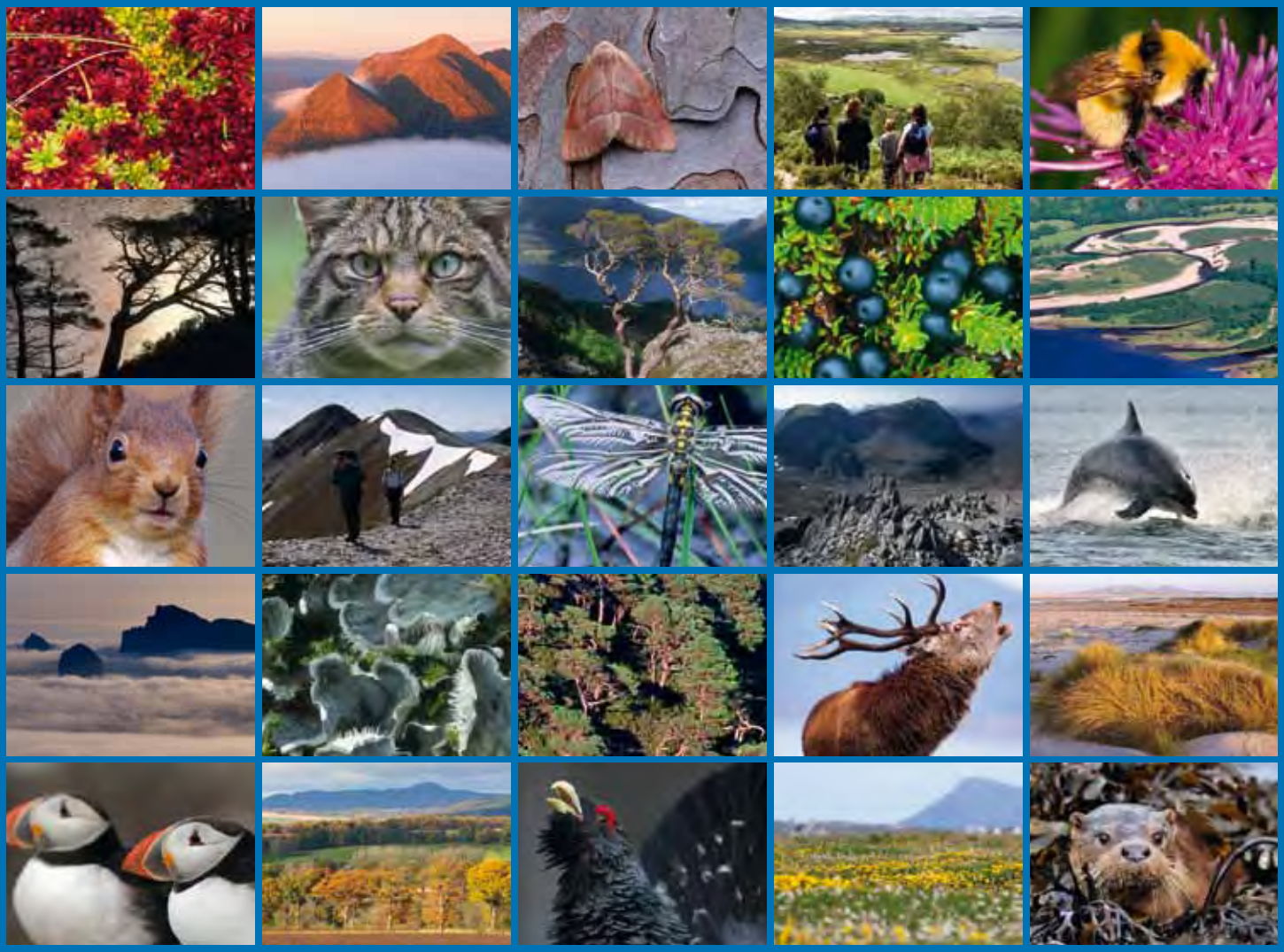
Scottish Natural Heritage
Commissioned Report No. 450

The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals – First Annual Report 2010



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COMMISSIONED REPORT

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The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals - First Annual Report 2010

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This report should be quoted as:

Harrington, L.A., Feber, R., & Macdonald, D.W. (2011). The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals – First Annual Report 2010*. Scottish Natural Heritage Commissioned Report No. 450.*

COMMISSIONED REPORT

Summary

The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals – First Annual Report 2010

Commissioned Report No. 450 (iBids No. 7062)
Contractor and Partner: The Wildlife Conservation Research Unit, University of Oxford.
Year of publication: 2011

Background

In 2008, the Scottish Government approved a licence for the Scottish Wildlife Trust (SWT) and the Royal Zoological Society of Scotland (RZSS), to undertake a 5-year trial reintroduction of the European beaver *Castor fiber* after an absence of over 400 years. The aims of the trial include an assessment of the ecology of the beavers, and their impacts on the Scottish environment. The success or failure of the trial will be based on a number of specific criteria, which relate to the ability of the reintroduced population to sustain itself, the effects of the beavers on biodiversity, the economic effects of the beavers, and the cost of their reintroduction and ongoing management.

In order to effectively assess the Scottish Beaver Trial, Scottish Natural Heritage (SNH) is coordinating a monitoring programme, in collaboration with a number of independent organisations. A core element of this is the monitoring of the beaver population itself. SNH is, therefore, working in partnership with the Wildlife Conservation Research Unit at the University of Oxford (WildCRU) in order to ensure the monitoring of the beavers, and other riparian mammals present at Knapdale, is suitable and appropriate. WildCRU is responsible for independent analysis of data received on the ecology of the released beavers; this is the first of five annual reports planned over the duration of the Scottish Beaver Trial. The aim of this report is to appraise the initial methodological protocols for the monitoring of the beaver population and other riparian mammals, to report on any necessary amendments, to summarise the data gathered on the ecology of the beaver population and other riparian mammals during the first year of the project, to report on initial ecological analyses, and to outline the revised methods for Year 2. This report covers the period 30th May 2009 (when the first beavers were released) to the 7th July 2010.

Main findings

A total of 15 beavers in five families or pairs were released during the first year of the trial. Two deaths were recorded in the wild, and one animal was withdrawn from the programme and placed in captivity (but died shortly afterwards), all of these animals were males. Only one sub-adult (a 2-year old female) is known to have dispersed from their natal group. A total of three animals (all females) are currently classified as 'missing' and, as of June 2010, nine animals were believed to be alive and present in the release area. The most significant monitoring difficulties during the first year of the trial resulted from the use of radio-telemetry methods, and difficulties presented by the terrain and vegetation at the release site. Consequently, in following years, there will be decreased emphasis on radio-telemetry for

ecological monitoring purposes and increased emphasis on visual observational methods and analysis of field signs. At the end of the first year of the trial there were sufficient data to show that two beaver families had successfully established territories. One family failed to establish and a further two were only recently released and had not had time to establish a territory at the time of writing this report.

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ACKNOWLEDGEMENTS

Thanks are due to Martin Gaywood and Karen Taylor (SNH) for general discussion and useful comments on drafts. Duncan Blake (SNH) collated data associated with the Trial. Gill Dowse (SWT) and Roisin Campbell-Palmer (RZSS) provided useful feedback on the initial monitoring protocols and practicalities of effectively gathering the required data in the field, and a large number of Scottish Beaver Trial staff and volunteers collected beaver ecological data using the SNH/WildCRU protocols. Rob Raynor (SNH) carried out the otter survey. LAH is extremely grateful to Ruairidh Campbell for his advice on beaver monitoring methods and for sharing his expertise on beavers. Thanks also go to the external referee who provided helpful comments on a draft and to Phil Boon.

This project was supported through a partnership of Scottish Natural Heritage and the University of Oxford Wildlife Conservation Research Unit as part of the independent monitoring of the Scottish Beaver Trial. The authors thank the Royal Zoological Society of Scotland (RZSS), the Scottish Wildlife Trust (SWT), and Forestry Commission Scotland for their help and cooperation. RZSS and SWT will also contribute funds to the overall monitoring programme.

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1 INTRODUCTION

1.1 Background

The European, or Eurasian, beaver *Castor fiber* became extinct in Scotland around the 16th century as a result of over-hunting. Over recent years the potential for restoring this species to the natural fauna has been investigated. These investigations have resulted in a suite of information with regard to the scientific feasibility and desirability of conducting such a reintroduction. Relevant documents published by Scottish Natural Heritage (SNH) can be viewed at www.snh.gov.uk/scottishbeavertrial.

The work undertaken is in line with obligations on the UK Government, under Article 22 of the European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the 'Habitats Directive'), to consider the desirability of reintroducing certain species (listed on Annex IV), including European beaver. No work is currently planned for the restoration of any other species listed in Annex IV of the Habitats Directive.

The Species Action Framework, launched in 2007 by Ministers, sets out a strategic approach to species management in Scotland. In addition, 32 species, including European beaver, were identified as the focus of new management action for five years from 2007. SNH works with a range of partners in developing this work and further information can be found at www.snh.gov.uk/speciesactionframework.

In May 2008, the Scottish Government Deputy Minister for the Environment approved a licence to allow a trial reintroduction of up to four families of European beaver into Knapdale Forest, mid-Argyll.

The licence has been granted to the Scottish Wildlife Trust (SWT) and the Royal Zoological Society of Scotland (RZSS), who are managing the 'Scottish Beaver Trial'. The trial site, Knapdale Forest in Argyll, is owned by Forest Commission Scotland (FCS). Several families of animals were caught in Norway during 2008 and quarantined for six months. Three families were released in spring 2009, and a further two pairs[1] in May and June 2010. The release sites were Loch Coille Bharr, Loch Linne/Loch Fidhle, Creagmhor Loch and un-named Loch (south), also known as the 'Lily Loch'. The release is being followed by a 5-year period of monitoring that will run until Spring 2014. SWT and RZSS have a dedicated Field Officer staff in place to cover this period.

One of the objectives of the Scottish Beaver Trial, as set out in the original licence application submitted by SWT and RZSS, includes the 'study of the ecology and biology of the European beaver in the Scottish environment', which will, in part, fulfil another of the objectives, to 'generate information during the proposed trial release that will inform a potential further release of beavers at other sites with different habitat characteristics'.

The licence issued by The Scottish Government to the RZSS and SWT came with a number of conditions, a key one being that the monitoring of the project must be independently coordinated by SNH. As part of this process, SNH has, therefore, entered a partnership with the Wildlife Conservation Research Unit (WildCRU) at the University of Oxford to support, enable and report on the ecological monitoring of the beaver population and other riparian mammals[2] during the trial period. This is one element of a wider monitoring programme, coordinated by SNH, which includes:

[1] The fifth family was released, under agreement from the Scottish Government, as a replacement for the first family that failed to establish

[2] The number of 'other riparian mammals' that we are able to monitor is limited by resources and therefore we chose to concentrate on the otter because it is a qualifying feature of the Taynish-Knapdale Special Area of

- Beaver health
- Terrestrial vegetation
- Aquatic/ semi-aquatic macrophytes
- Fish
- Odonata
- Water chemistry
- Hydrology
- Riverine geomorphology
- Socio-economics
- Public health
- Scheduled monuments

WildCRU does not have a lead role with the other monitoring projects listed above, but the various elements are coordinated so that data can be efficiently collected and shared by those involved with the monitoring programme.

The licence application also sets out success criteria for the project, some of which are specific to the ecology of the beaver (rather than the wider socio-economic and other environmental aspects of the trial). These are:

- Survival of introduced animals is similar to that of successful reintroduction programmes elsewhere in Europe at a similar stage of population establishment.
- A stable or increasing core population is achieved within the limits of the study site.

There are also failure criteria, including:

- Mortality levels preclude establishment of a population.
- Significant and unsustainable damage is incurred by the ecosystem within the study site.
- The area suffers significant economic loss as a result of beaver activities.
- Costs of project/damage/management significantly exceed expectations.

1.2 Aims of the ecological monitoring project

The overall objectives of the Scottish Beaver Trial, and the success and failure criteria as set out in the licence application (above), were taken into account when identifying the aims of this monitoring project.

The over-arching aim of this project over 5 years is to contribute towards the development of a programme of 'essential' beaver and riparian mammal ecological monitoring work required to address the aims and success/failure criteria of the trial, and to ensure SNH will have access to suitable, independent information so that it can report to Scottish Government during and after the trial. More specifically, the initial aims were:

To produce standardised methodological protocols

(i) To produce methodological protocols in time for the release of beaver in spring 2009 for the monitoring of 'essential', key aspects of beaver ecology.

Conservation (2.7 and Appendix A). We included American mink and water vole because field signs for these two species can potentially be detected while carrying out otter surveys, and thus without the requirement for additional resources. The water shrew is designated as a Species of Conservation Concern in the UK but we are not aware of any water shrew records from Knapdale so this species was not included in the monitoring programme.

(ii) To produce an associated 5-year work programme (spring 2009 – spring 2014), for the monitoring of 'essential', key aspects of beaver ecology.

(iii) To ensure the methodology includes the collation of suitable data which will allow the refinement of the existing beaver population model commissioned by SNH (Rushton *et al.* 2002), thereby improving our ability to predict future trends in beaver populations should the trial support the case for further reintroductions.

(iv) To produce a methodology which addresses other relevant mammal monitoring during the trial (in particular otter *Lutra lutra*, but also water vole *Arvicola amphibius*, and the invasive non-native American mink *Neovison vison*).

(v) To produce a detailed protocol for the Field Officers which will guide them in the collection, storage and dissemination of beaver-related data during the trial, suitable for later analysis by WildCRU in liaison with SNH.

To produce annual reports:

(vi) To produce annual reports, and other relevant outputs, on the results of monitoring of beaver ecology, using data/information received from the Field Officer staff and other project workers.

To produce an 'end of trial' report:

(vii) To produce a report, and other relevant outputs, at the end of the trial on the results of monitoring of beaver ecology, covering the entire trial period.

The standardised methodological protocols were written by Ruairidh Campbell *et al.* and were published by SNH in 2010 as *Campbell et al. (2010). The Scottish Beaver Trial: Ecological monitoring of the European beaver and other riparian mammals – Initial methodological protocols 2009. SNH Commissioned Report No. 383*[3]. Field tracking of the beaver population, including radio/Argos telemetry and trapping of the animals, is undertaken by SWT and RZSS as part of the management of the release population. However, at the same time, SWT and RZSS were asked to collate ecological data, following the standard methodological protocols set out in Campbell *et al.* (2010), to be used by SNH and WildCRU for the independent ecological monitoring. SNH is undertaking the otter monitoring. This report is the first of the five annual reports on the ecological monitoring of the beaver. The second annual report will be due in winter 2011.

In order that beaver welfare issues are properly addressed, and are balanced with the need to meet the aims of this project and the overall trial objectives, some broad principles were applied in developing the monitoring protocols. Tracking methods will always involve some level of disturbance to the animals. The methods appropriate for Knapdale were selected as the minimum necessary to address the beaver ecological monitoring requirements. The broad principles are:

- The welfare of the beavers during the trial is a priority. Animal welfare is being monitored by the relevant veterinary specialists (both those based at the RZSS and the independent specialists based at the Royal (Dick) School of Veterinary Studies) and will be kept under continuous review throughout the trial.
- Disturbance of the beavers, and the use of invasive tracking methods, is kept to a minimum to allow behaviour to be as natural as possible, and to allow successful

[3] Referred to hereafter as Campbell *et al.* (2010)

establishment of the animals in the trial area. This, however, has to be balanced with the need to track beavers for scientific monitoring and management purposes.
- Tracking methods are being constantly reviewed by RZSS/SWT, SNH and WildCRU, and will be throughout the trial, to take account of ongoing experiences, and the development of technical advances.
- Results of ecological monitoring work will be published to allow open debate of the relevant issues.

1.3 Key information required

To address the project aims, Campbell *et al.* (2010) identified the following key information:

- Population change (number of animals) during the trial.
- Fecundity.
- Mortality (and their causes).
- Population density.
- Age structure of the population.
- Number and size of territories.
- Sociality of the population (i.e. family structure and territory ownership).
- Dispersal by sub-adults.
- Movement within and outwith the trial area.
- Territory location (in relation to environment and to other territories).
- Habitat selection by individuals within territories.
- Habitat selection by other riparian mammals.

The initial monitoring protocols were written with the aim of collecting this key information by undertaking six tasks that interlink with each other and, to some extent, with other Scottish Beaver Trial monitoring projects: trapping, observations, radio-telemetry, Argos-telemetry, and field sign surveys for beavers and field sign surveys for other riparian mammals. Although the monitoring protocols included an element of cross-over with some of the tasks (i.e. one task may repeat the information gained from another), this apparent redundancy was considered essential because one task may not provide the desired information in all situations.

