have led to beavers sourcing woody material outside this section. Felling and damming activity was only seen upstream outside the trial area for the remainder of the monitoring period.

Figure 37. Tree paint trial – pale bluish trunks painted with Wobra that goes transparent when fully dry; whitish trunks painted with DIY abrasive paint.

The DIY version was shown to be successful (but consideration should be given to the small scale of the trial). There is, however, a limited range of colours available which makes it difficult to match tree bark. This makes the DIY version more obvious visually, so it may not be acceptable for the protection of amenity trees.

Wobra was costly but comparable to the cost of wire mesh protection in the long term. Wobra is advertised as being able to protect trees for up to 15 years, whereas experience from America suggests the DIY version requires reapplication at least every two years.

This trial suggested tree protection paint was successful, although it has only been tested on a very small scale in Tayside. It is recommended that protection of individual trees by wrapping in wire mesh would always be the first option due to its high, long term success rate.

10.1.3 Flow control devices[1]

Beavers resident in a large pond built a dam at the outflow point causing concerns that rising water levels in the pond behind the dam could cause flooding in an upstream village. As a result the dam had been removed several times by the grounds manager. A flow control device was installed in October 2012.

The dam was firstly deconstructed at the position where the device was to be fitted (Fig. 38). A soft plastic polyethylene 25cm diameter drainage pipe was installed to pass through the dam structure (Fig. 39), and the dam rebuilt over it (Fig. 40). The inflow to the pipe was located approximately 15m from the dam, weighted down with bricks to ensure that it remained below surface water level. A mesh cage created from 15cm (6inch) weldmesh was installed at the inflow of the pipe to prevent beavers from blocking it (Fig. 41). The outflow of the pipe was set at a height to drain the pond to the required level to prevent flooding upstream, but also to retain conditions that were suitable for beavers with a minimum depth of 80cm-100cm deep.

[1] Based on Skip Lisle http://www.beaverdeceivers.com/ & Mike Callahans http://www.beaversolutions.com

Figure 38. Deconstructed dam

Figure 39. Pipe installed

Figure 40. Dam constructed over pipe

Figure 41. Cage protecting inflow end of pipe, set back from dam

This device has operated consistently since installation and has kept the water level of the pond at a stable height tolerable for both the beavers (reducing the need for them to dam elsewhere) and the landowner, with no flooding issues being reported upstream. Debris has been cleared from the inflow cage twice since installation.

During autumn 2014 the beavers began to repair and reinforce the dam on the pond side, with no attention being paid to the downside of the dam where the flow control device pipe drains.

An initial flow control device was installed on the same site at a different location, where damming activities were flooding an estate track. The device was not successful in draining the water to the desired level due to incorrect installation. The pipe was installed over a large tree root which hindered its ability to drain and weights were not added to the pipe to ensure it stayed on the bottom of the watercourse. Lessons derived from the failure of this installation attempt were applied in the construction of the second device.

In the right circumstances, particularly where damming occurs at a natural pinch point in the system (such as the outflow of a pond), a correctly installed flow control device can be extremely effective. They work at sites where a degree of rise in water level behind the dam is tolerable. The aim is not to drain the pond to the original level but to reduce it to a depth which limits flooding upstream, but is deep enough (approximately 80cm-100cm) that the beavers do not feel the need to continue to raise the water level. If drained below this threshold, beavers may abandon the pond and start to dam elsewhere, or if they locate the device inflow they may attempt to block it.

Straight, narrow water courses such a drainage channels do not provide suitable situations for a flow control device as its likely beavers will attempt to dam at other points in the system because there is no natural pinch point. It is also unlikely that a rise of water level would be acceptable in principle.

It is also important to note that TBSG was unable to study the implications of the flow control device on fish movement. In situations where dams were constructed in water courses which provide fish passage, it would be important to ensure that fish passage was facilitated, especially for salmon and trout, but also for other migratory species such as lamprey.

