in association with

& Paul Johnson

Monitoring the impacts of recreational activities on the designated wildlife sites in and around Loch Lomond



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Authors:

Morris, T[1], York, C[1], Johnson, P, Marshall, K[2], Cummins, R[2] and Beale C[2].

[1] – Walking-the-Talk, Tarves, Aberdeenshire

[2] – Macaulay Scientific Consulting Ltd, Aberdeen

Executive summary

This report details work undertaken over an eighteen month period focusing on a study area which included some of the Loch Lomond islands and the Endrick Mouth area. The work was undertaken by a team of contractors from Walking-the-Talk, Macaulay Scientific Consulting and Paul Johnson, and was overseen by staff from both the Loch Lomond and the Trossachs National Park Authority (LLTNPA) and Scottish Natural Heritage (SNH).

The study area is protected by a number of natural heritage designations and includes several designated habitats and species. The area is also a popular destination for visitors, some of whom bring dogs, camp and explore within the islands and Endrick Mouth zone. The LLTNPA and SNH were aware of the potential for these visitors to cause pressure on the sensitive wildlife within the study area and so they commissioned this research project to investigate monitoring the impacts of recreation on some of the designated habitats and species.

The work undertaken within this project can be divided into three main areas:

- A literature review to establish the sensitivities of each species / habitat to a range of recreational activities.
- The establishment and implementation of a monitoring protocol to collect data on the extent and type of recreational activities occurring within the study area.
- Data analysis and evaluation to combine the information from the literature review and the monitoring to establish where impacts on habitats and species may be occurring. Recommendations are then provided as to how to manage or further monitor those impacts.

From the literature review, it is clear that sensitivities to the various recreational activities vary substantially between habitats and species. The extent of available research also varies greatly – for example, a significant body of literature exists which considers impacts of various recreational activities on capercaillie, whereas most research on otters focuses on the impacts of pollution rather than recreation. Based on the literature review, a table is provided within this report which summarises each species / habitat's likely sensitivity to the different recreational activities which were found to be occurring with the study area. This showed that capercaillie, waterfowl, Greenland white-fronted geese and nesting waders are the most sensitive species, whilst otter, osprey, aquatic macrophytes and Atlantic oakwoods are less sensitive to recreational activities.

A monitoring protocol was established and tested which covered several aspects of recreational activities within the study area. Modifications were made to some existing data collection processes to allow more useful data to be collected, whilst a new monitoring protocol was established for collecting data on the activities taking place within the most visited areas on the Loch Lomond islands, which have been named 'congregation zones'. This on-island monitoring should be repeated annually to allow the collection of a time-series of data in order to establish if and how recreational activities are changing within the study area.

By combining the species / habitat sensitivities with the extent of recreational activities, the project team were able to ascertain where these activities may be having an impact on the designated wildlife. Recommendations are provided as to how to manage these impacts and these are outlined overleaf. The most important recommendations concern the capercaillie, where access restrictions are suggested as a means of reducing impacts on the capercaillie populations using the Loch Lomond islands. An overarching recommendation for all habitats and species is to

establish a central data repository for the Loch Lomond area, to allow datasets to be accessed, compared and overlain, thereby allowing trends and correlations to be picked up more easily.

An evaluation of SNH guidance on monitoring access and recreation at sensitive natural heritage sites was also undertaken. This highlighted that the guidance was generally well-written and easy to follow. However, some suggestions for improvements were made, including the production of an easily-printable version; the inclusion of likely potential sources of information on species sensitivity and further detail on methods of data analysis which could be used.

As well as this report, this work also produced a series of deliverables which can be used by both LLTNPA and SNH staff. This includes:

- a monitoring manual, which details the survey methodology and which can be used to support the implementation of the monitoring protocol in future years;
- a Geographical Information System which brings together much of the existing data for Loch Lomond in a map based format;
- an Access database which can be used to collate future monitoring records

Recommendations

The recommendations in this report have been divided into those which relate to potential future monitoring work (numbered MO1, MO2 etc) and those which relate to management actions (numbered MA1, MA2 etc). For ease of reference all the recommendations contained within this report are summarised per section below.

3.1 Analysis of recreational data

MO-1 Launch data should be collected in a comparable manner at each slipway and in such a manner that overnight visits can be recorded and the data categories standardised with other boat surveys. Staff time should be allocated to analysis of this data.

3.2 Data collation and Geographical Information Systems (GIS)

MO-2 LLTNPA should establish a data repository for information collected on Loch Lomond, the islands and the NNR. Ideally this should incorporate data in a map based format wherever possible to allow for easy comparison of datasets. Responsibility for on-going management of the data resource should be delegated to specifically named people within the National Park Authority.

3.5 Capercaillie Data Analysis

MO-3 Improve the monitoring of capercaillie to ensure that changes in population and breeding status can be identified with confidence.

MA-1 Instigate a comprehensive campaign to develop and promote clear guidance on how to avoid disturbance to capercaillie, potentially using the 'Caper Hotel' leaflet used in summer 2010 as a basis for this guidance.

MA-2 Consider the legal and public relations implications of any restrictions of access as outlined in section 3.5.6 and Table 13

MA-3 Undertake a pilot phase of restricting certain activities during defined time periods / geographical areas (as outlined in section 3.5.6) and assess the outcomes.

MA-4 If there is reasonable evidence of risk to the breeding population from recreational activities, work with land owners and local stakeholders to expand the access restrictions to other islands and the mainland.

MA-5 Review the risk assessment and implementation of management actions in liaison with SNH and RSPB on an annual basis

3.6 Otter Data Analysis

MO-4 Monitor the holt at zone 6 to see if it is still in use.

MO-5 Monitor tree-cutting and fire activity within the annual on-island survey so that habitat loss due to cutting, burning or erosion is identified.

3.7 Osprey Data Analysis

MO-6 Ensure coordinated annual monitoring and reporting of all nest sites continues and is included in the central data repository

MA-6 Advise visitors, e.g. at the boat slipway or other launching sites, of any sensitive osprey nest site that they should avoid.

MA-7 If the Inchconnachan site continues to be used, then the present exclusion measures should be continued during the breeding period.