This report summarises the monitoring review process and presents early results on the ecology of the released beavers and other riparian mammals at the end of the first year of the Scottish Beaver Trial (7th July 2010). We:

- Outline the amendments made to the monitoring methods during the first year of the trial.
- Summarise the data available on the ecology of the beaver and other riparian mammals at the end of the first year of the trial.
- Present preliminary analyses on the ecology of the released beavers.
- Set out revised methodology protocols, based on the necessary amendments made during the first year for Year 2 of the trial.

In ensuring that the relevant key information is collected, the aim throughout is to achieve a balance between data collection, animal welfare and maintaining natural behaviours within the population.

1.4 Reviewing of methods

Since the release of the beavers in May 2009, it has been possible to test the initial proposed monitoring methods as detailed in Campbell *et al.* (2010) in the field and to identify successes and problems. Over the first year of the trial some changes were made and these are outlined in this report. SNH and WildCRU will continue to review these methods throughout the trial, in close discussion with SWT and RZSS, and any further changes will be identified in future reports.

2 METHODOLOGY PROTOCOLS – FIRST YEAR AMENDMENTS

Inevitably a number of issues with the proposed monitoring methodology were identified during the first year of the project. As a result some amendments to the published monitoring protocols in Campbell *et al.* (2010) were necessary.

In the following section, we summarise the aims, methods and workplan[4] from the original monitoring protocols as published in Campbell *et al.* (2010). For each protocol we describe any problems that have arisen during the course of the first year, and summarise the changes that have been agreed for each protocol as a result. All protocol changes were discussed at a beaver monitoring meeting of 17 November 2009 and amendments were agreed with SNH and WildCRU. Final changes to existing protocols and revised protocols for Year 2 were discussed at a second beaver monitoring meeting on 14 August 2010 and at the annual Research and Monitoring Group (RMCG) meeting on 26 November 2010.

The most significant difficulties have resulted from radio-telemetry methods (2.3 below). Consequently, in following years, there will be decreased emphasis on radio-telemetry for ecological monitoring purposes and increased emphasis on visual observational methods and analysis of field signs.

2.1 Trapping

Aims — To assess population and demographic parameters by marking animals and attaching tags. Also, to collect samples to obtain additional animal data[5].

Methods — Two alternative techniques were proposed: (Norwegian) trapping by boat or by cage traps. All animals should be captured, standard morphometric measures taken and fitted with both ear-tags and PIT tags (if not already fitted) (metal ear tags can modified by applying reflective tape of different colours). Animal welfare is paramount in terms of suitable trapping method and duration of trapping effort. Trapping by boat should not be carried out for more than two successive nights at the same location, and if a beaver avoids capture and returns to the lodge, trapping should be abandoned. In both cases, one week should be left before resuming trapping at the same location. Cage trapping should be continued until all animals are captured but if an animal is not captured within one week of the penultimate capture, cage traps should be relocated or another method used. If an individual is repeatedly captured in cage traps over three consecutive nights, traps should be relocated or trapping abandoned. Experienced workers should take less than 30 minutes to process an animal.

Data quality — Every animal should be trapped once per year (ideally through spring-autumn) (and more frequently if ear-tags or telemetry tags need replacing). All young animals (wild-born kits) should also be trapped in their first year.

Work plan — Trapping can be carried out on an ad hoc basis but should be concentrated around Oct-Nov 2009 and Apr-May 2010.

Issues — The Scottish Beaver Trial did not initially have the expertise required for trapping by boat using the Norwegian method; this issue has now been resolved and the preferred trapping method is by boat, although it is not

[4] Further methodological details are available in *Campbell et al.* (2010)

[5] Note that these samples will not necessarily be a part of the essential monitoring but may be used for 'non-essential' research by other parties; details of potential uses are in Campbell *et al.* (2010).

possible on all lochs (see section 5), and permission to use a powered boat on lochs within the Special Area of Conservation (SAC) has to be sought from SNH.

During the initial release of the beavers in May 2009, it was not possible for the Scottish Beaver Trial staff to tag all animals prior to release. Problems with tag loss and poor visibility of tags were also encountered.

Ear tags were fitted to all animals trapped during trap sessions in December 2009 or February/March 2010. Based on initial experience of tags, two large coloured plastic (rotatag) tags are being used to mark individuals; metal tags (unavailable in 2009) will be made available for marking any kits in future (covered with coloured tape to aid identification).

Trapping was carried out in December 2009, February-March 2010 and May 2010 (see section 3). Trapping effort was stopped in mid-May (although some animals known to be present remained untrapped) to prevent the accidental capture of adult females during pregnancy for welfare reasons.

Amendments **Trapping to continue, with increased emphasis on the Norwegian boat method where appropriate. Due to the SAC designation of some of the lochs at Knapdale, Scottish Beaver Trial has to write to SNH with details whenever the Norwegian boat method is required; SNH will then assess whether consent can be granted on a case-by-case basis.**

Employment of ear tags to continue, using most appropriate tag types based on experience to date.

Some further amendments were made to the protocols for when to cease trapping based on experience to date and with a view to improving welfare considerations – details are in Revised Methodology Protocols (section 5).

The following alterations have been made to the trapping data sheet: National grid reference column added (eastings and northings columns were retained as a standard SNH requirement), column TS removed (and all sighting data kept in a separate GIS database), N/A entered in Time 1 when traps used, columns WeightBS and WeightS replaced with WeightB for beaver only (weight of sack deducted), Tailtagloc changed to tagloc as tail tags are not being used at present, Tailtagtype and Freq columns replaced with three columns headed Tagtype, RF Freq, PTT Freq, because beavers may be released with two tags, colour-key added at the end of the sheet to aid identification of current status of individuals. A column was also added to record the purpose of the trapping, and for recording blood samples taken.

2.2 Observations (Locations and Behaviour)

Aims To assess (1) animal presence at a location, (2) the presence of unmarked individuals (released adults and wild-born young), (3) the relationships between individuals, (4) beaver behaviours and habitat use. Observational records can be treated as recaptures in a capture-mark-recapture analysis and be considered equivalent to telemetry ‘fixes’.

Methods Sit and wait observations (in a hide or boat), or search loch by boat until a beaver is spotted. When a beaver is observed, note location, ear tag combinations (if possible), behaviour (and relevant additional information such as food type) and interactions with any other beavers.

Data quality Each beaver colony should be observed on at least six occasions to determine the presence and number of beavers at colonies. To obtain more detailed behavioural data, where possible, the location and behaviour of the focal animal should be recorded every 15 or 30 minutes.

Workplan Observations should be conducted during the dispersal phase (spring) and the emergence of kits from lodges (mid-July – August). Thus, as a minimum, observation sessions should include at least one evening in May and one evening in early August (both until approximately midnight), with additional sessions (ideally a minimum of six in total) on an ad hoc basis (including prior to trapping).

Issues **Initial observer experience suggested that beavers released in Scotland in their first year post release, differed from study populations in Norway in their reaction to observers and to the spotlights used by observers (even using red filters). Even in natural light beavers were disturbed by observers and, therefore, extended behavioural observations of focal animals were not usually possible.**

Scottish Beaver Trial have more recently been carrying out observations on a monthly basis in an attempt to habituate released beavers to the lights. Scottish Beaver Trial note that for the first few months after any release behavioural data may be affected by the presence of observers and lights.

Individuals cannot always be identified because tags are lost (above).

Amendments

Observation sessions are to be carried out monthly. This change is now necessary since observations will largely replace radio-telemetry data (below) with the specification that all families are 'tracked' for at least one night per month.

Observations will be single observations of individuals; detailed focal animal observations will not be carried out in Year 2 (see Revised Methodology Protocols, section 5).

All presence/absence and behavioural observations are to be stored in a single file within the Scottish Beaver Trial geodatabase before being forwarded to SNH. This differs from the initial published protocols (Campbell *et al.* 2010) that specified that presence/absence data should be included in the Trapping data spreadsheet, and behavioural observations with the Radio-telemetry data.

2.3 Radiotelemetry

Aims To (1) assess animal movements, (2) monitor dispersal of sub-adults, (3) estimate home range and family territory size, and (4) describe habitat use.

Methods — Although visual observations have the advantage of allowing behaviours to be ascribed at known locations, radiotelemetry should be used when an animal is not in view. One adult per family should be fitted with an RF tag at any one time. RF tags should be attached to beaver tails prior to release (as in the original methodology protocols). Triangulation should be used to estimate animal locations over night; additional day-time locations should be identified by homing-in on day-rest sites.

Data quality — One complete night of tracking (or two half nights, with one running over the first half and the other over the second half of the night) should be completed for each family once a month in the first year to allow home range and habitat use to be calculated over three month periods. Based on similar work in Norway, approximately 90 'fixes' (locations) obtained over three nights are required to estimate home range size and habitat use.

Workplan — All families tracked one full night per month. Day-time locations obtained twice per week for first two months post-release, weekly from 2-6 weeks post-release and bi-weekly from 7-12 months post-release. (Note that day-time tracking was not required if day-rest locations were identified at the end of the night tracking sessions).

Issues — **Most RF tags attached to beaver tails were lost within two to three months post-release.**

The terrain and habitat at Knapdale (heavily wooded, with steep ridges between lochs and river systems) presented several problems for the transmission of RF signals[6] and serious difficulties were encountered in assessing directionality of the telemetry signal. Effective and accurate use of triangulation methods to determine animal locations was, therefore, not possible.

Due to the problems encountered, radio-telemetry data obtained during the first year provides confirmation of the presence of an animal (that may be useful for assessing individual survival, as well as for general management purposes) but does not provide sufficient information on the animals' location.

Amendments — **As a temporary measure while awaiting upgraded tags[7] (in an attempt to solve some of the problems encountered with improved equipment), night-tracking periods were changed to early morning and late evening sessions over winter, while existing RF tags were lost or non-functional.**

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[6] Including:

a. Reflection – where radio signals bounce off trees and cliffs.
b. Refraction – where radio signals disperse when exiting water.
c. Diffraction – where radio signals bend around objects such as trees.
d. Interference – where radio signals can bounce off trees and come together again cancelling each other out
e. Polarisation – where only "half" of a radio signal is received.
f. Absorption – where the signal is absorbed by the vegetation – even more so if it is wet

(information received from Dr Ian Hulbert, Skorpa Consultancy, supplier of RF equipment to the SCOTTISH BEAVER TRIAL)

[7] New tags were larger with increased power – these tags increased the range over which a signal could be detected, but problems caused by the terrain and habitat at Knapdale remained.

Replacement tags fitted during trapping in December 2009, and later, were glued directly to the beavers' fur using epoxy glue (based on new tag attachment methods used in Norway). This method is still being assessed (but will be used for management purposes only – see below).

Triangulation to obtain location data is currently perceived to be unreliable in giving accurate location data, and therefore, will largely be replaced with observational and field sign data to assess habitat use and home range sizes. Note that this amendment supersedes any other amendments to the radio-tracking protocols, and that RF telemetry is no longer being used as a monitoring method (see Revised Methodology Protocols, section 5).

GPS telemetry has been discussed as an optional technique, which if available would be helpful to the ecological monitoring (see section 5). The feasibility of GPS telemetry will be discussed at a later date.

2.4 Argos telemetry

Aims To obtain low-resolution data on the location of at least one of the dominant adult members of each family. This cannot be used to calculate home range size or to assess habitat use but could be used to monitor and to track large shifts in home ranges and movements of beavers away from the release area. The proposed Argos system is not an essential component of the ecological monitoring but may be useful for management purposes.

Issues and Amendments **The low number of fixes received from Argos tags fitted on two beavers (as well as the same retention problems as for RF tags) meant that the system was deemed not to be useful or cost-effective for management purposes. It had already been decided by SNH and WildCRU that data arising from Argos telemetry would not be appropriate for ecological monitoring purposes. Argos telemetry is no longer being used by the Scottish Beaver Trial.**

2.5 Field signs

Aims To locate (1) dams, lodges and dens, (2) areas of high foraging activity and (3) likely territory borders (if any).

Methods Foot surveys along loch and river banks recording all observed field signs and their locations. Recorded field signs should include: lodges/burrows, dams, food caches (late-autumn/winter), fresh feeding signs (% of trees that are cut within 5 m of the water and the two most common felled species), foraging trails, feeding stations, scent-mounds and scent-marking sites. Dams should be photographed. Search effort should be recorded. For foraging signs record only one location per 10 m length of bank. For cut trees, record % cut within 5 m of the water in the 10 m section around the GPS point.

Data quality Foot surveys do not need to be conducted frequently and could be combined with other work such as otter surveys (below). All riparian habitat in areas known to contain beavers should be walked every two months and other areas within the release site walked every fourth month.

Workplan It is important that at least one survey at each site is conducted in November after autumn leaf fall and when the die-back of vegetation aids visibility. The other two surveys of the whole site should be done in approximately March and July. Field-sign surveys should be combined with day-time radio-telemetry checks.

Issues **In the first few months of the project, monitoring protocols were not followed exactly by the Scottish Beaver Trial: foraging signs were not recorded within a 10 m radius as specified, distances covered and time spent searching were not recorded.**

Not all field signs were recorded initially.

Data collection in the field was quite complicated and time consuming.

Amendments **Field sign surveys are not now being combined with otter surveys (which are to be carried out by SNH - below)**

Issues have now been resolved: foraging signs will be recorded within 10 m sections of the bank (and earlier data extrapolated to this level); search effort is now recorded.

To simplify field sign survey strategies, a full survey of each loch containing beavers (up to 40 m away from the waters' edge) will be surveyed each season.

To avoid overlap and redundancy due to woodland monitoring that is already taking place (see Moore *et al.* 2010) the data to be recorded have been simplified. Data on the percentage or number of trees cut, and the species cut, are no longer included in the monitoring protocols.

2.6 Surveys of otters and other riparian mammals

Aims To investigate whether there are changes in the habitat use of the otter based on the distribution of field signs within the release area over the course of the project. American mink and water vole presence will also be recorded opportunistically during otter survey work.

Methods The methods are based on Strachan (2007) and will be undertaken by SNH. Surveys will be carried out within the release area and, for comparison, in a separate and independent control area (of similar habitat to the release area but located far enough outside the release area to minimise the chance of a single otter territory overlapping both the release area and the control area). Ten 100 m survey sites will be surveyed in each area. To identify survey sites, all loch and river banks will be divided (using GIS) into 100-m sections, based on River Habitat Survey (RHS) sections. Survey sections will be allocated at random, stratified amongst three broad habitat types (inland watercourse, freshwater loch outflow, coastal watercourse outflow/shoreline), with the additional specification that the two national otter survey sites within the release area – Loch Fidhle burn, OS grid ref. NR782892 and the burn between Loch Barnluasgan, OS grid ref. NR790910 – are included amongst the ten sites to allow the use of survey data from earlier national otter surveys. The same sites will be revisited every survey.

Sites will be surveyed by searching the entire length of the 100 m site and recording the following field signs: sightings (actual animal seen), total number of otter spraints, number of otter resting places, presence of tracks/runs etc., total number of mink scats found, presence of mink tracks, other evidence of mink (including local reports), total number of water vole latrines, presence of water vole burrows and feeding signs. Otter spraints and mink scats will be collected and stored in 96% ethanol for future species identification (if deemed necessary) and/or for potential 'non-essential' monitoring or research work.

Data quality — One survey per year.

Workplan — Surveys should be conducted once per year during September. It is estimated that the whole survey should take one surveyor approximately four days (five 100 m survey sites per day).

Issues and Amendments

Full details of the survey design are given in Appendix A. These expand on the details provided in Campbell *et al.* (2010).

Spraints were rarely suitable for DNA analysis and the number of spraints encountered during the first survey was low (see Appendix A). Thus, the potential usefulness of samples for future non-essential research is limited. Spraints and scats in future surveys will only be collected if species identification is uncertain.

3. ECOLOGICAL DATA OBTAINED IN YEAR 1

This section details the data that were collected during the first year of the trial (30th May 2009 – 7th July 2010). Preliminary analyses of the data are presented in the following section.

3.1 Released animals

A total of 15 beavers in five families or pairs were released in Knapdale during the first year of the project (Table 1, Figure 1); the first three families were released in May 2009, a fourth pair was released later in May 2010. A fifth pair was released in June 2010 as a replacement for the loss of family 1 (Table 1) with the aim of establishing a minimum of four potential breeding pairs within the release area by May 2011[8].