11. Discussion

The occurrence of a free living population of beavers in Tayside has provided an opportunity for the study of beavers and beaver activity in a land use context that is very different from that in Argyll where the official SBT has taken place. The Tayside population is dispersed widely through the catchment of the Rivers Tay and Earn, and is mainly found along running water courses, including those situated within intensive agricultural land. This compares to the small number of families released into a landscape of lochs surrounded by coniferous woodland in Knapdale. This has allowed the study of a wide range of interactions between beavers and land management interests in a way that complements the SBT and thus provides additional information for the Minister when making their decision on the future of beavers in Scotland due in 2015. It does not however provide any additional information as to the ecological effects of the beaver population, including any ecosystem services/dis-services that may result from their presence.

11.1 Genetics

The release of the beavers in Tayside was not licensed, and as a result there was an absence of information on their genetic origins. Accordingly significant effort was invested in ascertaining the genetic status of the Tayside beavers. The results in the published paper cited previously have shown that the population is of Eurasian beaver *C. fiber*, with no evidence of the North American species *C. canadensis*. The beavers were found to originate from three distinct genetic lines, derived from animals imported from the Bavarian population (McEwing *et al.,* 2014).

11.2 Health and risks

Due to the lack of knowledge regarding the health of the Tayside population, there were concerns over the potential disease risk to humans, livestock and other wildlife. 21 beavers were sampled as part of the veterinary health screening programme, a number which fell within the target sample range of 15 to 30 individuals. Together with the sex ratio, age range and geographic spread of examined animals, this provided an adequate sample from which to draw conclusions. Veterinary screening found the sampled beavers to be free from a wide range of non-native parasites, including the pathogenic tapeworm *Echinococcus multilocularis*. Additional screening was undertaken to include Johne's disease[2] and tuberculosis[3] in response to concerns raised by NFUS. The study suggests that the Tayside beaver population posed no health risk to humans, livestock and other wildlife. All beavers displayed good body conditions and no concerns were raised regarding the beavers ability to survive in the wild in Tayside (Campbell-Palmer et al 2014).

11.3 Beaver productivity

[2] *Mycobacterium avium* subspecies *paratuberculosis* an infection which predominantly effects ruminants
[3] *Myobacterium bovis*

The lodge productivity study confirmed that Eurasian beavers are successfully reproducing throughout the part of the River Tay and Earn catchment sampled. They appear to be adapting to and surviving in a modern Scottish landscape with varying land-use practices. The results indicated that 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. If left in place, it appears that the Tayside population could be expected to continue to expand in number and distribution throughout the catchment over time.

11.4 Impacts on land uses

A key opportunity presented by the study of the Tayside population, was the investigation of the interaction between beavers and a wide range of land management interests within a more heavily populated part of Scotland. As a consequence the TBSG made an early decision to prioritise the documentation of land use impacts and investigate their potential management/mitigation in situ. This decision means that the ecological and wider environmental effects of beavers in the area were not explored in detail and are likely to be under recorded.

Significant effort was directed to recording and responding to those situations where landowners were aware of impacts of beaver activity. Effort was directed particularly to members of key landowner organisations, NFUS and SLE. Working with the NFUS and SLE representatives sitting on TBSG, numerous opportunities were provided for people experiencing beaver impacts to get in touch with the group and record their experiences. As a result, the effects of beavers were recorded at 56 locations across the catchment. Half of the 56 sites reported negative impacts as a result of beaver activity, whilst 41% reported no impacts.

The numerical representation of impacts recorded is limited by the actual distribution of beavers and the types of land and the nature of the management interests where they occurred. It is also notable that land managers experiencing/perceiving problems were found to be more likely to instigate contact with the PO than those who had no concerns. Experience also found that the former were more keen to have their experiences documented, including the completion of a questionnaire.

In light of the above, it is important not to attach too much weight to comparative numbers in the various categories of impact reported. Nevertheless, because all but four reports out of the 56 obtained were verified on site, and a number of reports were replicated within similar types of land use, a high degree of confidence can be placed on the types of experiences recorded.

11.4.1 Impacts on land of low commercial value

There was usually little or no concern about beaver activity where they were utilising land of low commercial or amenity value, such as areas of established semi-natural riparian habitat. Some reports of perceived damage in semi-natural riparian woodland related to concerns about the principle of tree felling and the loss of biodiversity. Investigations by the PO

concluded no actual detriment to biodiversity interests. Other reported impacts were found not to have been caused by beaver activity. This emphasised the need for reports to be assessed and verified by site visits.