3.8 Nesting waders Data Analysis

MO-7 Tie in breeding bird monitoring zones with recreation monitoring zones at Endrick Mouth

MO-8 Increase breeding bird survey coverage in June/July to pick up wader chick/alarm calls (this can be done during the day)

MO-9 Record all disturbance events and any visible impacts within the weekly monitoring programme and record any changes in recreational activity and location

MO-10 Consider enhancing recreational monitoring coverage at Crom Mhin, and elsewhere if possible, at weekends

MO-11 Consider a wider review of shore-line nesting wader performance across the Park

MA-8 Continue to discourage access development within the wet grassland/marsh areas of the Endrick Mouth

3.9 Waterfowl and Greenland White-fronted geese Data Analysis

MO-12 Continue monthly waterfowl counts

MO-13 Implement the revised monitoring protocol for Endrick Mouth area to monitor and record all disturbance events and impacts to waterfowl during routine weekly visits and bird counts

MA-9 Liaise with National Park Access Officer to ensure no formal access development is undertaken beyond from the Balmaha area onto the NNR at and beyond Crom Mhin. Similarly ensure no formal access development beyond the end of the existing, formally improved and managed Shore Wood Path at the Net Bay Viewpoint.

MO-14 Continue national goose survey counts; ensure complete coverage by plotting roosting sites from Duncryne ahead of monthly counts

MO-15 Monitor and record all disturbance events and impacts during counts and other routine work; record time spent in the field so that future analysis can measure change against monitoring effort

MA-10 Liaise with National Park Access Officer regarding any future change in access provision

MA-11 Ensure any developments at Wards Pond do not lead to increased disturbance

3.10 Aquatic macrophytes Data analysis

MO-16 Implement the monitoring protocol as specified at the congregation zones to include measurement of shoreline vegetation along with the use of fixed point photography to record any significant changes.

MO-17 Monitor the size (width and length and then calculate potential maximum area) for the water lily stands in zones 13 and 14 on an annual basis.

MO-18 Ensure that SEPA's macrophyte classification data is collated within the central data repository for the loch.

3.11 Atlantic oakwoods / wet woodlands Data analysis

MO-19 The monitoring of tree cutting within the on-island survey should be implemented as recommended, despite the difficulties of obtaining absolute numbers.

MO-20 If additional resources are available in the future, it would be useful to have some idea of the species of tree being felled or damaged. This could be relevant for example where pines or exotic conifers form part of the woodland and may be being targeted for their better burning qualities.

MO-21 The importance of the loss of, or damage to, trees in congregation zones relative to an SSSI as a whole cannot be assessed without some idea of tree density in each zone. Although not part of the on-going monitoring work, consideration should be given to undertaking a one-off assessment of this would be useful, even if it was an indicative estimate (this could be an interesting project for senior school pupils or a volunteer group).

4.3 Recommendations for improvement of the SNH guidance.

MA-12 Additional guidance should be prepared on the difficulty of sourcing information on species sensitivity – this could potentially include a list of likely sources. To some extent this is highlighted in the literature review, but not all site managers will read the full literature review and therefore this point may be missed.

MA-13 An easily downloadable pdf version or hard copy of the guidance should be produced.

MA-14 Emphasis on the preparation of site background information should be reduced, whilst emphasis on reviewing existing data sources should be increased.

MA-15 The identification of issues and objectives should be placed at an earlier stage in the guidance.

MA-16 Additional guidance should be prepared on the importance of collating and sharing data.

MA-17 Additional emphasis should be given to the process of data analysis, with some pointers given to potential methods that can be used.

5.1 Implementation of the monitoring protocol – resource implications

MO-22 Continue the modified boat-stopping survey as per the original protocol and with the additional observations in the congregation zones

MO-23 Undertake the baseline survey of zones every five years and the selected zone survey every year.

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1 Introduction

The work presented in this report was undertaken by an inter-disciplinary team which included Chris York and Tamsin Morris from Walking-the-Talk; Paul Johnson; and Keith Marshall, Roger Cummins and Colin Beale from Macaulay Scientific Consulting Limited. The work was undertaken between December 2008 and May 2010 and was steered by a project board from the Loch Lomond and the Trossachs National Park Authority (LLTNPA) and Scottish Natural Heritage (SNH).

1.1 Project objectives

The work described in this report was undertaken in response to a project brief sent out by the LLTNPA in October 2008. This brief highlighted the National Park Authority's responsibilities in relation to recreation and wildlife around Loch Lomond. It acknowledged that visitor pressure on the loch and the question of impacts on sensitive wildlife and habitats had been a subject of debate for many years. It therefore set out the following project objectives:

- To undertake survey and assessment work over a calendar year
- To establish a baseline and repeatable methodology for the long term monitoring of recreation impacts on the islands and NNR
- To assess the numbers and behaviour of visitors to the Loch Lomond islands and National Nature Reserve (NNR)
- To assess the impact of these numbers and behaviour on a number of designated habitats and species found within the islands and NNR
- To assess the applicability of SNH's guidance on 'Monitoring access and recreation at sensitive natural heritage sites' within the context of the Loch Lomond islands and NNR
- To provide recommendations to appropriate management options for the islands and NNR

1.2 Project study area

The project team and the project board agreed that the study area included two separate parts of the Loch as delineated in Figure 1.

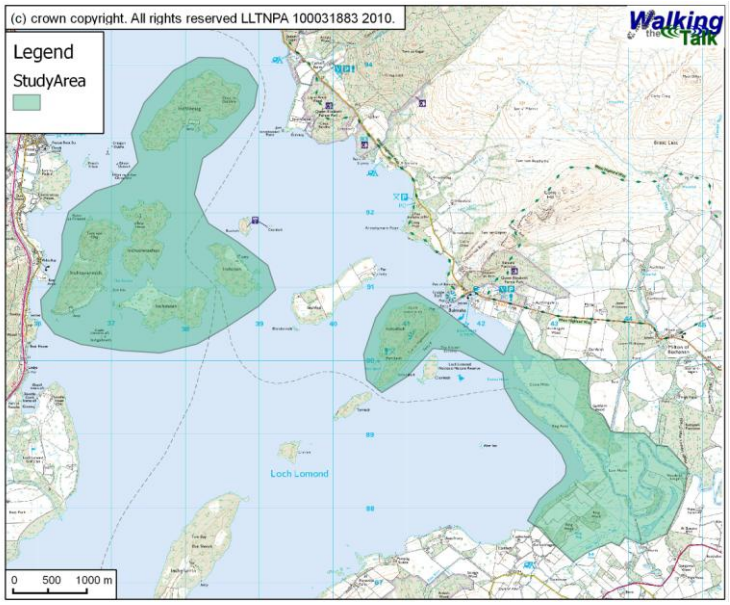


Figure 1: Study area (marked in green)

1.3 Habitats and species under consideration

The project team and the project board agreed that the study would consider the following habitats and species:

- Otter (*Lutra lutra*)
- Capercaillie (*Tetrao urogallus*)
- Osprey (*Pandion haliaetus*)
- Water fowl
- Greenland white-fronted geese (*Anser albifrons flavirostris*)
- Nesting waders
- Aquatic macrophytes
- Atlantic oakwoods / wet woodlands

1.4 Project timeline

The project team and board agreed a proposed timeline for delivering this work. This included a literature review and stakeholder workshop during the first part of the project (Dec 08 – April 09) to gather existing data. This was then followed by a period of data collection to establish the extent of recreational activities on the islands and surrounding loch waters during the summer months of 2009. The winter of 2009/10 was then used to analyse and combine the results of the literature review and the data collection exercise in order to establish likely impacts on the selected habitats and species.