Table 1. Beavers released in Knapdale, Argyll, May 2009 – June 2010

Name	Sex	Age[a]	Family	Release data	Release loch	Fate (as of June 2010)
Andreas Bjorn	M	5+	1	31/05/2009	Creaghmhor	Withdrawn from programme Dec 2009 (died in captivity May 2010)
Gunn Rita	F	5	1	31/05/2009	Creaghmhor	Missing[b]
Mary Lou	F	1	1	31/05/2009	Creaghmhor	Missing[b]
Frank	M	Unknown	2	30/05/2009	Loch Linne	Alive
Frid	F	Unknown	2	30/05/2009	Loch Linne	Alive
Biffa	M	2	2	30/05/2009	Loch Linne	Alive
Biffa's brother	M	2	2	30/05/2009	Loch Linne	Dead (shortly after release)
Bjornar	M	Unknown	3	30/05/2009	Loch Coille-Bharr	Alive
Katrina	F	Unknown	3	30/05/2009	Loch Coille-Bharr	Alive
Mille	F	2	3	30/05/2009	Loch Coille-Bharr	Alive
Marlene	F	2	3	30/05/2009	Loch Coille-Bharr	Missing[c]
Tallak	M	5+	4	04/05/2010	Un-named (S) or 'Lily Loch'	Dead (approx 2 weeks post-release)
Trude	F	2	4	04/05/2010	Un-named (S) or 'Lily Loch'	Alive
Eoghann	M	2	5[d]	23/06/2010	Creaghmhor	Alive
Elaine	F	2	5[d]	23/06/2010	Creaghmhor	Alive

[a] Estimated age at the time of release
[b] Gunn Rita disappeared in the second week post-release, her female kit disappeared in mid-July - see 4.3.2 (below)
[c] Marlene was observed fighting with another family member in June 2009 (in the first month post-release), she was last seen in a nearby sea loch in August 2009 - see 4.3.3 (below)
[d] The fifth pair of beavers was released as a replacement for the loss of Family 1 with the aim of establishing a minimum of four potential breeding pairs in the release area by May 2011.

Three deaths (two in the wild and one in captivity following recapture and withdrawal of the animal from the programme), all males, were recorded during the first year of the trial (Table 1, 4.1 below). A further three animals (all females) are currently classified as 'missing' (Table 1, 4.3 below). As of June 2010, nine animals were believed to be alive and present in the release area.

[8] Scottish Government granted permission for the replacement of dead or dispersed adult beavers for the period up to May 2011

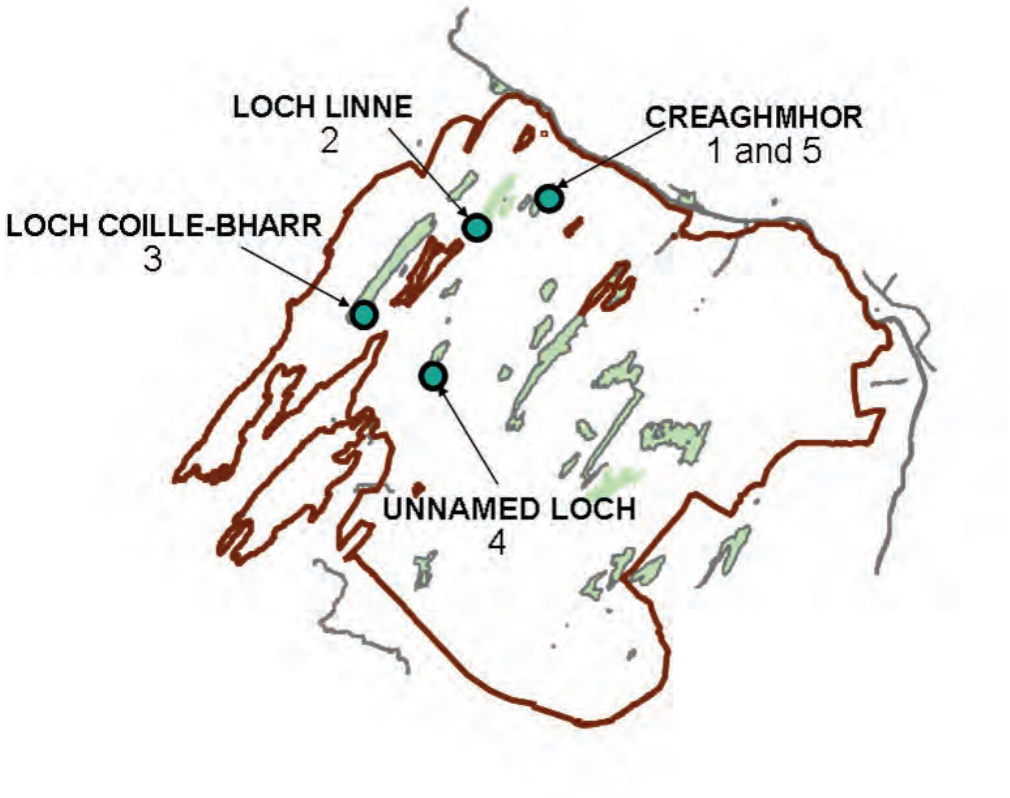


Figure 1. The Scottish Beaver Trial release area, Knapdale, Argyll. Release sites are shown by the dots, the numbers refer to families or pairs released in May 2009 – June 2010 (see Table 1). The brown lines show the release area boundary, and areas excluded from within it.

3.2 Trapping

Two main trapping sessions were carried out: the first between 23/11/2009 and 11/12/2009, the second between 01/02/2010 and 24/03/2010 (Table 2). Some additional trapping was carried out in May 2010.

Table 2. Trap effort within the release area, May 2009 – June 2010

Dates	Site	N traps	N hours	Total trap hours[a]	N nights boat trapping	New captures	Recaptures
23/11/2009-11/12/2009	Loch Linne	2	120	213	1	3	0
23/11/2009-11/12/2009	Creagmhor	-	-	-	2	1	1
01/02/2010-24/03/2010	Dubh Loch[b]	2	192	348.5	-	1	1
May 2010[c]	Dubh Loch	?	?	?	?	0	1

[a] corrected for tripped traps

[b] a small loch to the south of Loch Coille-Bharr
[c] details of trap effort not collected by Scottish Beaver Trial (to be provided in future); trap session abandoned to avoid recapturing the female at Dubh Loch during the potential pregnancy period

Prior to the main trap sessions, two ad hoc trap events were carried out outwith the trial area: one on the Crinan Canal (06/07/2009, 1 trap set for 48 hours) and one at Kilmartin Fish farm (12/08/2009, boat trapping), in an attempt to recapture the three beavers in family 1 that had left the release site (see Table 1). The adult male of the family (Andreas Bjorn) was successfully recaptured and returned to his release site (Creagmhor)[9]. The attempt to recapture the two females on the Crinan Canal failed.

Morphometric data were obtained for six of the seven animals known to be present in the release area during the trapping periods (6.5 - 10 months post-release). Animal handling per animal took between 25 and 55 minutes (mean = 40.8 minutes). All animals (with the exception of the adult male that was taken back into captivity – see footnote 9) were uniquely marked with ear tags in both left and right ears. Hair and faecal samples were obtained from five animals, castoreum and anal gland secretion from two and blood samples from one – analysis of these samples is not considered part of the essential ecological monitoring, although some may be relevant to the veterinary monitoring. Decisions on the use of the samples are discussed and agreed by members of the Scottish Beaver Trial Research and Monitoring Coordination Group when appropriate.

No new wild-born animals were expected in the first year of the project[10]; trapping, marking and sexing all wild-born kits will be an essential component of trapping sessions in following years (see Revised Methodology Protocols, section 5).

3.3 Observations

632 beaver observations were recorded; 180 of these were of unidentified individuals. The number of observations per individual varied considerably but observations (and the number of days over which observations were made) were similar for the two families released in 2009 that appear to have established, and that have been monitored for the longest period (Table 3, 4.2 below). Sample sizes for family 5 are small but this family was released on the 23 June 2010 and thus, at the time of this report was only two weeks post release.

There are currently sufficient data available for home-range analysis for two beaver families (family 2 and 3, 4.3. below). Families 4 and 5 had only been released two months and two weeks, respectively, at the time of this report and were, therefore, excluded from data analyses. Data were available for families 2 and 3 for all seasons, albeit with relatively low sample sizes in some seasons (e.g. autumn, and winter for family 3) (Table 4).

[9] This animal was recaptured in poor body condition during the December 2009 trap session, the decision was made to return him to captivity where he died in May 2010.
[10] The first wild-born young, if any, would be born in approximately May 2010 but not expected to emerge from the den until July 2010. Recent reports suggest that kits were observed in Knapdale in July/early August – details to be published in next year's report.

Table 3. Beaver observations recorded, June 2009- July 2010[a].
Shaded animals identified in the table were released in May or June 2010 and so are excluded from further home range analyses in this report because they had been released less than two months at the time of writing. Unidentified individual locations were included in a family on the basis of spatial clustering.

Beaver family	Individual	N Observations	N days of Observations	Months Observed	Total Observations per family
1	Andreas Bjorn	2	1	Nov 2009	2
1	Gunn Rita	0	0		
1	Mary Lou	0	0		
1	Unidentified	0			
2	Frank	66	13	Jun-Oct 2009 Jan-Mar 2010	279
2	Frid	46	11	Jun-Sept 2009 Jan-Apr 2010	
2	Biffa	70	12	Jun-Oct 2009 Feb-Mar 2010 May-Jun 2010	
2	Biffa's brother	0	0		
2	Unidentified	97			
3	Bjornar	51	10	Jun-Sept 2009 Mar-May 2010	235
3	Katrina	29	11	Jun-Sept 2009 Mar-May 2010	
3	Mille	71	14	Jun-Sept 2009 Nov 2009 Mar-Jun 2010	
3	Marlene	4	1	Jun 2009	
3	Unidentified	80			
4	Tallak	27	8	May 2010	92
4	Trude	65	20	May-Jun 2010	
4	Unidentified	2			
5	Eoghann	7	5	Jun–Jul 2010	20
5	Elaine	13	6	Jun–Jul 2010	
5	Unidentified	0			

[a] Data for all beaver families/pairs (except family 1) includes June 2010 and thus for the first beaver families to be released exceeds one year

Table 4. Seasonal observation data available for family 2 and 3, 2009-2010

Family	Season	N Observations[a]	N Days
2	Summer	96	6
	Autumn	31	5
	Winter	86	8
	Spring	56	9
3	Summer	107	4
	Autumn	33	6
	Winter	11	3
	Spring	35	5

Summer = June, July, August
Autumn = September, October, November
Winter = December, January, February
Spring = March, April, May

[a] Seasonal observations do not sum to totals given above because June 2010 is excluded from the seasonal data, such that each season is from only one calendar year

Most observations were of swimming beavers, but foraging was also observed (territorial and social behaviour only rarely) (Figure 2). During most 'foraging' observations, beavers were seen feeding on woody vegetation; feeding on aquatic and herbaceous vegetation was observed in 20 (11% of all foraging observations) and six (3%) cases, respectively. Based on experience from Norway disturbance of the beavers during observations was not anticipated and, therefore, the original protocols did not specify that observers should record when a beaver was disturbed and when not. We inferred from comments in the database received from the Scottish Beaver Trial that at least 5 % of recorded observations were of a disturbed beaver (although in many cases the beaver was probably disturbed after its initial location was recorded). In future years, observations of disturbed beavers should be excluded from analyses (see Revised Methodology Protocols for Year 2 in section 5), because they are not of natural behaviours and because animals may move into areas outside their home range or natural activity areas if they feel threatened. However, since it appears from the data that most 'disturbed' observations were of beavers swimming away from the observers and back to the lodge, although the behaviour and the timing of it were most likely influenced by the observers, it is also likely that the beaver was travelling along a route that would ordinarily be used and, therefore, inclusion of these locations in preliminary analyses of home-range size are unlikely to introduce significant errors. A more serious source of error may be introduced into estimates of home-range size by the inclusion of observations in which the beaver was not actually seen (the location of the 'noise' may be highly inaccurate) – these observations (n= c. 25 in total) will be excluded from analyses (see also Revised Methodology Protocols, section 5).

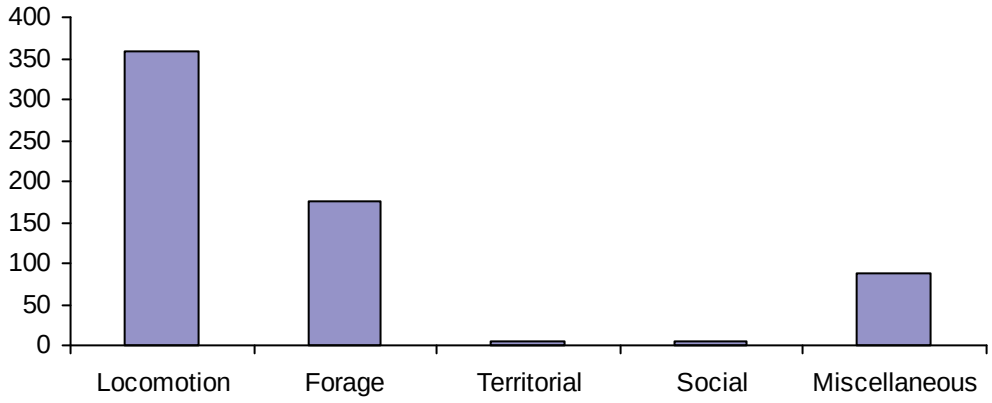


Figure 2. Activity types recorded during observations of beavers, June 2009- June 2010 (n=632 observations)

3.4 Radio-telemetry

180 RF signals were recorded between 24 February 2010 and the 7 June 2010. However, all records were of a single bearing from the observer and thus, we are unable to estimate animal locations from these data. A number of the records involved direct sightings of beavers, or records of animals in the lodge - these will be extracted and combined with the observations data in future analyses. Other potential uses for these data are as records of an animal's presence, which may be useful for assessing survival. RF data were not used in the preliminary analyses in this report and RF telemetry is no longer being used as a monitoring method (see Revised Methodology Protocols, section 5). If the Scottish Beaver Trial switches to the use of GPS tags in the future then the data produced would be of value to the ecological monitoring work.

3.5 Field sign surveys

A total of 1155 field signs were recorded within the release area, plus an additional 38 field signs outside the release area. Between 61 and 552 field signs were recorded per beaver family (Table 5) (no field signs have yet been recorded for the last released pair).

Table 5. Field signs recorded, June 2009- July 2010[a].
Shaded families identified in the table were released in May or June 2010, and so are excluded from further home range analyses in this report, because they were released less than two months at the time of writing.

Beaver family	N Field signs
1	131
2	552
3	373
4	61
5	0

[a] Note that for the first beaver families to be released the data cover more than one year

Field-sign data were available for families 2 and 3 over all seasons, but the number of observations in each season varied considerably (Table 6).

Table 6. Seasonal field sign data available for family 2 and 3, 2009-2010

Family	Season	N Observations[a]
2	Summer	53
	Autumn	130
	Winter	172
	Spring	129
3	Summer	33
	Autumn	59
	Winter	37
	Spring	209

Summer = June, July, August
Autumn = September, October, November
Winter = December, January, February
Spring = March, April, May
[a] Seasonal observations do not sum to totals given above because June and July 2010 are excluded here, such that each season is from only one calendar year

Scottish Beaver Trial advise that prior to March 2010 not all field signs were recorded and therefore, winter and spring data may include old field signs from earlier seasons – analyses of seasonal changes for this year should therefore be interpreted with caution.

Most signs recorded were of general beaver activity (felled or gnawed trees and cut or stripped branches). Feeding stations were also frequently recorded (Figure 3). There was some, albeit infrequent, evidence of scent-marking (Figure 3).