11.4.2 Impacts on intensive agricultural land

The most serious concerns were reported within the areas of highest importance for agricultural production. This was especially so within the intensively cultivated arable ground on the flood plain of the lower River Isla and its confluence with the River Tay. This land is subject to extensive networks of drainage ditches and associated field drains, and much is protected from river flooding by flood banks. The concerns and impacts reported by land managers were associated with the construction of beaver dams and burrows.

The shallow gradients on these flood plain areas results in a very low tolerance threshold for any rise in water levels before the field drain network ceases to function. If beaver dams were left in situ within the drainage ditches, the resultant waterlogging and flooding could prevent cultivation of productive land. The only mitigation option available in this situation was dam removal. It was, however, a frequent experience at some sites that removed dams were quickly replaced by beavers. The fears over the consequences of impeded drainage, led to a significant increase in the monitoring frequency of ditches. This together with repeated removal of any dams, resulted in additional costs in terms of time and the associated use of any equipment.

Also of great concern was the potential risk posed by burrowing activity to the integrity of earthen flood banks. Many of these banks lie within 10 metres of the river bank, and could be impacted by burrowing activity. While breaches of these flood defences have occurred before beavers were present, the example documented by TBSG in the case study was a major event and is an example of a breach resulting from beaver burrowing activity.

No trial of potential mitigation/prevention options was offered by TBSG in response to burrowing, as the cost to protect an adequate length of bank would have been beyond the resources available. For similar reasons, no land manager was willing to undertake a trial at their own expense.

11.4.3 Dams causing little concern.

While beaver dams were of serious concern in agricultural drainage ditches, they were of less concern in situations where some rise in water level was acceptable. In these types of situation dams could be left in situ or in some instances, if required, could be managed successfully by the installation of a flow control device, with consideration being given to ensuring that they allow unimpeded fish passage. Such a device was found to be effective in places where a dam was located at a pinch point draining a much wider expanse of water behind it (and with no vulnerable interests close to the banks).

11.4.4 Impacts on trees and forests

The gnawing and felling of trees by beavers is one of the most obvious signs of their presence, and it is not surprising that this was most frequently reported beaver field sign.

Where this occurred within semi-natural riparian woodland, there tended to be limited to no concerns reported, and coppiced regrowth was observed at many sites.

Tree loss was deemed a more significant issue at sites where individual trees, or groups of trees, possessed a particular amenity or sentimental value such as in in gardens and managed riparian areas. In these situations a strong sense of damage/loss was provoked as the result of gnawing and felling. Mitigation and protection in the form of mesh attachment to individual trees to form tree guards, use of stock fencing and application of tree protection paint were all found to be effective in preventing further damage, at modest cost. Damage to commercial trees and forests by gnawing, felling and/or flooding was also found to be a concern. It would be expected that fencing and removal of dams would both be effective in protecting these areas, although the cost would depend on the scale of the works required.

Despite a widespread concern over the loss of trees, land managers at several sites were observed to be undertaking active tree removal along stretches of burn in an attempt to discourage beavers from the area. While this is perhaps an instinctive response, it is not a recognised or recommended management technique. There is no guarantee that it would be successful in achieving its desired purpose and, furthermore, it can harm other biodiversity interests and risk destabilising banks.

11.4.5 Fisheries

Efforts made to engage with the freshwater fishing community, were of limited success. The fishery concerns that were brought to attention related to dams and their potential to impede fish movement. In two instances dams constructed within artificial fish passes required removal (including the removal of a fish counter). In another instance a dam raising concern in a known salmon tributary was found to have been washed out by the time the PO could investigate on site.