1.5 Social and policy context

This work was undertaken within the context of the high natural heritage value of the study area. Within the study area, the designations of National Nature Reserve, Special Protection Area, Special Area of Conservation, Ramsar site and Site of Special Scientific Interest all apply to selected sections. The study area is also within a high profile area of the Loch Lomond and the Trossachs National Park. Figure 2 shows these designations.

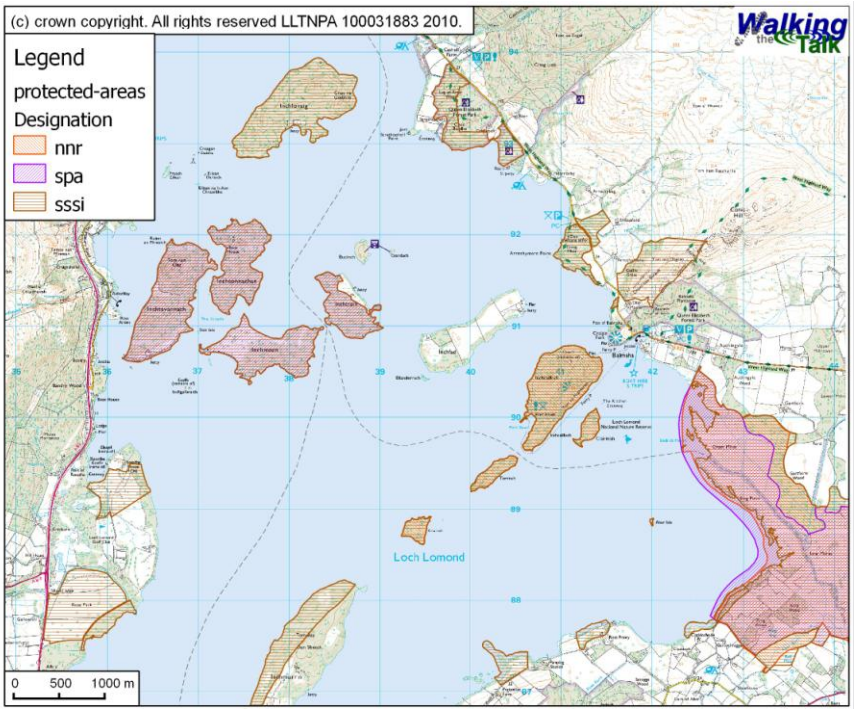


Figure 2: Statutory designations within the study area

The broader social context is also important to this work, as Loch Lomond is a popular area for informal recreation. It is within easy reach of a large part of Scotland's population and is a popular destination for both day trips and longer stays. As part of the process of managing the Loch Lomond area, the Loch Lomond Regional Park Authority introduced a series of bye-laws in 1996. These were reviewed in 2006 and the new bye-laws became effective from 21 May 2007. Consideration is being given to a further review of these bye-laws. An important part of any review will involve considering the impact that recreational activities are having on the designated habitats and species within the Loch Lomond area. This study was therefore undertaken in the context of a potential bye-law review and the need to gather data to establish any recreational impacts.

The Land Reform (Scotland) Act 2003 has provided a legal right of responsible access to the majority of Scotland's land, encouraging greater confidence for many to visit the outdoors. Much attention has been given to the Scottish Outdoor Access Code (the Code), and there has been debate about what constitutes 'responsible access', particularly with respect to impact on the natural heritage value of the countryside. However, there is often ambiguity between activities that affect the quality of recreational experience of others, and actions that have a measurable impact on the environment.

Recreational activities within the study area have been linked with anti-social behaviour and in 2009, the 'Respect the Park' campaign was undertaken to try and tackle some of these issues. This multi-agency operation aimed to promote responsible behaviour within the countryside. It included the use of high-profile patrols by the Ranger Service and local police forces under 'Operation Ironworks' within the national park area, with an increased presence on the ground at evenings and weekends all through the six month summer season (April to September). It should be noted that baseline data for this study were gathered during the summer of 2009 and therefore there is the potential for these data to have been (positively) affected by the activities being undertaken under the campaign.

There are long-standing concerns over the impact of camping and anti-social behaviour on the east side of Loch Lomond which have continued at a high level despite the Respect the Park campaign. At the time of writing, the LLTNPA is, in response to these concerns, undertaking a consultation on a proposal to control informal roadside and loch-shore camping within certain areas though new byelaws under the Land Reform Act. It is likely that this consultation will be the subject of considerable debate, but the outcomes may well influence visitor management decisions in other areas of Scotland.

2 Methodology

The overall purpose of this study is to understand the impacts of recreational activities on a range of habitats and species. It must be recognised that in a complex system such as Loch Lomond it is difficult to disaggregate the full range of environmental pressures and impacts in order to demonstrate cause and effect. For example, cumulative pressure from different sources may have a measurable impact, but in the absence of unequivocal evidence, attributing this impact solely to recreational activities is rarely justifiable or defensible. This is particularly important where management action could have legal implications. Equally, there is a distinction that needs to be made between activities that have an impact on the visitor *experience*, and those that have a direct impact on designated habitats and species. The intervention point may be different for the respective objectives of improving the visitor experience and the conservation of designated sites and the monitoring regime may need to be adjusted accordingly. The brief for this study was to assess the impacts of recreation on the habitats and species of designated sites. The monitoring protocol developed for this study is not designed to provide a full picture of anti-social behaviour or compliance with the Scottish Outdoor Access Code.

In response to the brief, the project team proposed a methodology which sought to involve and utilise the National Park ranger service and the SNH's local National Nature Reserve team in collecting many of the data required for a long-term monitoring scheme. The project team felt that this provided an opportunity for regular, repeatable and long-term monitoring whilst reducing the long-term dependence on external consultants. This approach was agreed by both LLTNPA and SNH prior to work commencing.