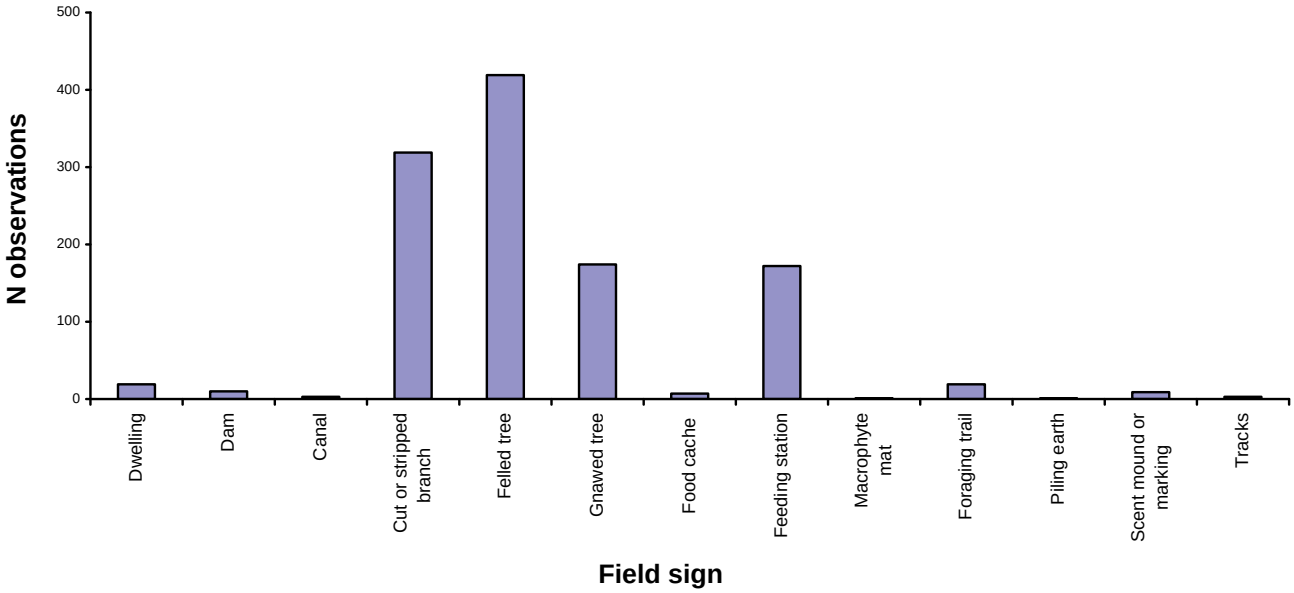


Figure 3. Types of beaver field signs recorded, 2009-2010

3.6 Other riparian mammals

Data on otter and mink presence at all 20 survey sites were provided by SNH, although weather conditions and delays in the timing of the survey meant that otter (and mink) presence may have been underestimated (see Appendix A). Additional data on mink presence were available from 11 mink rafts installed by Scottish Beaver Trial for mink-control purposes. It is likely that the nature of the survey sites and the timing of the survey are not suitable for providing supplementary data on water vole presence within the release area (however, this was not the main aim of the survey).

4. ECOLOGICAL MONITORING RESULTS

In this section we present preliminary analyses of the ecological data collected during the first year of the trial. Because two of the beaver families had been released less than two months at the time of writing this report, sample sizes were limited and analyses must be considered as preliminary. Habitat use was not assessed at this stage but will be included in the second annual report.

In addition to presenting preliminary data on the establishment of beavers at Knapdale, a secondary aim of these analyses was to assess the suitability of the data collected during the first year of the trial for ecological analyses as specified in Campbell *et al.* (2010).

4.1 Mortality and morphometrics

Three known deaths (all males) were recorded during the first year of the trial (Tables 1, 7). Andreas Bjorn was found in poor body condition and withdrawn from the programme in December 2009 (7 months post-release) and died a few months later in captivity of natural causes. Tallak died a couple of weeks post-release and post mortem results suggest that he did not feed, most likely due to an individual failure to cope with the stress of change in environment (S. Girling, RZSS, pers. comm.). Andreas Bjorn and Tallak were both older males (their teeth will be sent for cementum analysis to determine their exact ages); the only younger (2 year old) male to die post-release, died overnight on the day of release, possibly due to stress (R. Campbell-Palmer, pers. comm.).

Table 7. Beaver deaths by age class, 2009-2010

Sex-age class	Recorded deaths (n, %)	Cause of death
1 year olds	0	-
2 year olds	1 (14)	Unknown / stress related?
Adult females (3 years +)	0	-
Adult males (3 years +)	2 (50)	Natural causes (Andreas Bjorn) Lost body condition post-release – stress related? (Tallak)

Three animals (all females) were classified as 'missing' (fate unknown) (Table 1) as of June 2010. Known survival, therefore, as of June 2010, was approximately 55% (for those animals released in 2009) or 60% for all animals released. Analyses in future years will include a formal comparison with survival and mortality rates reported in other beaver reintroductions in Europe.

All four animals for which pre- and post-release morphometric data were available (excluding Andreas Bjorn withdrawn from the programme[11]) gained a statistically significant amount of weight post-release (median weight gain = 4.3 kg, n=4; Table 8). There was no statistically significant increase in body length, tail length or tail width, nor was there any statistically significant change in tail thickness post-release (but sample sizes for these tests were only three, so conclusions should be drawn with caution until further data are available).

[11] This animal lost 0.6 kg in the first 2.5 months post-release, and a total of 2 kg by six months post-release – at this time the animal was assessed as in poor body condition and withdrawn from the program

Table 8. Morphometric data for five beavers released in 2009.
Data are pre-release, post-release values; medians are given for sex-age classes with n>1. Post-release measures were taken at 6.5 or 10 months post-release.

Sex-age class	N	Body length (cm)	Tail length (cm)	Tail width (cm)	Tail thickness[a] (cm)	Weight (kg)
Adult female[b]	2	77.5, 79	28.7, 28.5	8.5, 9.8	2.33, 2.18	17.7, 21.2
Adult male	1	77, 78	30.2, 29	8.6, 10.5	2.36, 1.70	12.1, 19.4
2 year old male	1	64, 70.5	25.5, 26.7	7.0, 9.6	1.56, 1.62	11.0, 13.9
2 year old female[c]	1	- , 68	- , 28.5	- , 11.5	- , 1.9	- , 16.4
Pre-Post release difference[d] (W, P)		6.0 0.091	2.5 0.704	6.0 0.091	1.0 0.423	10.0 0.05

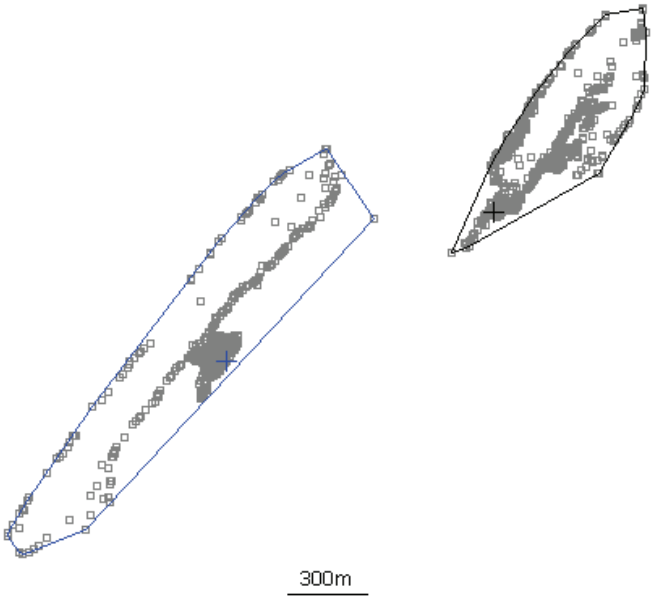
[a] Measured as the mean of four separate measures taken from four standard points on the tail (details in Campbell *et al.* (2010))
[b] Pre-release data only available for one of the adult females (except for weight which was available for both)
[c] Pre-release data not available for this animal
[d] Wilcoxon signed rank test; test for tail thickness was two-tailed, all others were one-tailed (n=4). W is the Wilcoxon signed rank test statistic, p is the probability value ($p \geq 0.05$ is accepted as statistically significant)

4.2 Beaver Territories

Two beaver families established territories in the first year of the project: family 2 and family 3 on Loch Linne and Coille-Bharr, respectively. Family 1 failed to establish; family 4 (consisting of only a single female as of June 2010) and family 5 were only recently released and had not had time to establish a territory at the time of writing this report.

Territory sizes for the two established beaver families were calculated in Ranges 7 (www.anatrack.com) using both observation and field-sign data combined. We calculated 100% minimum convex polygons (MCPs) for families 2 and 3 for the year and for each season. We also calculated 100% restricted edge polygons (REPs)[12] (using a restriction distance of 0.2); these appeared to provide a better estimate of the used area than MCPs (Figure 4). To illustrate the relative use of the home range area over the whole year, we plotted 50%, 75% and 95% kernel contours (Figure 5) – these will be used in future analyses to investigate utilised area and habitat in more detail. Finally, the length of river/loch bank used over the year (a standard measure of territory size for beavers) was calculated in ArcGIS 9.0 (www.esri.com) as the length of waterway edge within the MCP (Table 9).

[12] Minimum convex polygons (MCPs) are the smallest polygon that can be drawn around a set of locations where the external angles are all greater than 180º. 100% MCPs include all locations within the polygon; they are a widely used technique and are therefore particularly useful for comparisons among studies. The area and shape of MCPs are heavily influenced by outlying locations and restricted edge polygons (or concave polygons) may provide a better method if MCPs include large areas that are not visited by the animal (e.g. a patch of unsuitable habitat). REPs are constructed by drawing lines between edge locations in the same way as for MCPs except that lines are only drawn if they are shorter than a selected fraction of the range width (the 'restriction distance'; 0.2 in this case), resulting in a concave range where linkages between edge locations are long. The restriction distance, in this analysis, was selected as the smallest distance that did not result in fragmentation of the range. (Kenward *et al.* 2003)



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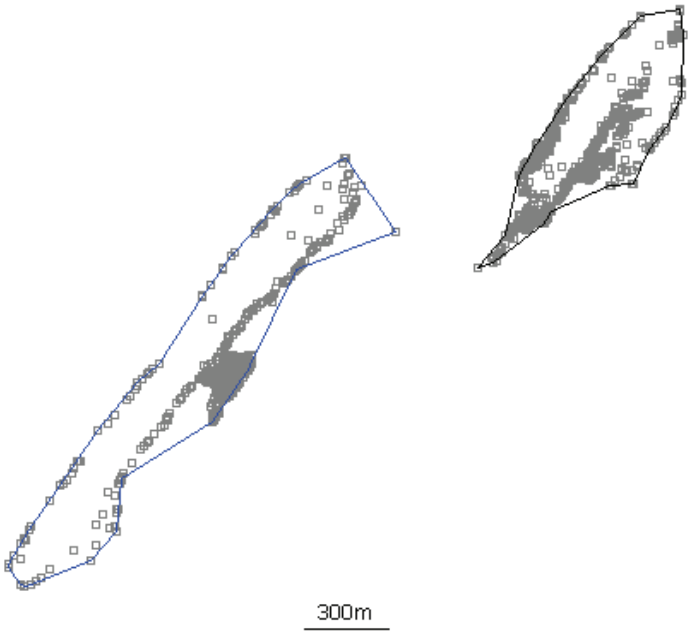


b)

Figure 4. Diagrammatic representation of yearly territory size using a) 100% MCPs and b) REPs (restriction distance = 0.2) for family 2 and family 3 during the first year post release, 2009-2010. Family 3 is outlined in blue, family 2 in black. Open squares are individual locations, recorded from either visual locations or field signs.

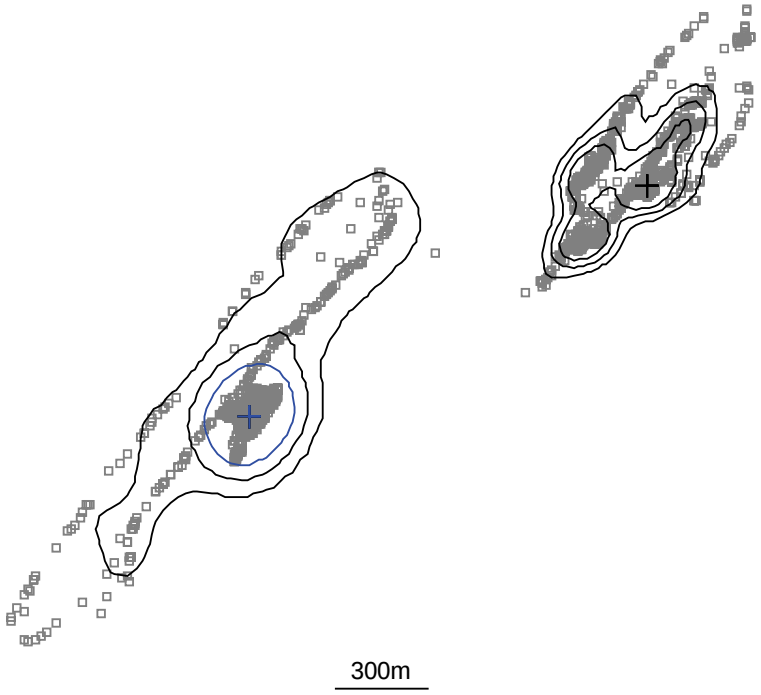


Figure 5. Diagrammatric representation of 50, 75 and 95% kernel contours (using fixed kernals, href = 1) showing differential use of the area within the territories of family 2 and family 3, and the establishment of 'core' areas (marked with a cross and represented by the inside - 50% - cores), during the first year post-release, 2009-2010.

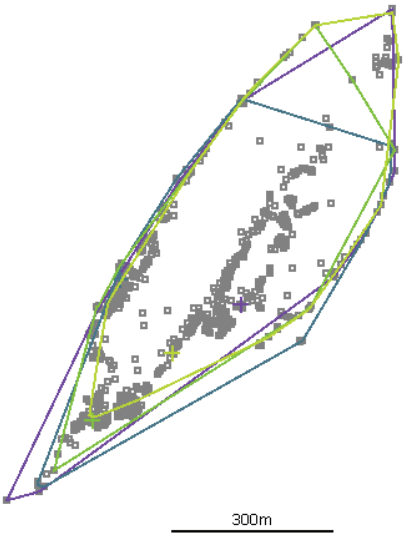
Table 9. Territory sizes (ha) for family 2 and family 3, during the first year post release, 2009-2010

Family	Season	100% MCP (ha)	100% REP (ha)	Length of river/loch bank
2	Summer	24.1	18.0	
	Autumn	21.9	13.6	
	Winter	21.7	18.6	
	Spring	21.8	20.8	
	All year	27.8	25.1	c. 3.4 km
3	Summer	44.8	34.7	
	Autumn	4.6	1.6	
	Winter	3.0	1.4	
	Spring	56.3	44.8	
	All year	57.4	45.7	c. 4.5 km

Summer = June, July, August
Autumn = September, October, November
Winter = December, January, February
Spring = March, April, May

Calculating home ranges (using 100% MCPs) for each season separately revealed little difference in the area used by family 2 among the seasons (Figure 6a). In apparent contrast, family 3 appeared to use a much smaller area in autumn and winter than in spring and summer (Figure 6b). The winter of 2009-2010 was a particularly cold winter in which ice formed over many of the lochs, and it is possible that family 3 restricted its activities to a small productive area around its lodge during this time. Differences in seasonal home range size may, however, be an artefact of small sample sizes for autumn and winter (Table 6), and potentially also observer bias.

Previous studies of beavers in Telemark, where animals were located every 15 minutes, found that the minimum number of locations required to calculate meaningful estimates of home range and habitat use was about 90 over approximately three nights (Campbell *et al.* 2005; Schlichter (2008) cited in Campbell *et al.* (2010)). Incremental plots of territory size against the number of beaver locations showed that estimates of both yearly and seasonal territory size had stabilised (ie. the number of locations was sufficient to calculate territory size) for both families 2 and 3, and that approximately 100 locations were required (Figure 7, 8, 9). The graph below (Figure 7b) shows that as the number of locations increased over c. 350 locations, the territory size of family 3 increased further, but this probably reflects a new extension in the area used by the beavers (to include Dubh Loch a smaller neighbouring loch situated to the south of Loch Coille-Bharr, Figure 1) rather than a sample-size issue.