Whilst the lack of engagement with fisheries interests was disappointing, detailed investigations of the potential impacts of beaver activity on salmon and trout were undertaken by the Beaver Salmonid Working Group (BSWG) who worked in parallel with the TBSG. Their work has included Tayside but was broadened to take a national perspective. The findings of the BSWG are presented in a separate report which will provided to the Minister (*Beaver Salmonid Working Group (2015). Final Report of the Beaver Salmonid Working Group. Prepared for The National Species Reintroduction Forum, Inverness.).*

11.5 Potential costs and benefits

Several landowners who had no, or limited, concern about beaver activities on their land, did recognise potential economic benefits from beaver tourism. No landowners were found to be advertising beavers as an attraction at present due to the uncertainty over the future of the Tayside population. Some were aware, however, of people making visits to the area specifically to see beavers. Two local groups were also known to have undertaken small-scale beaver watching tours over the last two summers, which proved consistently popular.

The questionnaire also recorded some sites where the managers wished to receive advice on positive opportunities presented by beavers, including conservation and tourism.

Many land managers expressed concern about the current and potential scale of future costs of managing beavers, while conservation organisations emphasised the possible benefits for habitats and environmental quality as well as for tourism. Tourism bodies also thought that beaver presence would benefit local businesses through increased tourism draw. It is recognised that direct costs and benefits may be borne and realised by different individuals so that one may not offset the other in an individual's experience.

The majority of landowners who were in contact with the PO were willing to receive a visit and appreciated their experiences being documented. Some were also keen to receive advice on potential management techniques, although the interest in actually trialling techniques was low. This lack of interest in mitigation arose from a perception that some techniques were unlikely to work or were too expensive. Some landowners did not wish to try anything that, in their opinion, could enable beavers to stay in place regardless of the likelihood of reducing unwanted impacts. This stemmed from their view that the Tayside beavers were present illegally and that it would have been better for them to have been removed some years ago. While this view is understandable given the nature of some of the impacts experienced, the removal of beavers was not an option provided by the TBSG in line with the Minister's decision to allow them to remain in place for this study.

No information is currently available as to the potential costs or benefits of the beaver population associated with any ecosystem services/dis-services (such as flooding or flood alleviation, sediment/pollutant trapping, habitat creation and or management) that might be provided through beaver activities such as tree felling and dam creation.

11.6 Possible implications for the future decision

11.6.1 Advice and mitigation

If the Minister decides to allow beavers to remain in Scotland, it could be expected that advice and mitigation would be sought more actively, as there could no longer be any expectation of their complete removal. The level of demand would also be likely to increase as the beaver population grew and spread further. The TBSG has found that the deployment of an informed PO has been essential in achieving its remit, both in engaging with those who have beavers on their land and providing advice on the management of specific issues. This suggests that there could be value in establishing some sort of trained advisory service, able to provide expert advice and support for management of issues with the minimum of delay. There could also be an advantage in having the work of any such advisory service overseen by a broader based management group capable of taking a more strategic approach to issues, especially where they extend across multiple land ownerships, or require more innovative responses at a regional scale.

The broad membership of the TBSG has helped to reduce fears of bias and thereby foster greater acceptance of the value of its work amongst land managers. If some kind of an advisory service and management group was being considered, our experience suggests that there would be advantage in drawing representation from a wide range of relevant partners.

Both an advisory service and management group would need access to resources, possibly including a budget to assist with practical management and development of more complex solutions. Whilst costs for tree protection and some dam removal or management were relatively modest, they were additional to the norm, and would not have been incurred without the presence of beavers. Other costs such as dealing with repeated removal of dams in vulnerable drainage ditches and resolving damage by burrows could be much greater, and there was an expectation expressed that public funds should be made available to assist, especially if beavers are permitted to remain.

If there is a decision to allow beavers to remain in Scotland, this study's findings indicate that there would be a need for the identification of an agreed set of practical measures to manage a broad range of land management issues. Some measures are already available and were found to be effective within Tayside. Conversely there would be an urgent need to identify practical and sustainable solutions to the types of problem caused by burrowing and damming within intensively drained and managed arable land.

Further research into the ecological impacts of beavers should also be encouraged to better understand the effect of beaver activity on a range of habitats, species and ecosystem services. .

11.6.2 Regulation

If the decision is made to restore beavers to Scotland, land managers have also expressed a strong opinion that their ability to manage beaver impacts should not be subject to a bureaucratic licensing system. Whilst they recognise that some regulation would be inevitable, they would seek a rapid approval system to manage emergencies and to avert significant risks. They also expressed their view that there may be some areas of land use where beavers would not be acceptable because the impacts/risks are too great and cannot be managed readily in an affordable manner.