The project team also highlighted the need to take a strategic approach to the assessment of impacts on the designated habitats and species. It was agreed that, within the available resources, it would not be possible to collect data which showed direct evidence of wildlife responses (such as changes in behaviour, distribution or breeding success) to recreational activities – this would potentially require continuous monitoring of individual animals for extensive periods of time. As highlighted by Dickinson *et al* (1998), the resources required for such a monitoring project are significant and hence relatively few such projects have taken place. However, it was agreed that it would be possible to gather data to indicate the extent of recreational activities occurring within the islands and NNR. In conjunction with this, information could be gathered from the scientific literature to establish the associated sensitivity of each species / habitat to potential pressures arising from those activities. These two sources of information could then be combined, to establish the likely impact of different activities on different species at Loch Lomond. This is illustrated in Table 1.

Table 1: Identification of impacts on species / habitats

	Associated sensitivity of species / habitat A to activity X		
Extent of activity X	**Small**	**Medium**	**Large**
Occurring frequently	Moderate impact, additional monitoring may be required	Significant impact, further monitoring or management action may need to be considered	Very significant impact, management action likely to be required
Occurring occasionally	Minimal impact, management action unlikely to be required	Moderate impact, additional monitoring may be required	Significant impact, further monitoring or management action may need to be considered
Not occurring	No impact	No impact	No impact

This approach is in accordance with the DPSIR (Driver, Pressure, State, Impact, Response) framework as used by the European Environment Agency. This framework is used to describe the interactions between society and the environment and is an extension of the Pressure – State – Response model developed by the Organisation for Economic Co-operation and Development (EEA website, 2010). Within this framework a driving force (often a socio-economic force which causes a human activity) leads to a pressure or stress that the human activity places on the environment. The state of the environment may then be altered in a response to that pressure, ultimately leading to a response by human society to the changed environment (UNEP website, 2010).

Within the Loch Lomond situation, we have used this framework as follows:

Driver - socio-economic changes allow greater leisure time and increased disposable income leading to increased recreational activities.

Pressure – recreational activities within the study area have the potential to cause a pressure on the environment.

State – the designated habitats and species have a sensitivity to each activity, which will govern their likely response.

Impact – depending on the extent of the activity / pressure and the sensitivity of each species / habitat, an impact will result.

Response – management recommendations may be required to enable human society to respond to the apparent impact.

The approach was agreed by the project board and was followed throughout the project. In the light of this rationale, the following methodology was used during the project:

2.1 Literature review

A broad search of academic literature from the UK and abroad was undertaken early in the project focussing on the identification of sensitivities and responses of the species and habitats included in this study. In addition, examples of other monitoring schemes were sought and reference was made to the SNH guidance on Monitoring Access and Recreation at Sensitive Natural Heritage Sites. These were used to inform the development of the recreational monitoring protocol.

2.2 Capture and collation of existing data

In responding to the project brief it became clear that there is a large amount of data and knowledge about Loch Lomond, but not all of it is accessible, or in some cases recorded. It was considered important therefore to capture and collate disparate data sources prior to developing any new monitoring protocols. This process was facilitated through two workshops.

2.2.1 Rangers' workshop

It was recognised that the LLTNPA rangers and SNH's local national nature reserve team have considerable experience and knowledge of the study area which could be of use in the development of a monitoring protocol. As highlighted above, the project team were also keen to ensure that the ranger service were involved in the development and implementation of the protocol and were able to undertake repeat monitoring actions in future years. In order to collate their information and knowledge, and to raise awareness of the monitoring work within the ranger service, a workshop was organised in January 2009 which bought together the LLTNPA boat team rangers, the East Loch Lomond rangers and Scottish Natural Heritage staff responsible for the Endrick Mouth area and Inchcailloch.

Attendees at this workshop were asked to provide information in four categories:

- The location of perceived impacts on habitats and species within the study area
- Any existing monitoring of, or repeated interactions with, visitors within the study area
- Any existing monitoring of habitats and species within the study area
- Which parts of the study area were visited on a routine basis by ranger staff

The information collected in this workshop was collated into a GIS project and was used to guide and inform the monitoring scheme design.

This workshop was also designed to develop 'ownership' of the monitoring programme by the National Park Authority and the ranger service in particular. This approach gave the project team a better insight into the competing pressures on the rangers' time; direct feedback on how existing protocols were handled and helped to clarify the range of skills and capacity that were likely to be available to implement recreational monitoring. We believe that the early involvement of the rangers gave them an opportunity to help shape the monitoring protocol directly and this represented the first stage in a continuing relationship with the rangers throughout the project.

2.2.2 Experts' workshop

A workshop was organised in March 2009 which brought together a range of 'experts' to seek their views on areas of the loch which were being affected by recreational impacts and to establish what data they may be able to contribute to understanding those impacts. This workshop was intended as an opportunity to engage other organisations and local experts in the work of the project. A list of attendees at this workshop are included in Annex 1.

The information collected at this workshop was used in two ways. Firstly, the areas which were highlighted as suffering from recreational impacts were mapped on a GIS and were considered during the design of the monitoring programme. Secondly, a list of additional datasets which would be helpful to the project was produced and attempts were made to source these data from external organisations. This included:

- Otter sightings / road kill data from Glasgow University;
- Otter holt location data from SNH
- Capercaillie lek and brood count data from RSPB
- Osprey breeding success data from RSPB
- Wetland bird survey data from British Trust for Ornithology
- Site condition monitoring data for the woodland habitat from SNH
- Capercaillie predator survey undertaken as part of the EU LIFE project in 2004
- Goose count data from Endrick Mouth from the Greenland white front website (http://greenlandwhitefront.homestead.com/69lochlomond.html) and SNH
- White water-lily (*Nymphaea alba*) stand size records from LLTNPA

2.3 Existing monitoring at the start of the project

Based on the outputs of the two workshops described above, the project team established the survey and monitoring arrangements which take place on an on-going basis within the study area. These can be summarised as follows:

- The LLTNPA boat team rangers have undertaken a 'boat-stopping' survey throughout the boating season since 2000. The frequency of this survey has varied from 3 to 9 times per month. The survey followed a set route with a routine series of stops. Each of these numbered stopping points was linked to an area of the islands where people were likely to camp, picnic and leave their boats. Each boat-stopping survey involved the recording of the number and type of boats at each stopping point; their registration letter (identifying the original location of registration) and the activity taking place (e.g. picnicking, camping etc).
- The LLTNPA operates a powered craft registration scheme and records all launches at the public slipways at Balloch and Milarrochy.
- Monitoring of capercaillie on the islands takes place each year, including lek and brood counting. The results of these surveys are kept by SNH, the Royal Society for the Protection of Birds (RSPB) and the Game and Wildlife Conservation Trust and are not released to the general public.
- SNH staff visit the Endrick Mouth part of the NNR on a weekly basis during the summer to undertake visitor safety checks. Records of damaged / dangerous infrastructure are made, along with recommendations for remedial action required.
- Wetland bird counts (WeBS) are undertaken on both the loch and in the Endrick Mouth area by the ranger service, SNH NNR staff and volunteers. Data are kept by the British Trust for Ornithology.
- An adapted form of the Common Bird Census (CBC) is undertaken twice a year at Endrick Mouth and sporadically in other areas of the loch by SNH NNR staff.