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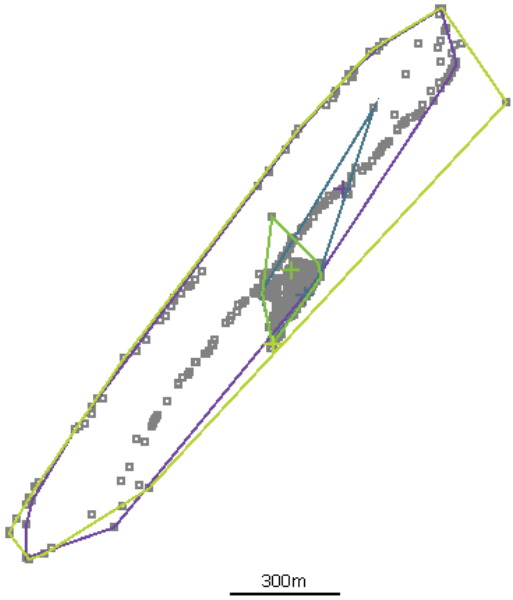
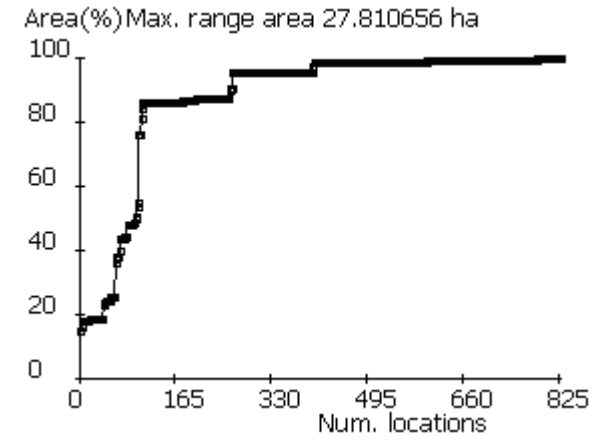
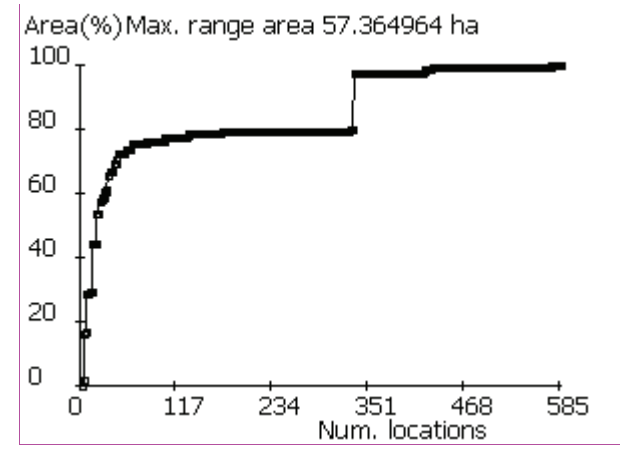


b)

Figure 6. Seasonal territories calculated using 100% MCPs for a) Family 2, b) Family 3 during the first year post release, 2009-2010. Summer=blue, autumn=grey, winter=green, spring=yellow. Note that restricted territory size for family 3 in autumn and winter may be due to small sample sizes and/or observer bias.



a)



b)

Figure 7. Incremental plots for estimates of the size of yearly territories for a) Family 2, and b) Family 3 during the first year post-release, 2009-2010. The point at which the line stabilises and shows no further increase in territory size indicates the number of locations required to estimate territory size.

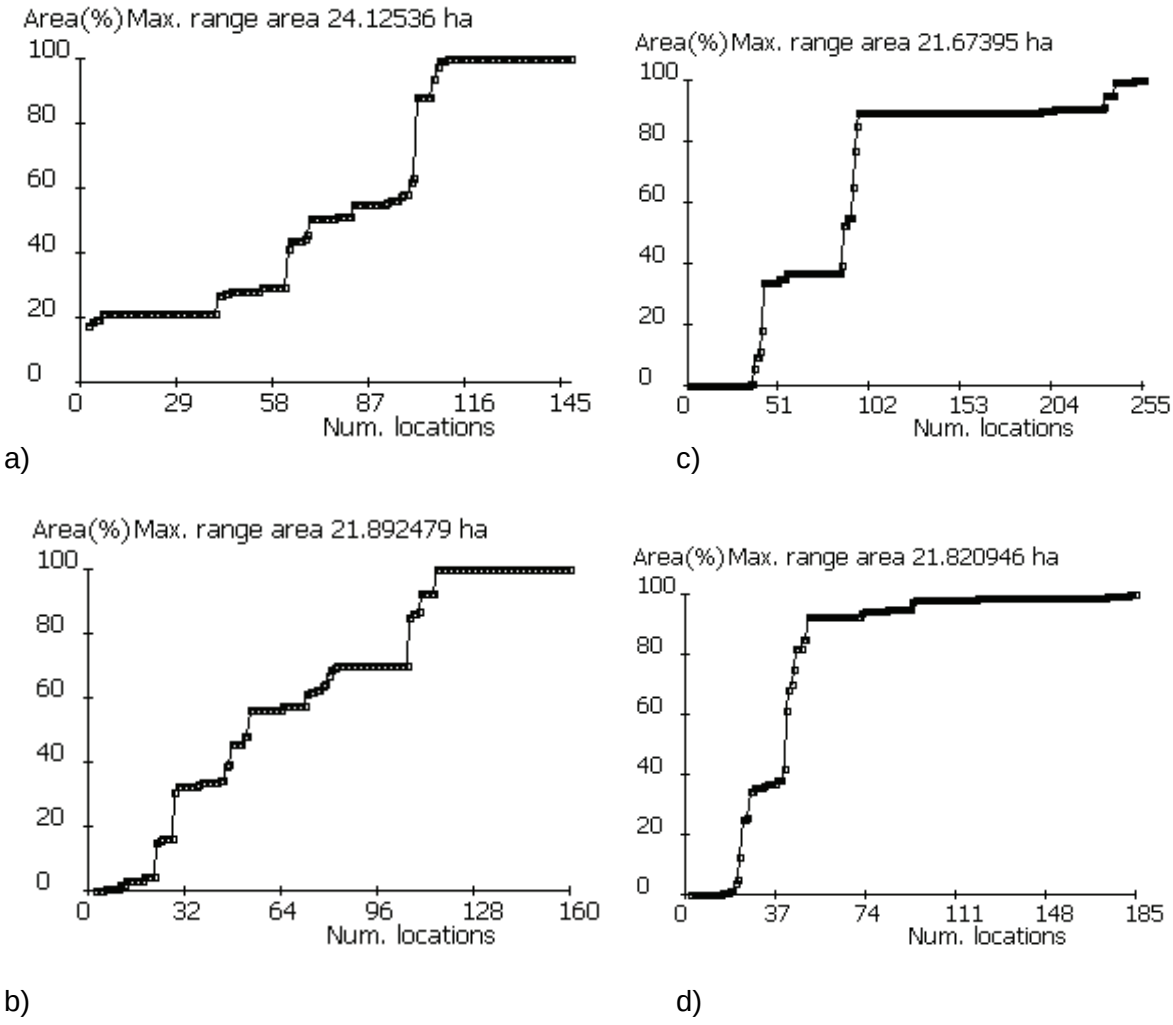


Figure 8. Incremental plots for estimates of the size of seasonal territories (a) summer, b) autumn, c) winter, d) spring) for Family 2 during the first year post release, 2009-2010.

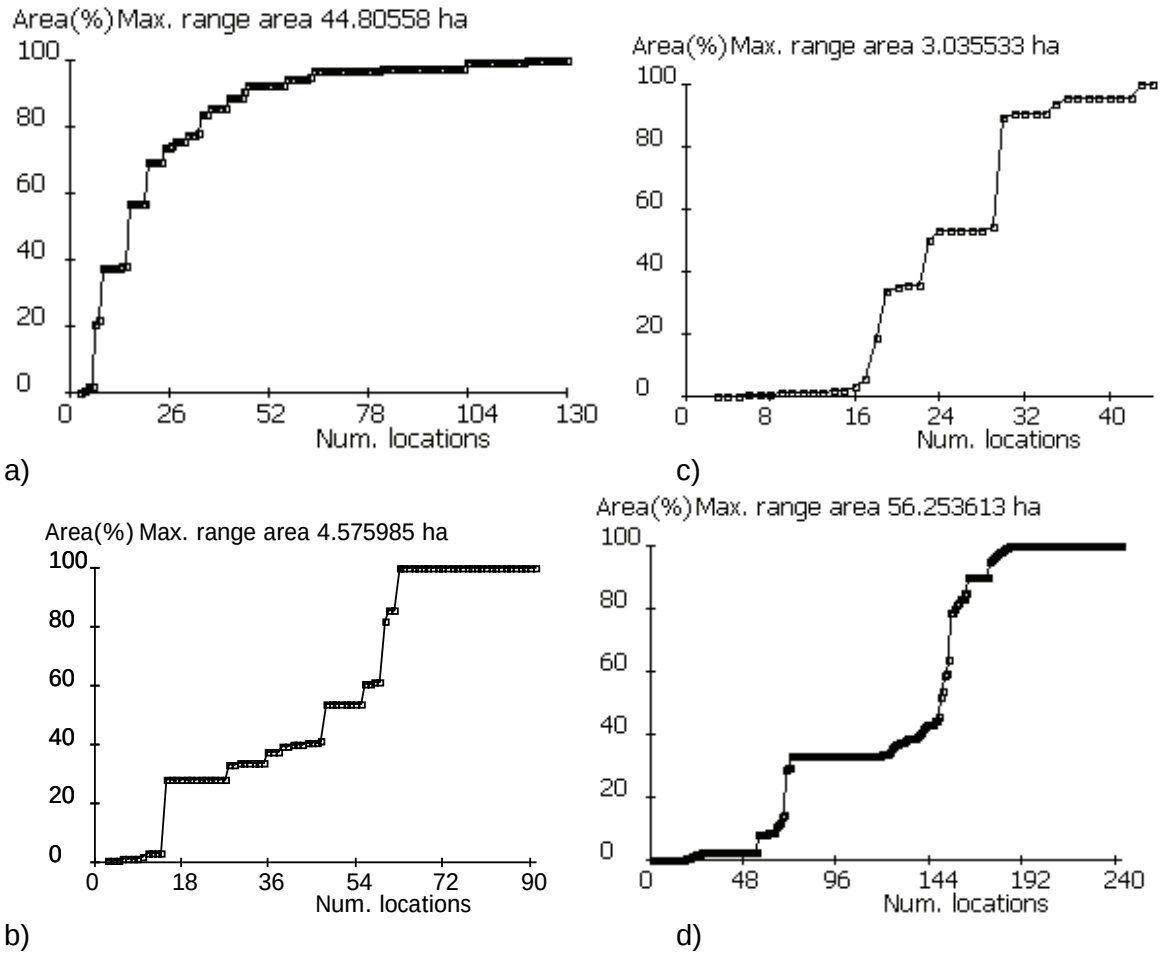
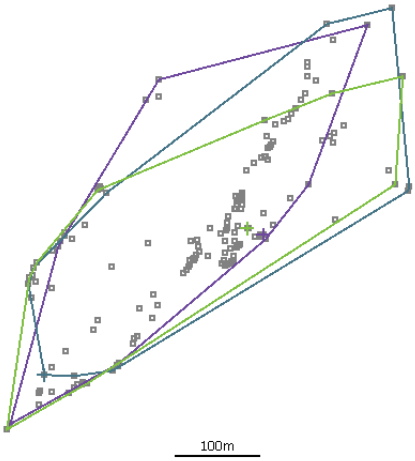


Figure 9. Incremental plots for estimates of the size of seasonal territories (a) summer, b) autumn, c) winter, d) spring) for Family 3 during the first year post release, 2009-2010. Note that in winter territory size approaches a stable estimate, but at a very small size. This is most likely due to observer bias (small sample size alone would not produce stabilisation unless all locations were recorded within the same small area) (see Figure 6b).

Individual yearly home ranges[13] (calculated using 100% MCPs[14]) (Figure 10a) and core areas (calculated using 50% kernel contours) (Figure 11a) show that individuals in Family 2 tend to use the same total, and core, area, suggesting that they use the area as a group. The pattern is similar but not as striking for family 3 (Figure 10b, 11b). Incremental plots are more difficult to interpret for individuals to assess required sample sizes and, whilst plots for most individuals do stabilise (Figure 12, 13), sample sizes are very small in some cases because of the requirement for observations of identified individuals (a large proportion of the recorded observations are of unidentified individuals[c] (Table 3), which are excluded from individual-level analyses). Further, estimates of the size of individual territories (Table 10) are substantially smaller than for the group as a whole (Table 9). Family level analyses have the advantage of being able to utilise both unidentified observations and field signs, which not only increases sample size, but also reduces bias caused by visibility problems and differences in visibility amongst habitats (for instance, beavers are usually only observed on the water or on the river or loch bank, beaver activity cannot usually be seen on land because of the dense vegetation). Family level analyses therefore produce more robust estimates of territory size (as seen from incremental plots, Figure 7 above) and potentially larger estimates (see Table 9 and 10, and Figure 14, 15). Given that the beavers appear to use the area as a group, that a large number of recorded observations are of unidentified individuals (Table 3), and that observational data alone may be biased (section 2 and 5), we suggest that in future years of the project analyses of territory structure and habitat use at the family level will be more appropriate than at an individual level.

[13] The available data were not sufficient to calculate three-monthly or seasonal home ranges for individuals

[14] 100% MCPs appeared to provide a better approximation of the area used by the beavers than 95% kernel contours (as specified in Campbell *et al.* 2010) and so were used here for preliminary analyses of territory size and overlap among individuals. The use of kernel contour methods to assess habitat use will be more fully explored in the second annual report in 2011.



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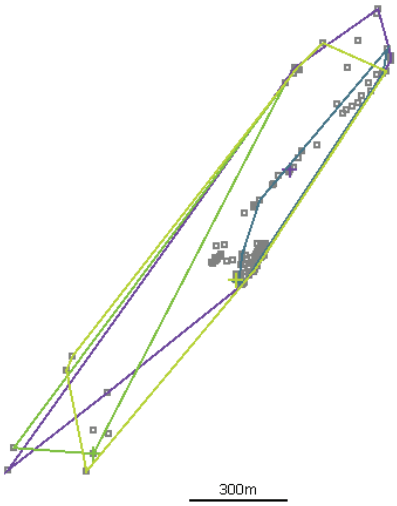
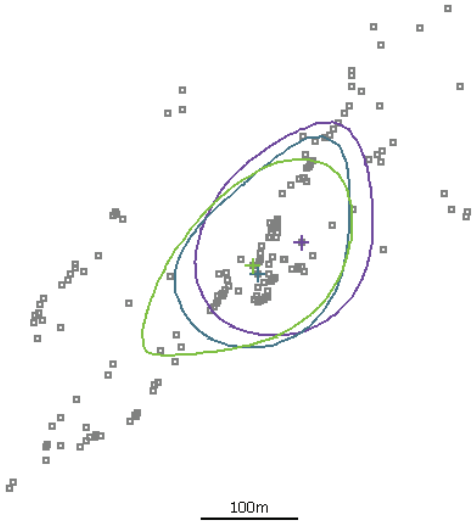


b)

Figure 10. Individual yearly home ranges calculated using 100% MCPs for a) Family 2, b) Family 3 showing overlaps among individuals and similarity in the areas used. Family 2: Frid = blue, Frank = grey, Biffa = green. Family 3: Bjornar = blue, Katrina = grey, Marlene = green, Mille = yellow/green.



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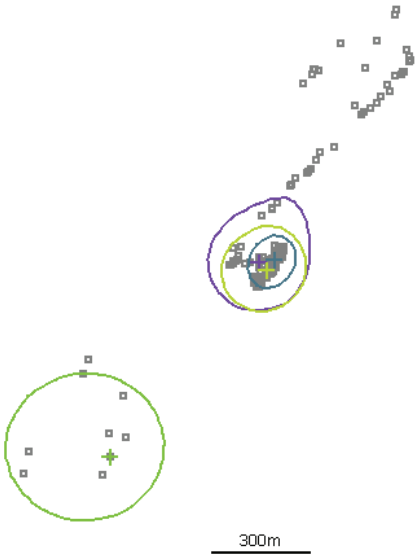
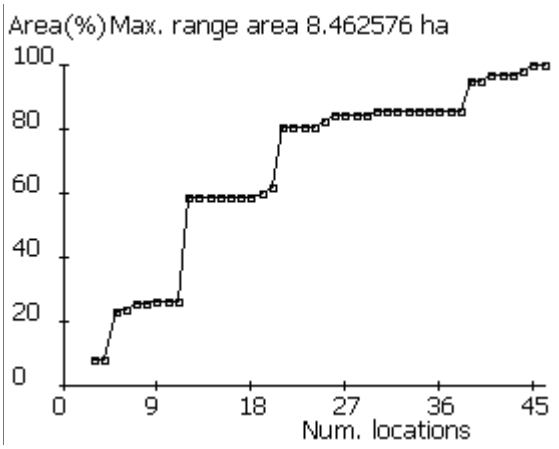


b)

Figure 11. Individual yearly core areas calculated using 50% kernel contours for a) Family 2, b) Family 3 showing overlaps and similarities among individuals. Family 2: Frid = blue, Frank = grey, Biffa = green. Family 3: Bjornar = blue, Katrina = grey, Marlene = green, Mille = yellow. Note that Marlene is assigned a different core area from the other individuals within family 3, which may represent the initial dispersal of this individual from the group. However, detailed investigation of the data reveal that the second core area also encompasses observations of other individuals within the group and so it is not possible (given current sample size) to determine whether this family uses two main core areas or whether it was only Marlene that used the second core area intensively prior to dispersing from the group (only four locations were recorded for Marlene on one day so sample size precluded calculating a home range for her).