11.6.3 Potential benefits of other land management initiatives.

In discussing the findings of its work, the TBSG has noted the occurrence of a number of national and local initiatives to create buffer zones next to water courses. At present these are being promoted to reduce diffuse pollution and run-off from land into water courses and standing water bodies; enhance riparian and aquatic biodiversity and fisheries, and to reduce flooding and erosion pressures. As the TBSG found few concerns about beaver impacts where water courses were bordered by semi-natural habitats, or by other land of low commercial or amenity value, the creation of buffer strips on a wider scale could have an additional benefit of reducing the potential for beaver/land use conflicts in many situations. Burrowing damage to flood banks in Tayside was not found where they were located 10

metres or more from the river bank. The creation of buffer zones by the relocation of flood banks to 10-20 metres from the river bank could, therefore also offer a long term solution to possible breaches by burrowing activity.

Clearly the trial of such an approach was well beyond the scope of the TBSG and indeed was not requested by any land owners. It would require a loss of some productive land for which compensation would be sought. Furthermore, it would require a strategic approach with willing partners and substantial public funding to cover costs and realise multiple public benefits on private land.

11.7 Concluding comments

In reviewing its work, the TBSG has been successful in documenting the genetic provenance and health of the Tayside beaver population. The group's range of initiatives has also been successful in achieving contact with a range of landowners who have beavers on their land. This has allowed the documentation of a variety of experiences. The group has collaborated and worked effectively to provide an objective overview of a range of issues arising from the presence of the free living population of beavers in Tayside. It has also established the need for expert and timely advice to understand the implications of beaver activity, and identify and manage a range of land-use impacts. In addition it has identified the most serious issues within Tayside which would require a more concerted/strategic approach to management if beavers were permitted to remain free in Scotland. It has also identified the need for research into the ecological impacts of beaver activities.

12. REFERENCES

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ANNEX 1: Press pieces

Media format	Organisation	Date	Content
Printed	Angus Courier	29/04/2013	General TBSG project update
Printed	Angus Courier	07/06/2013	Trapping and screening project
Printed	Farming Leader	01/06/2013	General TBSG project update
Printed	SLE members magazine	Summer 2013	General TBSG project update
Online	SLE website news section	01/07/2013	Landowner questionnaire
Printed	SLE members magazine	Autumn 2013	Landowner questionnaire
Printed	Highland Perthshire Comment	10/10/2013	Trapping and screening project
TV	BBC One Show	22/10/2013	Trapping and screening project
Printed	Blairgowrie Advertiser	25/10/2013	Trapping and screening project
Online	SNH February E Newsletter	13/02/2014	General TBSG project update
TV	BBC Countryfile	08/03/2014	Work of TBSG and positive and negative impacts of beavers in Tayside
Printed	Blairgowrie Advertiser	14/03/2014	SWBG involvement in Countryfile report
Online	SLE	28/03/2014	Beaver Information Session follow up article
Online	Scottish Farmer	31/03/2014	Living with Beavers article, follow up from SLE event and promotion of questionnaire
Radio	Radio Tay	02/04/2014	Promotion of questionnaire
Online	Scotsman	30/04/2014	Response to end of SBT and You Gov poll on reintroduction, incl concerns of impacts in Tayside

Media format	Organisation	Date	Content
Online	Scottish Farmer	02/05/2014	Response to end of SBT and You Gov poll on reintroduction, incl concerns of impacts in Tayside
TV	BBC Breakfast News	22/05/2014	Beaver activity in Tayside
Printed	Press and Journal	13/09/2014	Beavers in Tayside and issues for landowners
Radio	BBC Radio Scotland Out of Doors	13/09/2014	Project Officers overview of TBSG
Radio	BBC Radio Scotland Out of Doors	03/10/2014	Landowner pros and cons of beaver activity
Printed	Scottish Farming Leader	December 2014	NFU Scotland's Policy on Beaver Reintroduction to Scotland
TV	BBC Landward	05/12/2014	Work of TBSG and positive and negative impacts of beavers in Tayside