- Greenland white-fronted geese counts are undertaken on a monthly basis during the winter months at Endrick Mouth by SNH NNR staff.
- Ad hoc recording of otter mortalities and sightings within the Loch Lomond area.
- Annual measurements of several stands of white water-lily within the Narrows area of the loch (between the islands of Inchtavannach and Inchconnachan).
- The University of Glasgow collates information on boat use on Loch Lomond via an annual survey and provides reports to the LLTNPA.

2.4 Development of a recreational monitoring protocol

Following discussions with the rangers, the project team undertook a visit to the islands within the study area to establish the nature of recreational activities. It was clear that most activities take place within relatively small areas within the islands – these are usually zones around a beach or other mooring point, where visitors are picnicking and camping. For the purposes of establishing a recreational monitoring system, these zones are referred to as 'congregation zones'. Their identification was based on the existing boat-stopping survey zones, and some additional zones were defined to capture additional areas where activities were taking place (on Inchcruin, Inchlonaig and Inchcailloch).

Building on the existing survey arrangements and resource allocations, the project team designed a new monitoring protocol which can be used by the LLTNPA and SNH to gather information on the extent of recreational activities within the study area. This recreational monitoring protocol was discussed with the ranger service and can be sub-divided into four different areas:

- Attitudinal / behavioural survey of visitors
- Modifications to the existing boat-stopping survey
- Monitoring of activities within the Endrick Mouth area
- On-island monitoring of activities in congregation zones

2.4.1 Attitudinal / behavioural survey of visitors

This monitoring seeks to establish the *manner* in which visitors are behaving whilst on the Loch Lomond islands. The only truly effective way to confirm the range of behaviour would be to use covert video recording on a 24 hour basis, but this is clearly unacceptable, both socially and from a resource point of view. It is recognised that direct questioning of visitors on how they behave within the study area cannot be guaranteed to provide an accurate representation of actions. It is unlikely that all visitors would be willing to participate and many respondents are likely to give the answer that they think the questioner 'wants' to receive. However, it was considered important to question some visitors to establish potential patterns of behaviour. A questionnaire was produced by the project team which includes a range of questions – these were designed to be as 'neutral' as possible to encourage honest answers. The questionnaire was also framed as seeking views on recreational experience rather than looking at the visitors' own impact on the environment. A specimen questionnaire is shown in Annex 2.

The questionnaire was piloted with the rangers over the Easter weekend in 2009 and adaptations were incorporated before being used at the Duncan Mills Memorial Slipway in Balloch and the Milarrochy Slipway. Three different methods were used to gather data from visitors – completion of a paper questionnaire by a member of staff, completion of an electronic version (using a handheld PC) by a member of staff, or self completion by the visitor.

Staff on duty were requested to conduct the survey throughout the week and at weekends at different times of day, with the aim of collecting around 500 surveys across the season (this was roughly translated as a target of 25 per week). Staff were asked to invite 'the next available boat' to participate during each data collection period. Following feedback that people were reluctant to take part because they were trying to load their boats and pack away belongings, revised guidance was given to target boats where there was a 'spare' person in a group – this potentially allowed a response to be collected whilst the boat was being taken out of the water, without interfering with the process of egress. This introduced an additional element of bias to the survey but helped to recruit more respondents.

2.4.2 Extensions to the existing boat-stopping survey

The Loch Lomond boat rangers have undertaken a boat-stopping survey during the summer since 2000. This has collected information on the number of craft moored in different locations around the loch and also ties in with Glasgow University's long term study of recreational boat use of the loch. These locations are listed in Table 2 and shown on Figure 3. Whilst this provides useful data, it was felt that the survey process could be modified to obtain more detailed information, without significant additional time inputs, which would be helpful in ascertaining the potential impacts of recreational activities. The boat-stopping survey was therefore modified to include observations of activities taking place within each of the on-island 'congregation zones' associated with each boat-stopping zone.

Table 2: Monitoring zones used within the boat-stopping survey

Island	**Monitoring zones**
Inchtavannach	9,10,12,13,15,16, 20,21,22
Inchconnachan	1,2,6,8,11,14,17,18,19
Inchmoan	4,5,7,23,24,25,26
Inchcruin	3,27,28,29