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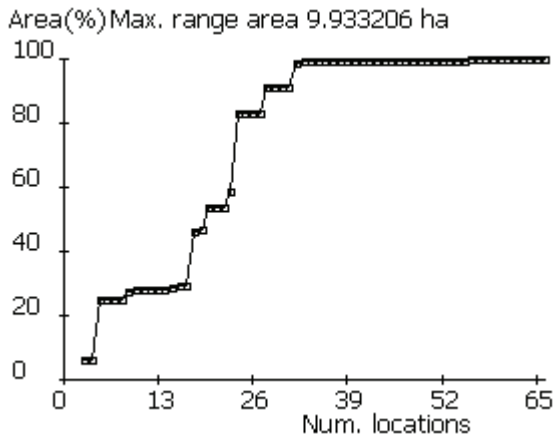

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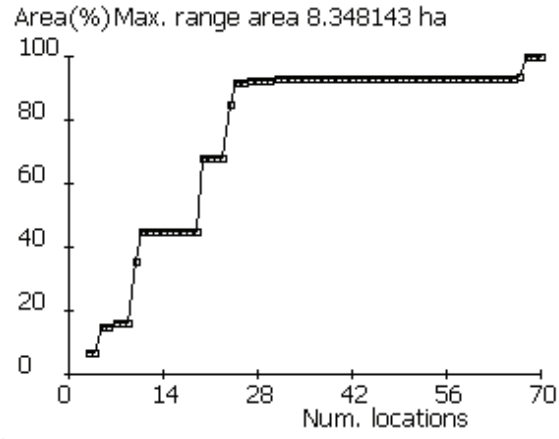
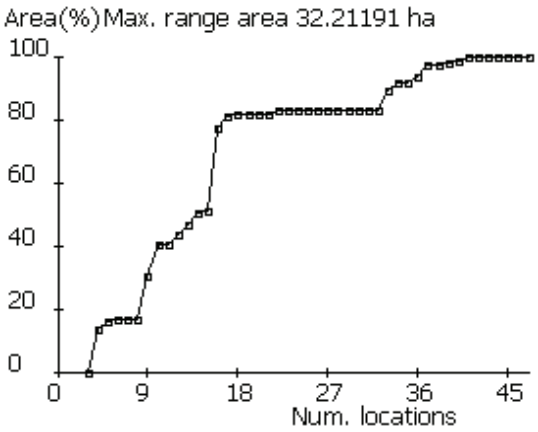


c)

Figure 12. Incremental plots for estimates of the size of individual home ranges for family 2 during the first year post release, 2009-2010. a) Frid, b) Frank, c) Biffa. Note that although stabilisation occurs in some cases, estimates of home-range size are lower than expected based on the size of family territories (Table 9, 10) (see explanatory text above).



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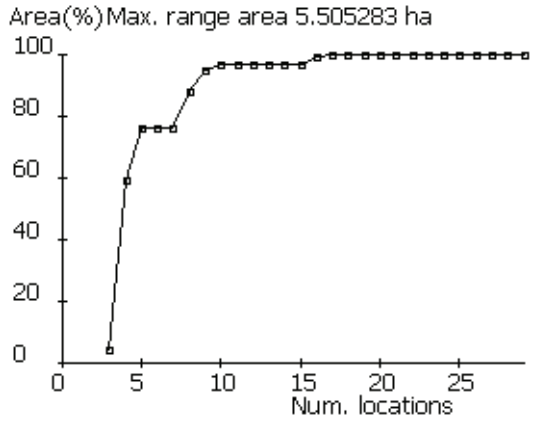

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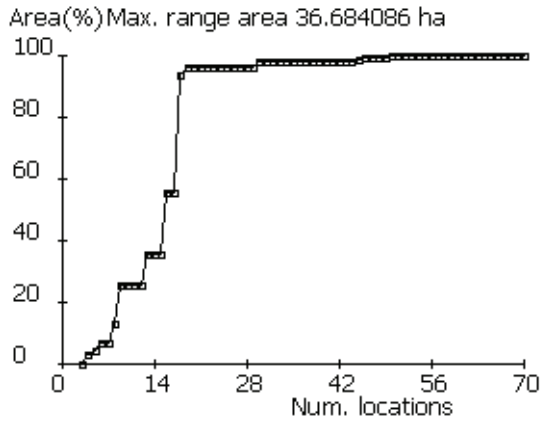


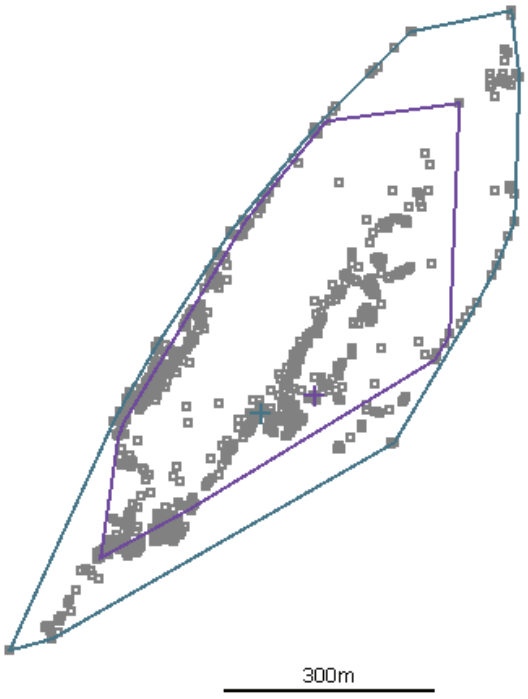
c)

Figure 13. Incremental plots for estimates of the size of individual home ranges for family 3 during the first year post release, 2009-2010. a) Bjornar, b) Katrina, c) Mille (sample size was too small to calculate a home range for Marlene).

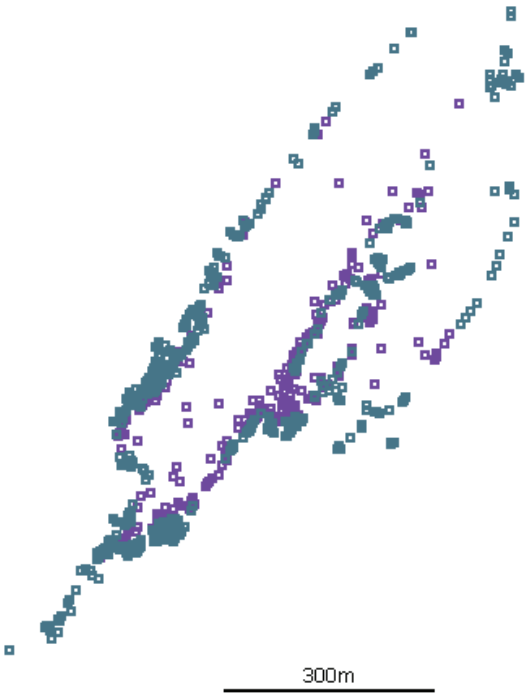
Table 10. Estimated size of individual home ranges for family 2 and family 3, 2009-2010.
Note that comparisons with estimates of family territory size (Table 10) suggest that individual home range size is underestimated (see explanatory text above).

Family	Individual	100% MCP (ha)
2	Frid	8.3
	Frank	9.9
	Biffa	8.3
3	Bjornar	32.2
	Katrina	5.5
	Marlene	14.7
	Mille	36.7

The following territory plots (Figure 14 and 15) show the relative contribution of observational and field sign data to estimates of territory size and structure, and illustrate the impact of potential biases inherent in either method alone. For family 2 we estimated yearly territory size to be between 16.9 and 27.8 ha, using observational data or field-sign data, respectively (compared with a yearly 'total' territory size of 27.8 ha estimated using all data available, Table 9). For family 3 estimated yearly territory sizes were 43.6 and 56.3 ha, using observational data or field-sign data, respectively (compared with a yearly 'total' territory size of 57.4 ha estimated using all data available, Table 9). The inclusion of field-sign data clearly adds information on terrestrial activity that cannot be seen during observations and helps to reduce the potential bias inherent in the observational data caused by visibility issues. Whilst observational data do not appear to contribute to the estimates of territory size, they do add information on internal territory structure and use of the area (particularly use of the aquatic habitat that is not usually detected during field-sign surveys, see section 5).



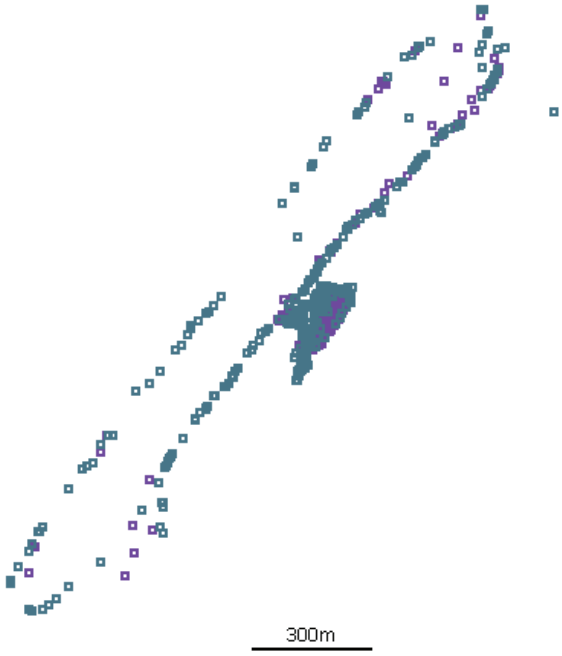
a)



b)

Figure 14. Family territories (calculated using 100% MCPs) (a) and individual locations of all family members (b) for family 2, showing the relative contribution of observational data (shown in blue) and field-sign data (shown in grey) to estimates of territory size and structure.

a)



b)

Figure 15. Family territories (calculated using 100% MCPs) (a) and individual locations of all family members (b) for family 3, showing the relative contribution of observational data (shown in blue) and field-sign data (shown in grey) to estimates of territory size and structure.

4.3 Movements and dispersal

4.3.1 Post-release movements within the trial area

Distance from the release point to the centre of the yearly group territories for the two families that established territories was approximately 0.4 km and 0.9 km for families 2 and 3, respectively (in both cases the release sites were contained within the estimated home range) (Figure 16).

In the absence of radio-telemetry data it was not possible to estimate nightly movement distances.

Figure 16. Yearly territories (estimated using 100% MCPs) (green lines) during the first year of the trial, and their respective release sites (green dots), for family 2 and 3. The brown lines represent the boundary of the release area with excluded areas shown as polygons with brown boundaries

4.3.2 Post-release movements outwith the trial area

Three individuals are known to have moved outwith the release area: Andreas Bjorn, Gunn Rita and their daughter (Mary Lou). Andreas Bjorn left the release area within a few weeks of release and was located approximately 10 km north of the release area at Kilmartin Fish Farm in August 2009 (where he was recaptured and returned to the release site, although later removed from the programme, see footnote 9). Gunn Rita disappeared in the second week post release, her female kit disappeared in mid-July[15]. The kit was initially tracked via

[15] In the interim period, in the absence of her mother, Mary Lou had been provided with supplemental food

RF telemetry to the Crinan Canal but then disappeared. Beaver activity was noted on the River Add, approximately 3 km north of the trial area in October 2009 (Figure 17), but previously occupied burrows appeared to have been abandoned following flooding of the river in early winter 2009 – although further field signs were recorded at the same location in March 2010, none was reported to be fresh. A small beaver (of unknown identity) was sighted (and old field signs recorded) on Crinan Canal in April 2010 less than a kilometre from the release area. It is not currently known whether these field signs and observations are of Gunn Rita, her young kit (Mary Lou) or both.

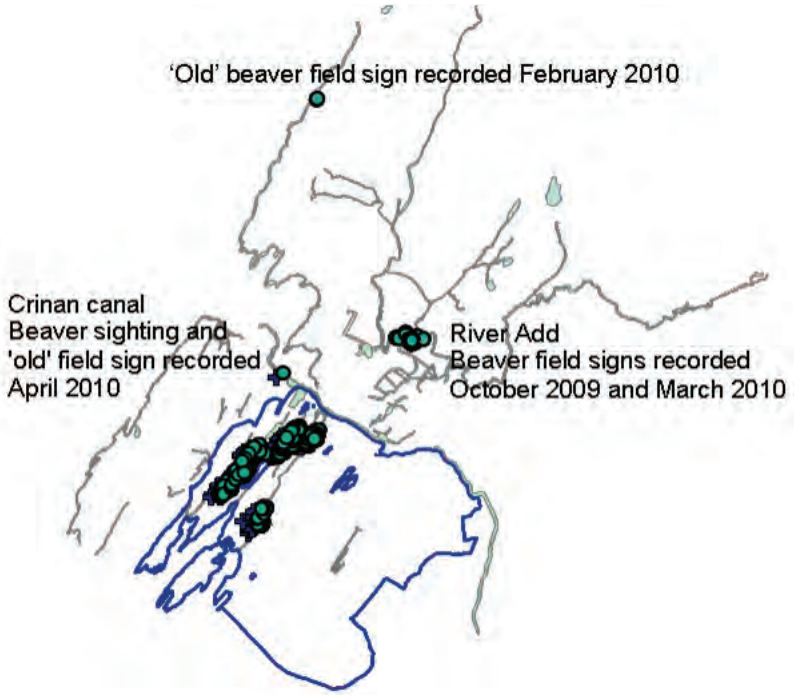


Figure 17. Field signs and observations (green dots) of beavers recorded outside the release area during the first year of the trial, 2009-2010. The blue line shows the boundary of the Knapdale release area.

4.3.3 Dispersal by sub-adults

The only recorded dispersal event of a sub-adult away from the natal group was of a two year old female in Family 3 (Marlene). Marlene was observed fighting with another family member in June 2009 (in the first month post release), and she dispersed south-west to a watercourse in the vicinity of the Fairy Isles (initially tracked by RF telemetry) and was observed in a nearby sea loch in August 2009. She has not been seen since.

4.4 Other riparian mammals

Evidence of otter activity (mostly spraints or footprints/otter paths) was recorded at eight sites (80%) in each of the trial area and the control area (details in Appendix 1). This is slightly lower than the overall mean number of positive sites recorded across the SNH Argyll & Stirling Area during the 2003/04 national survey (89.13%). It is possible that this year's survey results were underestimated due to the high water levels and leaf-fall in the days prior to the survey and high snowfall towards the end of the survey.

Mink signs were recorded at one of the survey sites in the control area, a further three sites had 'possible' mink presence (one in the release area and two in the control area, see

Appendix A). Mink tracks have not been recorded on any of the Scottish Beaver Trial mink rafts to date.

No evidence of water voles was found, but this is not surprising given the late autumn/winter survey dates and the heavily shaded habitat at many of the locations. No other signs of water vole have been recorded at Knapdale before or during the trial.

5. REVISED METHODOLOGY PROTOCOLS AND WORK PLAN FOR YEAR 2

This section of the report details the revised methodology protocols for Year 2 of the trial following amendments made during Year 1 (outlined in section 2) and following discussions between SNH, WildCRU and Scottish Beaver Trial in July/August and November/December 2010.

This section of the report follows the general format as used in Campbell *et al.* (2010), with a brief overview of each method as it applies to the trial, an outline of the workplan and the data required, as well as a summary of the key information provided by each method. Throughout, seasons are defined as follows: Winter = December – February, Spring = March – May, Summer = June – August, Autumn = September – November.

5.1 Trapping

Overview

The preferred technique is the Norwegian method of trapping from a boat because it allows targeted captures and reduces individual recaptures and overall capture time. Trapping from a boat will, therefore, be used on all lochs where it is possible (current areas include Loch Linne, Loch Buic and Creagmhor). However, on some of the smaller lochs use of a boat is not feasible and, therefore, cage traps will be used at those sites. Animal welfare is paramount in terms of suitable trapping method and duration of trapping effort, and thus, cage trapping at a specific location will cease if an individual is recaptured three times within a one-month period. Trapping should resume in an attempt to capture animals not yet trapped after a period of not less than two weeks, but not more than two months. All animals should be uniquely marked with both PIT tags and ear tags (large plastic tags for adults and smaller metal ear tags modified by applying reflective tape of different colours for newly-trapped kits). Argos tags will no longer be fitted. RF telemetry is not currently part of the revised methodology but will be used for management purposes.[16]

Over the first year the most important outcome of the trapping data was the health and survival of individual released animals. In future years identification of wild-born young will also be needed to allow assessment of their survival and description of population dynamics. Therefore, it should be a high priority to capture and mark any new unmarked young animals. Every known animal should be trapped once per year. Trapping of new wild-born kits should be an additional priority.