ANNEX 2: Questionnaire results

Would you like to be kept informed of the activities of TBSG?

yes	20
no	0
blank	11

Would you like to receive a visit from the Project officer?

yes	7
no	1
n/a	5
blank	18

Would you be willing to participate in a more detailed case study to follow up your responses to this questionnaire?

yes	16
no	1
n/a	1
blank	13

Please provide us with a brief description of your land management interest

Arable/woodland mix	6
Lowland arable	9
Lowland mixed arable	1
Lowland arable/livestock mix	2
Arable/parkland mix	1
Arable/sporting mix	2
Arable/parkland/woodland mix	1
Farming/woodland/tourism/sporting mix	1
Farming interest	1
Nature reserve	2
Private garden	3
Stretch of river	1

Would you be willing to permit live capture and release for a beaver health and genetic study?

yes	13
no	4
n/a	2
blank	9
yes but not released back	2
maybe	1

Approximately when did you first notice beavers on your land?

2014	5
2013	6
2012	7
2011	3
2010	4
2009	2
2008	2
2007	1
blank	1

What drew your attention to their presence?

Tree activity	25
Flooding	1
Damming	5
Bank erosion	1
Sightings	2
Collapsed burrows	1
Ghillies brought to attention	1
Crop damage	2
Blank	1
Holes in river bank	1
Lodges	1

What beaver activities have you experienced on your land?

Vegetation impacts	19
Tree impacts	28
Digging/burrowing activity	15
Lodge construction	10
Dam Building	17
Beaver sightings	16

Other	burn blocked by felled tree

Have any of the following interests been impacted?

Forestry/woodland	20
Agriculture	10
Tourism	0
Fish (ponds and farming)	1
Fishing (recreational)	2
Biodiversity	5
Infrastructure	6
Ornamental/amenity value trees	7
Gardens	6
Other	1

What, if any, concerns do you have about the presence of beavers on your land?

Damage to trees	8
Impeding drainage	5
Burrowing	5
Erosion	4
Impacts on flood banks	5
Conflicts with conservation/land management objectives	1
Lack of ability to control and manage in future	1
Impacts on fish populations	2
Negative impact on biodiversity	2
Flooding	5
Trees felled on roads	1
Loss of productive land	5
Loss of income	1
Unsightly tree protection measures	1
None	5

What, if any, benefits do you anticipate from the presence of beavers on your land?

none	18
none in this area	1
none that I know of	2
none at present	1
potential conservation and tourism	2
potential tourism	2

biodiversity	1
esoteric interest	1
blank	2
minimal	1

In your experience are there currently any financial costs or benefits to having beavers on your land?

Time/labour	7
Machinery	2
Loss of crop	1
Damage to trees	1
Damage to engineer works	1
Loss of trees of commercial value	1
Actual costs	3
No	3
Not yet	2
Cost of tree protection	3

Have you tried any mitigation or management measures?

dam removal	6
shooting	1
wire protection around trees	3
no	20
blank	1

On balance do you feel the presence of beavers is positive or negative?

positive	5
negative	18
neutral	3
mixed	4
no comment	1

What support do you feel you might need to assist in managing any beaver impacts on your land?

none	6
specialist advice on mitigation and management	10
removal	18

advice on realising potential benefits	3
depends on future impacts	1

Annex 3

Costings associated with various Mitigation trials

1. Wire mesh tree protection

- Protection of 16 trees: 50m rylock stock fencing £31;
- 50m standard chicken wire mesh (2.5cm mesh type), £46;
- fence posts £19.80.
- Labour was provided by the landowner.

2. Tree Protection paint

- Wobra 10kg £90 plus shipping (10kg covered 20 trees ranging from 24cm to 68cm in circumference and to a height of 1m).
- Masonry paint and sharp sand £22 (5L covered 20 trees ranging from 9cm to 70cm in circumference and to a height of 1m).

3. Flow Control Device

- Total equipment cost of £400 including weld mesh to form the cage, flexible drainage pipe and fittings.
- Labour was provided by the landowner and Scottish Beaver Trial staff.