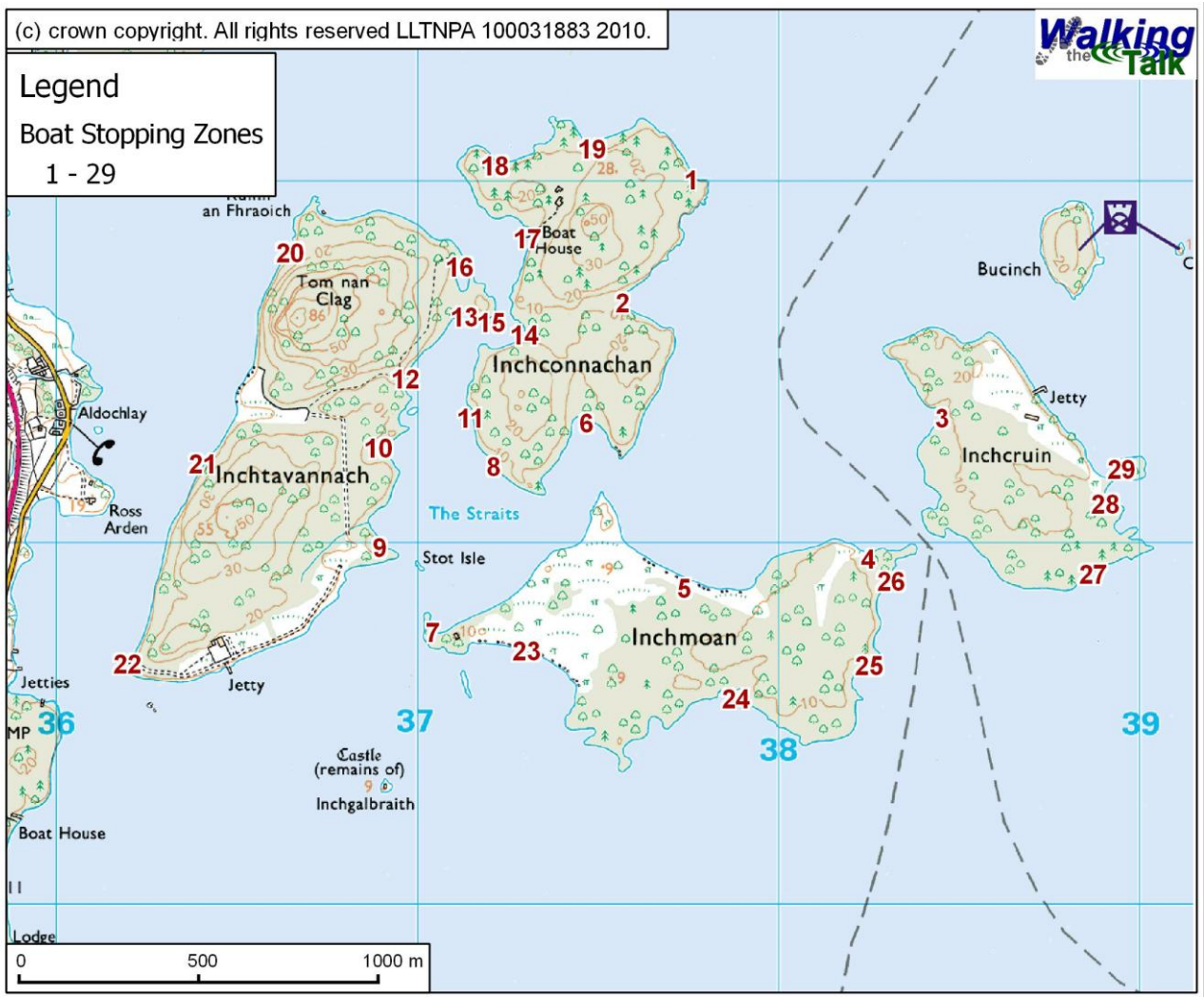


Figure 3: Map showing original zones for the boat stopping survey around the Luss Islands

Following an examination of the existing dataset, some questions arose regarding the consistency of data and interpretation of different terms (particularly relating to visitor activities). As a result, the data collection process was also modified to allow the use of a Microsoft Access database (either on the Brigadier boat's onboard PC or using a tablet PC) to provide data 'categories'. The rangers were requested to complete the monitoring throughout the summer using the existing data collection methodology in order to ensure that future data would be 'backwards compatible' and therefore provide a long data-run for boat movements within the congregation zones (up to 7 times per month). A number of minor issues relating to the use of the database were identified during the season and these were addressed as soon as possible – they mostly revolved around the ability to change data in the midst of a survey to rectify errors. Unfortunately, some of the rangers continued to use a previous version of the data collection methodology which had been adapted by them to include the additional data requirements (this was an Excel based spreadsheet). The data were submitted during the winter of 09/10 as a mix of database records and spreadsheets (some with only partial records) which were then compiled into a single dataset by the project team.

2.4.3 Monitoring of activities within the Endrick Mouth area

The Endrick Mouth area is included within the project study area, but receives significantly fewer visitors than the Loch Lomond islands. It is also managed within a different staffing regime, mainly by SNH. It was therefore decided that an alternative approach to monitoring impacts should be implemented within this area, but in a way that would produce data of a similar nature to other

parts of the study area. As highlighted in the existing survey arrangements, SNH NNR staff visit the area on a weekly basis during the summer months, but had previously only recorded specific health and safety issues. It was agreed that these visits would be modified to incorporate recording of a number of recreational criteria and this monitoring was undertaken on a weekly basis during the summer of 2009. Further modifications were agreed during the season to facilitate the communication of findings and the action required or taken. A copy of the final modified recording sheet is included in Annex 3.

2.4.4 On-island monitoring of activities in recreational areas.

As specified in the project brief, additional recreational monitoring is required on the islands to assess the behaviour of visitors. This monitoring needed to complement the attitudinal survey and the boat-stopping survey and provide information on the activities that were occurring within popular areas on the island. Each recreational activity has the potential to cause a number of pressures on the natural environment, as listed in Table 3. Whilst some of these activities may only cause limited or peripheral pressure on the particular species and habitats under consideration, they also provide a 'proxy' measure which will give an indication of the type and extent of different behaviours on the islands.

Table 3: Recreational activities and their associated potential pressures

Recreational activity	Potential associated pressures
Walking / human presence	Human disturbance to wildlife, erosion
Camping	Human disturbance to wildlife, erosion, deposition of human waste, deposition of food waste
Campfires / barbeques	Human disturbance to wildlife, erosion, removal or damage to live trees, loss of deadwood, deposition of food waste
Boating	Human disturbance to wildlife, erosion, water pollution, motor noise
Exploring / off-path stravaiging	Human disturbance to wildlife, erosion

A draft protocol for the on-island survey was prepared by the project team and was then tested on site in late May. This monitoring protocol was designed for use in 'congregation zones' within the islands – areas where people tend to gather for camping / picnics etc. Each of these congregation zones is associated with a zone which is used as part of the boat-stopping survey (as shown in Figure 3). However, during the first on-site evaluation it became clear that many of these zones were diffuse in nature and some merged into one another. As a result, some of the zone boundaries could not be identified with certainty and the data collected for a given zone would not necessarily be comparable between years. This is a particularly significant issue for a data series which will be collected over a period of years, when changes in staff are inevitable.

In order to ensure that the data collection process is robust, it was decided that a sample of zones would be selected for data collection. These zones tended to have relatively clear boundaries (for example, a steep slope or a marshy area) which prevented recreational activities from spreading

into too wide an area and made repeatable delineation more likely. It is possible that impacts in these areas may be greater than in areas where access is uninhibited. Some extra zones, additional to those used in the boat-stopping survey, were also selected, in order to ensure that the islands of Inchlonaig and Inchcailloch were included within the survey process, as well as a small additional site on Inchcruin. These are listed in Table 4 below:

Table 4: Additional monitoring zones

Island	Additional monitoring zone numbers
Incruin	31,
Inchcailloch	36
Inchlonaig	32, 33, 34, 35

It is acknowledged that the selection of monitoring zones is a compromise between the amount and quality of data that can be collected, and defining a methodology that is robust and repeatable. The on-island monitoring has therefore been divided into two parts as outlined below:

Strategic baseline survey

Each zone was visited and a qualitative record made of the condition of the site. A series of representative photos was also taken for each zone. This baseline survey of all the congregation zones on the islands took place in July 2009. The general condition of the zone was recorded, along with a sketch map of its shape and comments on the extent of spread / tree-cutting / fire sites. A database was designed for storing the records from this survey and, based on the outputs of this strategic survey and the zone delineation requirements outlined above, a series of suitable zones was identified for annual monitoring. This survey of all zones should be repeated every five years (i.e. the next survey should be in 2014).