Work plan

The precise timing of the annual trapping is not critical and can be fitted in with other activities (but must be recorded so that methodology can be accurately reported). However, the earlier in the monitoring year trapping is carried out the more time is available for capturing animals not yet caught. Further, to allow assessment of annual variation in body condition (estimated from animal weight and body metrics), the timing of trapping should be relatively consistent over consecutive years of the project (ie. within the same season). Late February to late spring, when females may be pregnant, should be avoided for intensive trapping efforts. Trapping for kits should be carried

[16] ARGOS telemetry is not part of the ecological methodology protocols (see section 2); RF telemetry is not currently part of the revised methodology but may be used on 'new' animals and sub-adults likely to disperse for management purposes – data should still be provided to SNH and WildCRU so that its use (and potential relevance to ecological monitoring) can be further reviewed at a late date; GPS telemetry may be used in future - this would benefit the ecological monitoring (5.4)

out as close to emergence time as possible, but this can be carried out as a separate trapping session to the annual trapping for known resident beavers. In the event that kits lose their ear tags they should be recaptured during the annual trapping (if this occurs after the kit trapping) to allow estimation of early losses (mortality rates of kits in the first few months post emergence).

Data — Data detailing the number of traps used and number of hours the traps are open (to allow calculation of trap effort) to be entered into the existing trapping spreadsheet[17]; trap locations of captured animals also to be imported into the observation file in the beaver trial database as an 'observation of a known animal' at a known location.

Key information provided

Survival of known individuals (yearly)
Body metrics for assessment of overall body condition
Reproductive rates (number of females breeding and number of kits per breeding female)
Population size and density within the release site
Age structure of the population
Dispersal (number or proportion of animals dispersing)[18]

5.2 Observations (visual checks and behavioural observations)

Overview — Observational data offer a non-invasive alternative to repeat trapping of animals and observations can thus be considered as 'recaptures' in a capture-mark-recapture (resight) analysis (to determine survival and population size). Observation locations of the beaver can be used instead of radio-telemetry 'fixes' to determine territory sizes and, potentially, habitat use. It may also be possible to carry out detailed behavioural observations of focal animals (see footnote[19]). The use of observations to assess survival and/or population size is dependent on the ability to identify individuals. Locations of unidentified beavers can, however, be analysed at a family level to assess family territory (home range) sizes and/or habitat use. The use of observational locations in analyses of home range size or habitat use are potentially subject to bias because animals are most often observed on the water and cannot be seen through the thick vegetation when they are ashore, biases can, however, be

[17] trap effort = total trap effort = number of traps x hours that the traps are open

[18] Whether dispersal is 'natural' dispersal of young sub-adults leaving the parental group , or 'dispersal from the release site' by newly-released adults, the proportion of animals dispersing can only realistically be estimated from the disappearance (lack of captures and observations) of animals from the site. Further, in the event of a disappearance, it will not always be possible to determine whether the disappearance was due to dispersal or to mortality. Some information on minimum distances moved will be obtained from reports of field signs outside the release area

[19] Note that behavioural observations of focal animals are not included in the monitoring protocols for Year 2 but detailed behavioural studies of established beavers will be introduced in later years. Observations of beavers in Knapdale are currently somewhat problematic because newly-released beavers appear to be disturbed by the presence of observers and/or the lights used by observers. Further, the behaviour of newly-released beavers is likely to differ in unknown ways from 'normal' behaviour of established animals. However, as beavers become habituated to observers and lights, and settle in the release area, focal observations should become possible, as well as more representative of 'normal' behaviour. Detailed behavioural data are supplementary to the essential ecological data currently being collected, but would be extremely valuable in further understanding the ecology of reintroduced beavers and may help to explain the ecological results obtained. The need for and the feasibility of focal behavioural observations will become apparent as the project progresses and will be reviewed and the practicalities discussed with SCOTTISH BEAVER TRIAL at a later date.

overcome to some extent by combining observational locations with field-sign locations (below).

Beavers can be observed using sit-and-wait tactics (from either a hide or a boat), or by searching the loch by boat until a beaver is spotted. When a beaver is observed, its location, ear tag combination (if possible), behaviour[20] (and relevant additional information such as food type) and interactions with any other beavers, should be recorded. Observers should then move away from the animal, and around the loch (or to another loch) to search for a different individual. Each loch should be searched systematically by moving continually either clockwise or anticlockwise but changing directions between sessions to ensure that the same animals are not always observed in the same places at the same time. If an animal is moving around when it is observed (and deemed not to be moving in response to the presence of the observers) more than one location can be recorded in any 'observation event' (successive locations should be 10 m or more apart, but the time interval between them is not critical).

Observations of active lodges and dens should also be carried out to count the number of animals present when kits emerge. During these observation periods it would be sufficient to count the number of animals (adults, yearlings and new kits) present at the lodge or den. However, if animals are seen foraging whilst carrying out counts, location and behaviours should be recorded as above (but only if this does not interfere with making accurate counts – counting the number of kits present is the priority during these sessions).

Spotlights should be used for observations in the dark if animals have been habituated; Scottish Beaver Trial have been habituating beavers to spotlights and should continue this. The use of night scopes should be considered for focal animal observations in future years.

Workplan

Observation sessions should be carried out monthly as part of the monthly visual checks carried out by Scottish Beaver Trial for management purposes. Because observational data are now, in part, replacing radio-telemetry, observations should be carried out with the aim of watching each family over a full night each month (although in practice, a 'full night' can be split over two nights, one covering the first half of the night and one covering the second – this will probably be essential over the winter months when nights are long)[21] [22]. This observational protocol requires 3 nights of observations per family per quarter or season (as is currently being done) but involves observing all

[20] The animals' behaviour should only be recorded if the animal is undisturbed or if it was possible to see what the animal was doing before it was disturbed. If the animal was seen foraging that should be recorded. If the animal was seen swimming it will be more difficult to determine whether or not the animal was swimming due to disturbance by observers and judgement will be subjective and based on an observer's own experience; swimming away from the boat (to avoid observers) should not be recorded but if the beaver has not been disturbed to any significant extent and/or was already in the water before it was disturbed then behaviour should be recorded as 'swimming'.

[21] A full night of observations is required because beavers might use their territories differently over different parts of the night – if this is not the case, then observation sessions could potentially be limited to, for example, the first half of the night only. Behavioural data from the source population in Norway could potentially be analysed to investigate this further, and to inform current monitoring protocols in Knapdale

[22] In future years, observations may be able to be reduced if GPS telemetry is used successfully to obtain detailed location data for home range and habitat use analysis (any further amendments on this basis should be discussed with WildCRU and SNH at the appropriate time)

families each month rather than each family on a different month. Within this protocol it is possible to either make observations of 1-2 families each night and move between lochs/families between nights or to move around the entire release site each night and repeat over 3 nights – the exact protocol chosen will depend on logistics and can be decided at the discretion of Scottish Beaver Trial and observers in the field, bearing in mind that the aim is to record different locations and that repeat observations of beavers at the same location add little to the data. Given the requirement for approximately 100 locations per season (but considering that some locations will be provided by field signs), an approximate guideline would be 15-20 observational locations needed per month per family, which for a pair of beavers is 2-4 observations of each individual/night repeated over 3 nights or 7-10 observations of each individual/night if each loch/pair/family is observed over a single night/month (approximately 1 per hour). If observations are recorded over all lochs each night and repeated over three nights, observers must ensure that the order in which each loch is visited is changed each night.

Additionally, weekly evening observations of active lodges or dens should be carried out when kits emerge (from approximately mid-July, through August). Observation periods should be determined, at least in part, by experience of when beavers first emerge from the lodge/den in the evening, and should continue until the light fades and observers are unable to see beavers clearly (lights should not be used for counts at lodges/dens to avoid scaring the kits). Approximate observations periods will be 7.30-10pm.

Data

All location and behavioural observations should be entered into the existing observations file within the GIS beaver trial geodatabase. For unidentified animals, 'null' should be entered in the ID column. To allow the extent of disturbance to be assessed, a field should be added to the database to record if a spotlight was used or not, and an additional field to record if the animal was disturbed or not (with separate codes for: animal disturbed immediately, animal disturbed after initial location recorded). Locations for beaver 'noises' should only be recorded when a) an observer is certain that the noise was from a beaver and b) the location of the noise can be accurately determined. Any further explanatory information should be entered into the comments field; additional information can be invaluable during data screening prior to analysis (the types of information that might be useful include notes on the accuracy of the information recorded – animal location or animal identification, any difficulties encountered in recording the data, if the location comes from an animal capture, any relevant information on the animal under observation).

Counts of animals at lodges/dens should be entered into a separate spreadsheet with columns for lodge/den location (name of loch and grid references), date, numbers of observed adults, 2-year olds, yearlings and kits, so that there is a row for each evening observation for each lodge/den.

Key information provided[23]

Survival of known individuals (monthly)[24]
Reproductive rates (number of breeding females and number of kits per breeding female) (from lodge/den counts)
Population size and density within the release site

[23] Information on beaver behaviour will also be provided if focal observations are carried out in future years.
[24] Dependent on identification of the animal

Sociality of the population[25]
Dispersal (number or proportion of dispersing animals) (see footnote 19 above)
Territory locations, as well as number and size of territories (from animal locations)
Habitat selection within territories (from observations of foraging animals)[26]

5.3 Field-sign surveys

Overview

A lot of useful information can be gained from field-sign surveys. These surveys can be used to locate dams, lodges and dens, territory borders and areas of high foraging activity. Assessment of habitat use based only on field signs is biased towards use of woody vegetation (there are few obvious signs of foraging on herbaceous or aquatic vegetation), but field signs can be used to supplement other more difficult and labour intensive methods (e.g. direct observations) to provide a more complete picture of beaver foraging-habitat use (as above).

Field signs (and their locations) should be recorded during foot or boat surveys along loch and river banks, and in the surrounding area. Surveyors should walk (or travel by boat) until a field sign is observed. If it is a single field sign, record its location (and other associated data); if two different types of field signs occur in the same location record both separately. If it is a patch of field signs, record the location in roughly the centre of the patch (and record all other information for that patch as a whole)[27]. For activity and foraging signs only one location (for either a single field sign or a patch of field signs) per 10 m length of bank needs to be recorded[28]. Types of field signs that should be recorded are summarised in Table 11. Dams should be photographed. Search effort should be recorded and mapped. Any foraging trails or dug canals should be followed to locate additional field signs away from the water's edge. For feeding signs, only fresh signs (ie. those left within the last month) should be recorded; for other field signs (eg. lodges, burrows, or scent mounds), only those with evidence of recent (within the last month) use should be recorded. Dams can be recorded repeatedly, although additional notes on recent maintenance activity and/or deterioration should be recorded in the database. To assess accurately whether a field sign is fresh or not, or been used recently, will require a degree of expert judgement, but assessments may be assisted by using an effective marking system to mark field signs when they are first recorded[29]. During Year 1 of the project a marking system was developed using natural wool to distinguish old (previously recorded) field signs from fresh field signs – this system is

[25] Dependent on observations of two or more animals together or of observations of multiple animals leaving the same lodge/den

[26] Foraging observations will be biased towards foraging in water and/or on the edge of the loch banks due to thick vegetation and visibility problems elsewhere, but can be combined with field sign locations to provide a more complete picture of beaver habitat use

[27] The only complication that should arise will be if field signs become so prominent that they are essentially continuous (over more than 10 m) along the loch/river bank – if that becomes the case SCOTTISH BEAVER TRIAL should discuss with WildCRU and SNH how to most efficiently record signs in the field.

[28] It is not necessary to predetermine the 10 m survey sections – this can be done retrospectively at the analysis stage to monitor e.g. changes over time in the proportion of survey sections containing foraging signs.

[29] Markers used need to be able to persist in the environment for 1 to 2 months, but also not distract from the aesthetics of the area since Knapdale Forest is located within a National Scenic Area open to visitors.

currently believed to be effective and so should be continued. However, alternative more efficient marking methods should be investigated and considered (e.g. non-toxic sprays or marker pens used in forestry, and used where not easily visible by members of the public).

Any reported or observed field signs (e.g. during searches for lost animals) outside the release area should also be recorded to provide information on dispersal (albeit on an anecdotal basis).

Table 11. Field sign categories.

Type:	Feature:	To include:
Dwelling	**Burrow**	
	Lodge	
Construction	**Dam**	
	Canal	
Feed Sign	**Food cache**	Underwater stores of cut saplings and branches outside the lodge/burrow
	Tree/branch cutting	Felled trees/saplings Cut tree stumps Gnawed trees Cut branches Stripped branches/sticks
	Feeding stations	
	Foraging trail	
	Other	Grazed area = cropped (by beavers) ground vegetation Aquatic macrophyte mats
Activity	**Tracks**	
	Scent mound or marking	Single marks, or recent marking of a larger, frequently used scent mound

Workplan

All riparian habitat in areas known to contain beavers should be walked once in every season around each loch/river known, covering an area up to 40m away from the waters' edge.

Additionally, other riparian areas within the whole beaver trial area boundary should be walked every fourth months (in approximately November, March and July). It is important that at least one survey of the wider area is conducted in November after autumn leaf-fall and when the die-back of vegetation aids visibility. If field signs are located in the wider riparian area, these areas should be incorporated into the seasonal field-sign surveys. These surveys need to encompass, as a minimum, all burns surveyed within the trial area for river-habitat monitoring purposes (Gilvear & Casas Mulet, 2010). This is to enable subsequent river habitat and other monitoring work to be targeted at any new sites with beaver activity. This type of survey will presumably also be of use for Scottish Beaver Trial's own management purposes, particularly since the use of radiotelemetry has had to be reduced.

Data

Data should be entered into the existing field-sign file in the beaver trial database. For any signs that cover a large area (e.g. foraging signs), the recorded GPS point should be approximately central (to the area of foraging) - only one point should be recorded in any 10-m stretch of bank. For field signs recorded outwith the release area, any relevant explanatory notes should be added to the comments field (for example, known or suspected animal

identification, any associated trapping efforts, animal now known or believed to be dead/alive, animal now rescued and returned to the release area).

Key information provided

The number and location of dams and lodges built
Territory locations, as well as number and size of territories
Territorial marking behaviour
Habitat selection within territories (combined with observational data – above – to provide unbiased data)

5.4 GPS telemetry

GPS telemetry is not currently part of the monitoring protocols, but it is recommended that Scottish Beaver Trial consider using it in future years as an alternative to RF tags. GPS telemetry is potentially able to provide a very detailed series of locations for beavers remotely and thus without the difficulties associated with observing beavers directly or with triangulation in RF telemetry, and without significantly increasing the workload of the field team. Such data would allow detailed analysis of home range and habitat use, and could significantly help the ecological monitoring (both the quality of the data and the efficiency with which they can be gathered). The costs of GPS telemetry mean that not all animals could be tagged and there are still attachment issues that need to be resolved, but tags could be rotated between animals such that each animal was monitored for one month at a time[30]. One of the advantages of GPS telemetry is that beavers would only have to retain tags for a short period of time (e.g. 2-4 weeks) which reduces the risk of tag loss (although some lost tags should be expected). The disadvantage is that animals would need to be recaptured (and handled) within approximately 4 weeks to remove the tag[31]. Prior to the use of this technique, it will be essential for Scottish Beaver Trial to test the accuracy of GPS telemetry at Knapdale, and to discuss the experimental design of their use (animals implemented with tags, and months in which they should be implemented) with WildCRU and SNH.

5.5 Surveys of otters and other riparian mammals

Overview

One of the qualifying features of the Taynish-Knapdale Special Area of Conservation (SAC) is the Eurasian otter (*Lutra lutra*) (which is also a UK BAP priority species). To demonstrate that the trial reintroduction of beavers into the SAC will not negatively impact on the site's qualifying features or on UK BAP priority species, otter presence in the area will be monitored over the duration of the project. Surveys for the presence of otter field signs will be undertaken by SNH following standard otter-survey methodology (see 1.7, Appendix A). Supplementary data on the presence of mink field signs will also be recorded, since mink field signs are easily recorded alongside otter field

[30] The potential costs of GPS collars must be balanced against the cost of staff and resource requirements associated with RF telemetry and triangulation techniques. Further, if GPS telemetry could be used, and if it provided high quality data, observation and field sign surveys could potentially be reduced so there is a trade off in costs.

[31] It would not be possible to leave tags on for a longer period because of the risk of tags being lost from the animals.

signs, using the same methods. Further additional data on the presence of mink will be provided by Scottish Beaver Trial from their mink control activities.

Workplan — 20 surveys sites (10 in the release area and 10 in the control area) will be surveyed annually in September by SNH (ideally, but should be delayed if weather conditions are unsuitable). The survey should not be undertaken immediately after a period of high-water levels and should be completed in a single four-day period of fieldwork, rather than split into two. Survey site locations are given in Appendix A; the same sites will be surveyed each year. Samples needing their identification verified should be stored in a freezer.

Data — Data will be input into the riparian mammal survey data spreadsheet using unique section IDs that link to the survey sites in the GIS database. A record should be kept of all stored samples with IDs to allow links to survey data.

Key information provided

Presence, distribution and relative abundance of otters[32]

5.6 WORK-PLAN SUMMARY

Trapping — Annual trapping - once per year targeting all individual animals, time of year to be decided by Scottish Beaver Trial, but should be reported, and (ideally) within the same season each year

Kit trapping – September or as soon as possible after emergence from the lodge

Observations — Visual checks – one full night of observations (recording locations and behaviour if possible) each month for each family (excluding the month when kit counts are carried out)[33].

Kit counts - weekly evening observations of active lodges or dens, counting animals present when kits emerge (from approximately mid-July, through August). This action should take priority over all other monitoring actions for one month when kits are emerging from lodges.

Field sign Surveys — Surveys of known occupied areas - every season, recording all new field signs seen (within 40 m of the water's edge).

Surveys of the wider release area - every fourth month (in approximately November, March and July), but with at least one survey in November, to include all loch edges and riparian habitat covered by Gilvear and Casas Mulet (2010) during their river-habitat baseline survey.

GPS Telemetry — Consider potential use of this method, do preliminary tests as necessary, discuss with WildCRU and SNH.

[32] It is not possible to assess habitat usage of otters from otter spraints

[33] Because the need for kit counts prevents observational surveys from being carried out in August, observers should try to ensure that sufficient observational locations are recorded during June and July to achieve the required number of locations (see above) for the summer period

Otter surveys Annual survey carried out by SNH in September.

6 REFERENCES

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APPENDIX A

Monitoring of the otter *Lutra lutra* and other riparian mammals - report on the 2009 survey

Monitoring of the otter and other riparian mammals was carried out by Rob Raynor at SNH. The full report on this aspect of the monitoring project (authored by Rob Raynor) is provided here; a summary of the collected data and a brief overview of the results is given in section 3 and 4 of the main report.

Introduction

The rationale for undertaking monitoring of otters and other riparian mammals at the release site is detailed in the WildCRU report to SNH: *Campbell, R.D., Feber, R., Macdonald, D.W., Gaywood, M.J. and Batty, D.* (2010). The Scottish Beaver Trial: Ecological monitoring of the European beaver *Castor fiber* and other riparian mammals – Initial methodological protocols 2009*. Scottish Natural Heritage Commissioned Report No. 383.*

One of the qualifying features of the Taynish-Knapdale Special Area of Conservation (SAC) is the Eurasian otter (*Lutra lutra*). In order to demonstrate that the trial reintroduction of beavers into the SAC will not negatively impact on the site's qualifying features, it was acknowledged that a programme of monitoring, coordinated by SNH, was required and this should necessarily include the otter. Other riparian mammals, notably American mink (*Neovison vison*) and water vole (*Arvicola amphibius*) were included, as the former, at least, can be readily surveyed using the same methodology as for the otter. Both otter and water vole are UK BAP priority species and if information on the occurrence of the latter can be collected at the same time, this can only be beneficial, as the current distribution of water voles in Scotland is still incompletely known. Notwithstanding this, given the important ecological role that beavers play in influencing the hydrology of their habitat and experience from elsewhere in their European range, negative impacts from beavers on any of these other species are considered unlikely.

Development of the methodology

The proposed methodology for undertaking the survey is detailed in Campbell *et al.* (2010) and is largely based on that used in previous national otter surveys (see Strachan, 2007).

The survey protocol is based on 20 x 100m sample sections of watercourse and adjacent bank side habitat, recording all field evidence of otter, American mink and water vole. Such surveys cannot provide reliable information on the number of otters or mink present in the area, but do provide a useful index of their activity, which, if repeated annually at a comparable time of the year, may reflect a change in otter usage of the area.

A previous draft of Campbell *et al.* (2010) set out a survey protocol which involved selecting 17 of the 20 sample sites on a random basis (using random numbers inside the trial area and Hawths Tools for ArcGIS outside), with half the sites located within the trial release area and the other half (control sites) located outside. The three exceptions (two within the trial area and one outside) had previously been surveyed in one or more of the national otter surveys. These sites were automatically included to enable comparison with previous data. Additionally, the original proposed 10 control sites were located within a wider 10-km buffer zone surrounding the trial area.

The entirely random element within the site selection process differed from that used in the previous national surveys, in which sites were pre-selected to give a representative sample within each 10-km square, but were identified from maps as being locations that were both accessible and likely to show evidence of otter presence. Thus, many of these sites were associated with bridges and river confluences etc, where otters frequently deposit spraints. An initial visit to three of the original proposed sample sites at Knapdale (selected using the methods set out in the previous draft of Campbell *et al.* (2010)) was undertaken on 8 October 2009 to assess their suitability as monitoring points. Several of these were straight sections of very narrow watercourse with dense overhanging riparian vegetation and no obvious features like bridges or confluences which would increase the chances of finding otter signs. It was concluded that because of this, the proposed suite of sites could result in a high proportion of negative results, providing a false impression of otter activity in the area and potentially hindering any subsequent analysis.

It was decided, therefore, to identify a new suite of sample sites that would be sufficiently statistically robust, whilst maximising the chances of finding evidence of otters. The revised site selection protocol was developed in consultation with the SNH statistician and is summarised below. In order to ensure that the datasets for the beaver trial area and the control area would be statistically independent, it was considered that the latter should be located in similar habitat further away, to minimise the chance of a single otter territory overlapping both the trial area and the control. Therefore, in consultation with local SNH area staff, it was agreed that the area of Forestry Commission land surrounding Loch Glashan to the north-east of the Crinan Canal would be suitable in this respect. The full list of sites is given in Table 1. This revised methodology has been summarised in the final, published version of Campbell *et al.* (2010).

Within the release area

The release area was divided into three zones based on the catchments of the major water bodies in the area. In order to provide representative coverage of the major habitats used by otters in the area and avoid bias towards sampling areas where otter density might be expected to be higher, e.g. coastal habitats, three categories of sample site were identified:

- Inland watercourse
- Freshwater loch outflow
- Coastal watercourse outflow/shoreline

Within each of the three catchment zones, a minimum of three sample sites was allocated, one from each of above categories. The most southerly catchment comprising Loch Creagmhor, Loch Buic and Loch McKay had an extra inland watercourse site to achieve the required total of 10. Two of the sites were previously surveyed on 31 August 2003 (as part of the 4th national otter survey). They were also surveyed in February 1978, May 1985 and May 1992 during the VWT national otter surveys. Note that Site 18 on this map (Loch McKay outflow) was latterly replaced with a new site at Loch Creagmhor. The original site 18 was found to be unsuitable because the very small watercourse had been completely overgrown with rushes and there was no longer any visible open water.

Outside the release area (the control area)

The control area could not be readily divided into three hydrological units, so it was necessary to distribute the sample sites, using the same categories above, based on a combination of accessibility and the availability of potential sites, and across the site by visual assessment of the features shown on the O/S1:25,000 scale map. In selecting potential sites, a conscious effort was made to distribute the sites as evenly as possible over

the control area, whilst avoiding locations on the western periphery where there is the possibility of an otter home range extending south-westwards across the Crinan Canal into the release area. In order to enable comparison with previous VWT national otter survey data, three VWT sites were included. These were surveyed in February 1978, May 1985 and August 1992 as part of the VWT national otter surveys. A total of four inland waterway sites were selected, plus three coastal and three freshwater loch outflow sites.

The fieldwork

To control for seasonal variations in sprainting behaviour, surveys should be repeated at a similar time of the year. In the above examples there is unfortunately a rather wide discrepancy between the dates of the surveys, although the most recent survey (2003) and the 1992 survey both visited sites in the area in late August. Accordingly, the original proposed methodology for this survey recommended the month of September. In practice, unforeseen circumstances, including the decision to amend the site-selection methodology and competing workloads, resulted in a delay in commencement of the fieldwork such that the survey was eventually undertaken in two separate two-day periods in early November and mid December. This presented some practical constraints concerning the detectability of field signs at some locations, which is discussed later.

Most sites were associated with bridges or obvious physical features such as loch outflows. Digital photographs were taken of each survey section from the initial point of access, and a GPS 10 Figure grid reference recorded for the position at which the photograph was taken. The direction in which the camera was pointing was recorded as “upstream” or “downstream”, with the exception of one coastal site (7) where it was recorded as looking south.

At most sites it was possible to conduct the survey by walking within the watercourse channel and recording any field signs observed from there. In very narrow watercourses, both banks could be inspected simultaneously, whereas at others it was necessary to survey each bank separately and/or complete part of the survey from the bank.

The length of each survey section was estimated by counting paces as the survey progressed. The following field signs were recorded: holts/dens/places of shelter, spraints/scats, footprints/tracks and otter paths. Any evidence of prey was also recorded. The distance from the start to the first evidence of otter was recorded. Otter spraints and mink scats were collected and retained in labelled plastic bags. Direct contact with the spraints was avoided by using a wooden spatula or a piece of twig to manoeuvre the spraint into the bag. Spraints were bagged individually at those sites with few signs, but where there was abundant evidence (e.g. several spraints deposited at the same point), the spraints were put in the same bag. The material were later frozen and then eventually transferred to specimen tubes containing 70% alcohol.

Practical constraints

During the first period of fieldwork (5-6 November) water levels had recently been high following a period of prolonged unsettled weather and the rainfall continued throughout much of this fieldwork period. It is therefore likely that some field signs had been lost. Furthermore, the survey period was shortly after the main period of autumn leaf-fall, so at those sites located within broadleaf woodland, it is possible that some older signs were missed because they were hidden under leaf litter.

The second survey period (17-18 December) corresponded with the first period of cold weather of the winter and, while water levels were lower and the weather was largely dry, a combination of hoar frost and (latterly) light snow showers may have influenced sign detectability. For example, some scats were frozen and, therefore, could not be identified by scent as either mink or pine marten, and frost penetration into marginal substrates rendered some possible footprints unidentifiable. A light snow shower immediately before the visit the last survey site (10) may account for the absence of any otter signs at the location.

Results

The results of the survey are summarised in Table 2. Evidence of otter activity was confirmed at eight sites (80%) in each of the trial area and the control area. This is slightly lower than the overall mean number of positive sites in Argyll & Stirling SNH Area as a whole in the 2003/04 national survey (89.13%) and may be related to the high water levels and the recent leaf-fall during the first two days and snowfall towards the end of the final day of survey in December.

Most evidence was in the form of spraints or footprints/otter paths. Of the four sites where it was not possible to confirm otter presence, two had paths considered likely to have been made/used by otter, but there were no other visible signs to confirm this. At four sites, confirmed[34] otter lie-ups were found, although *potential* lie-ups/holts were recorded at various other sites. No feeding remains were found. One coastal watercourse site in the trial area (16) had abundant otter field signs. This is attributed to the entire survey length being located between the freshwater Loch Craiglin and the nearby rocky coast. This area forms an important thoroughfare for otters moving between freshwater and coastal habitats.

Mink signs were confirmed at one site, although three other sites had either scat or footprint evidence, which suggested mink presence, but this could not be confirmed.

No evidence of water voles was found, but this is not surprising given the late autumn/winter survey dates and the heavily-shaded habitat at many of the locations.

Recommendations for survey in 2010 and beyond

The two survey periods in 2009 were not ideal for the reasons already described. To avoid a recurrence of these constraints, the next survey should be undertaken in September, as originally proposed. The survey should not be undertaken immediately after a period of high water levels and should be completed in a single four-day period of fieldwork, rather than split into two.

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Scottish Natural Heritage

26 May 2010
(This is an edited version produced for the main report, published 2011)

[34] i.e with otter sign present.

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Table 1: Location of all survey sites inside the trial area (Y) and outside (N)

Site no.	x	Y	Inside_trial_area	Description	Location	National_site
1	188600	690900	N	100m downstream d/s of track	Inland	N
2	194500	692400	N	100m d/s of road bridge	Inland	Y
3	191200	694800	N	100m d/s of track	Inland	N
4	191200	690200	N	100m upstream of entrance to un-named pond/lochan	Inland	N
5	191700	689200	N	100m d/s of road bridge	Coast	Y
6	192600	691500	N	100m d/s of road bridge	Coast	Y
7	191700	686600	N	100m south of landward end of pier	Coast	N
8	192000	692700	N	100m d/s of dam	Freshwater loch	N
9	193300	695800	N	100m d/s of fish ladder	Freshwater loch	N
10	195300	697000	N	100m d/s of dam	Freshwater loch	N
11	178900	691000	Y	Burn near L. Barnluasgan - d/s from road	Inland	Y
12	176700	688700	Y	coastal burn u/s from shore	Coast	N
13	177800	689700	Y	outflow from L. Coille-Bharr	Freshwater loch	N
14	178100	689100	Y	d/s from bridge - By Gariob cottage	Inland	Y
15	179400	690500	Y	outflow from L. Linne	Freshwater loch	N
16	177300	687700	Y	100m d/s of road bridge by L. Craiglin	Coast	N
17	177900	687600	Y	up un-named coastal burn from shore	Coast	N
18	180200	690800	Y	outflow from L. Creagmhor[35]	Freshwater loch	N
19	179000	689200	Y	d/s confluence of 2 un-named burns, by ford	Inland	N
20	178200	686900	Y	d/s confluence of Barnagad Burn and Alltan Ghabhar	Inland	N

[35] For practical reasons this site replaced the original site at the outflow of Loch McKay

Table 2: Riparian mammal evidence, November and December 2010

Date	ID	Surveyor	Osight	Ospraint	ORP	OTR	Distance to first otter sign (metres)	Msight	Mscat	MTR	Mother	Wsight	Wlat	Wother	Notes
17/12/2009	1	RR	0	1	0	0	0	0	0	0	0	0	0	0	
05/11/2009	2	RR	0	0	0	?	N/A	0	0	0	0	0	0	0	Probable otter paths, but no other signs to confirm.
05/11/2009	3	RR	0	0	0	1	0	0	0	0	0	0	0	0	Tracks and otter path present
17/12/2009	4	RR	0	2	0	1	27	0	0	0	0	0	0	0	
05/11/2009	5	RR	0	2	1	?	70	0	0	0	0	0	0	0	Probable otter paths.
05/11/2009	6	RR	0	0	1	2	50	0	0	0	0	0	0	0	Tracks present (x2)
05/11/2009	7	RR	0	1	0	0	10	0	0	0	0	0	0	0	
05/11/2009	8	RR	0	1	1	0	11	0	1	0	0	0	0	0	Numerous potential resting sites. Otter spraint & mink scat both v. fresh and adajcent to each other.
18/12/2009	9	RR	0	1	0	0	60	0	1?	0	0	0	0	0	Old otter spraint. Mink scat unconfirmed as it was frozen. Numerous potential resting sites.
18/12/2009	10	RR	0	0	0	0	N/A	0	0	0	0	0	0	0	Light snow shower immediately before survey - enough to cover any signs
06/11/2009	11	RR	0	8	0	0	0	0	0	0	0	0	0	0	
06/11/2009	12	RR	0	3	0	1	27	0	0	?	0	0	0	0	Possible mink footprint (incomplete)
06/11/2009	13	RR	0	1	0	0	70	0	0	0	0	0	0	0	Old spraint.
06/11/2009	14	RR	0	3	0	?	27	0	0	0	0	0	0	0	Probable otter path present. V. fresh spraint.
17/12/2009	15	RR	0	0	0	0	N/A	0	0	0	0	0	0	0	
06/11/2009	16	RR	0	8	1	1	0	0	0	0	0	0	0	0	Several otter paths present. Mostly fresh spraint.
06/11/2009	17	RR	0	2	0	1	0	0	0	0	0	0	0	0	Very fresh spraint
18/12/2009	18	RR	0	2	0	1	37	0	1?	0	0	0	0	0	Numerous otter paths present. Possible mink scat (or pine marten) but unconfirmed as it was frozen.
06/11/2009	19	RR	0	0	0	?	N/A	0	0	0	0	0	0	0	Probable otter path present.
17/12/2009	20	RR	0	0	?	1	31	0	0	0	0	0	0	0	2 potential resting places.

ID = Transect identification number, Osight = otter sighting, Ospraint = otter spraint, ORP = otter resting place, OTR = otter track, Msight = mink sighting, Mscat = mink scat, MTR = mink track, Mother = mink other field sign, W = water vole sighting, Wlat = water vole latrine, Wother = water vole other field sign. Surveyor RR = Rob Raynor.

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ISBN: 978-1-85397-752-7

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