Annual congregation zone monitoring

As highlighted above, based on the outputs of the strategic survey, a sub-set of congregation zones was selected which would be suitable for annual monitoring (i.e. which could be clearly delineated and where the project team felt confident that comparable data could be collected from year to year). These are shown in Table 5 and Figure 4 below.

Table 5: Zones selected for annual on-island monitoring

Island	Zone number
Inchconnachan	2, 14
Inchtavannach	12, 15
Inchmoan	7, 4/26
Incruin	29,31
Inchlonaig	35

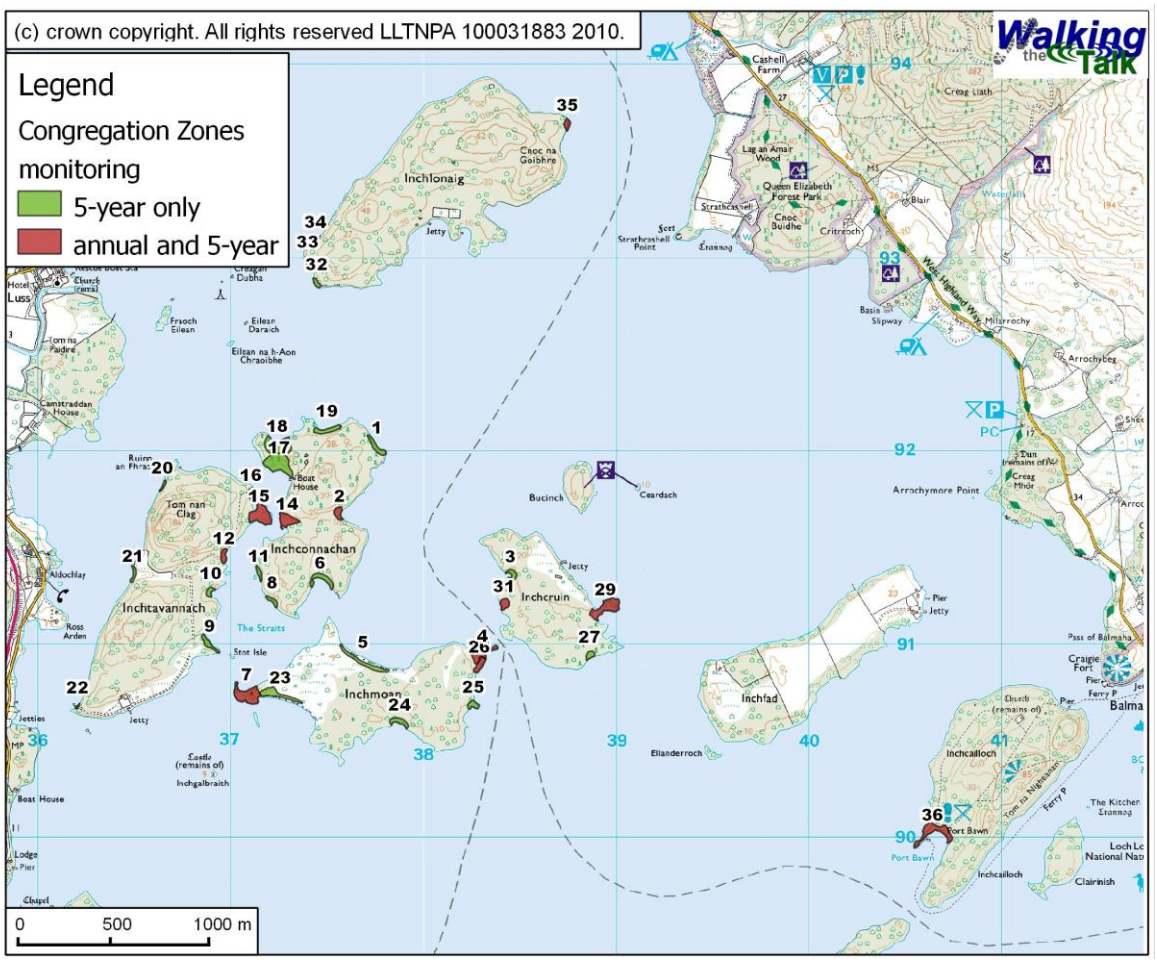


Figure 4: Map of selected zones for annual monitoring

This annual monitoring survey is designed to collect the following data (Table 6), which primarily act as proxy measures for the likely recreational pressures on designated habitats and species:

Table 6: Data collected during the annual congregation zone survey

Data gathered	Purpose and proxy measure
Number and type of fire sites	Potential for deadwood removal for burning Potential for cutting of firewood Likelihood of overnight camping Potential for wildlife disturbance beyond zone (e.g. collection of firewood)
Cut trees (felled or damaged)	Extent of physical damage to habitat including potential structural change to coppice woodland Long-term data will provide an indication of changes in visitor behaviour (increase or decrease in cutting)
Presence of latrine site	Likelihood of overnight disturbance of wildlife by campers
Presence of food waste (not general litter)	Potential to encourage scavengers (e.g. rodents or corvids) which could impact on breeding success of birds, particularly capercaillie.
Number of paths from zone	Potential for wildlife disturbance beyond zone
Shoreline condition	Physical damage to emergent vegetation

Monitoring Manual

The proposed survey methodology for the selected congregation zones was written up in the form of a survey 'manual' and field guide, which is included in Annex 4. The aim of this survey is to collect data on the cumulative recreational activities within each zone at the same time each year. It was agreed that the end of the visitor season (October) was the most suitable time to collect data. By repeating this survey annually, it should provide a time-series dataset to assess whether there are changes in recreational activity within the Loch Lomond islands.

Field recording sheets were also prepared, along with a database for storing records. Two days of training in the survey methodology were undertaken with the ranger service in October 2009. During this time a number of refinements were made to the survey protocol, based on the staff responses and the difficulty in obtaining repeatable data. As a result, data on tree cutting and damage is collected at a limited number of zones where there is the best chance of obtaining repeatable data.

After the training, members of the ranger service then completed the finalised survey at the remaining zones, so that a full first year dataset was collected which can be used as a baseline. This was then transferred to an electronic database and added to a GIS "project", which draws together various layers of data which can then be overlain to allow comparisons.

2.4.5 Adjustments and refinements made to the monitoring protocol during development

All four elements of the monitoring protocol were tested and refined during the study period. Many of these modifications were small-scale adjustments made to simplify the process of data collection, particularly the use of the electronic databases.

The most significant modifications were made to the collection of tree cutting data within the on-island survey. During the ranger training, it became apparent that different surveyors were recording significantly different quantities of tree damage. This was partly as a consequence of historic damage which had often 'rotted over' and could be hard to detect and partly due to differences in recording coppice stems versus main trunks as well as inconsistencies between surveyors in intensity and areas of search. Changes were made to the monitoring methods and to the monitoring manual, to establish a common protocol which could be used by all staff to obtain a reliable estimate. Further research into monitoring methods used to count tree numbers elsewhere has revealed a variety of methods, all of which would be very time-intensive. Assuming that this level of resourcing is unlikely to be available, it appears that the method established during the ranger training represents the best opportunity for gathering reasonably robust data. It is acknowledged that this is a compromise solution, which will provide an indication of longer-term trends in visitor behaviour, but will not necessarily provide a precise measure of the extent of tree cutting activity or allow robust estimation of impact as a proportion of the biomass of woodland.

2.5 Evaluation of SNH guidance

An additional objective of the project was to evaluate how the SNH guidance on Monitoring Access and Recreation at Sensitive Natural Heritage Sites could be applied to Loch Lomond. A qualitative analysis of the guidance was undertaken looking at the utility of the guidance and its applicability within this study.

3 Data analysis

Two 'strands' of data analysis were undertaken by the project team. The first strand uses the recreational data collected both prior to and during the project (public slipway launch records, the boat-stopping survey, the attitudinal survey, the Endrick Mouth routine visits and the on-island survey). Although much of this data has only been collected for one year, it is possible to use it to establish the likely extent of certain recreational activities within the study area. It is also possible to evaluate some trends over time within the data which has been collected over a longer period.

The second strand of data analysis focuses on the individual habitats and species which were identified in the project brief. The information produced as a result of the analysis of recreational data gives an indication of the type and extent of recreational activities which are occurring within the study area. This information has been analysed in conjunction with the outputs of a literature review to establish which species and habitats may be sensitive to which activities. Clearly not all habitats and species are sensitive to all activities (for example, the woodland habitat is not likely to be sensitive to the presence of boats close to the islands, but will be sensitive to the occurrence of fires on the islands).

Having established the relationships between species / habitats and their sensitivities to activities, the project team then undertook further evaluation to establish whether or not an impact was likely to occur i.e. is the species / habitat responding to that activity / action and if so, is that response likely to lead to a negative impact? Where impacts have the potential to occur, the project team then considered monitoring and management actions that could be implemented:

- to establish a more precise measure of the impact; or
- to mitigate the impact.

Recommendations are provided at the end of each section to highlight what management and monitoring actions are required. These are numbered according to whether they are a *Management* Recommendation (MA-1, MA-2 etc) or a *Monitoring* Recommendation (MO-1, MO-2 etc).

3.1 Analysis of recreational data

3.1.1 Public slipway launch records

Each craft that is launched at a public slipway (Balloch or Milarrochy) is recorded and some inferences can be made from this data source. It is not possible to correlate any of the records with the boat stopping survey or attitudinal surveys, but some indications can be made that help to assess the scale of recreational pressure on the islands.

Table 7 shows that during 2009 at the Balloch slipway 631 craft were recorded as being on the loch overnight, carrying a total of 1,419 adults. It may be reasonable to assume that at least some of those people will have camped on the islands overnight. However, there is no record of how many people actually camped on the islands within the study zone.

Table 7: Craft recorded as being on the loch overnight during 2009

Month	Canoe	Cruiser	Sailing Dinghy	Fishing	Other	Power/ Day Boat	Personal Water Craft	Speed Boat	Tender	Yacht	Total
January				2							2
February		1		1				1			3
March		4		4				4			12
April	11	12			1	4	2	33		1	64
May		21	1	8		10	12	44		5	101
June	1	25	2	14		12	4	39	1	1	100
July	9	31		8		9	8	67		5	137
August		31		12		4	9	57		5	118
September	2	14		8		5	3	30	1	7	70
October		6		4	1		1	7			19
November		1		2				1			4
December		1									1
Total	23	147	3	63	2	44	39	283	3	24	631

(Note: the boat classifications in Table 7 are based on data supplied by the National Park Authority and do not necessarily correlate with other categories used.)

The Milarrochy dataset and pre-2009 data for Balloch do not include this information, giving only the number of launches of each class of craft and no information about launch or recovery times. It would be useful to record information consistently between the two sites to give a fuller picture of the use of the loch (given that the data is collected anyway, using the launch slips).

Although the public slipway launches do not give a total number of boats using the loch (it does not account for boat hire, moorings or private marinas) it would be possible to use it as a relative measure of how things are changing over time. This is particularly the case in relation to overnight visits, and recording the number of dogs on board launched boats would also be a useful addition.

MO-1 Launch data should be collected in a comparable manner at each slipway and in such a manner that overnight visits can be recorded and the data categories standardised with other boat surveys. Staff time should be allocated to analysis of this data.

3.1.2 Boat-stopping surveys

Summarising the results from the boat-stopping data is complex owing to the variability in the numbers of surveys done each month in different years. The original methodology (Adams *et al* 1992) has not been followed consistently and this needs to be addressed in order to use future results with a greater degree of certainty. A compromise has been made in the light of these circumstances, to attempt to meet the objective of estimating total numbers of visits to the islands within the study area (note that there is a deliberate difference in counting visits rather than visitors). Therefore, by converting the raw count data to the equivalent of 7 counts per month it is possible to broadly compare changes over time on an annual basis, as shown in Table 8.

No weighting has been made for whether counts were made at weekends or on weekdays as the original survey methodology was designed to allow for these differences (estimated as 3.5 times higher use at weekends). It should be recognised that the data in 2007 and 2008 are less complete and discrepancies may have been introduced where the proportion of weekday to weekend counts is imbalanced (i.e. variation from the methodology). In particular, the August 2008 figures are likely to be unrepresentative as only one count was made, on a Saturday. Figure 5 shows the annual variation in boat counts, with the apparent sharp decline in boat activity recorded in 2008, and Figure 6 shows annual variation for selected zones to show the variation through time on different islands.

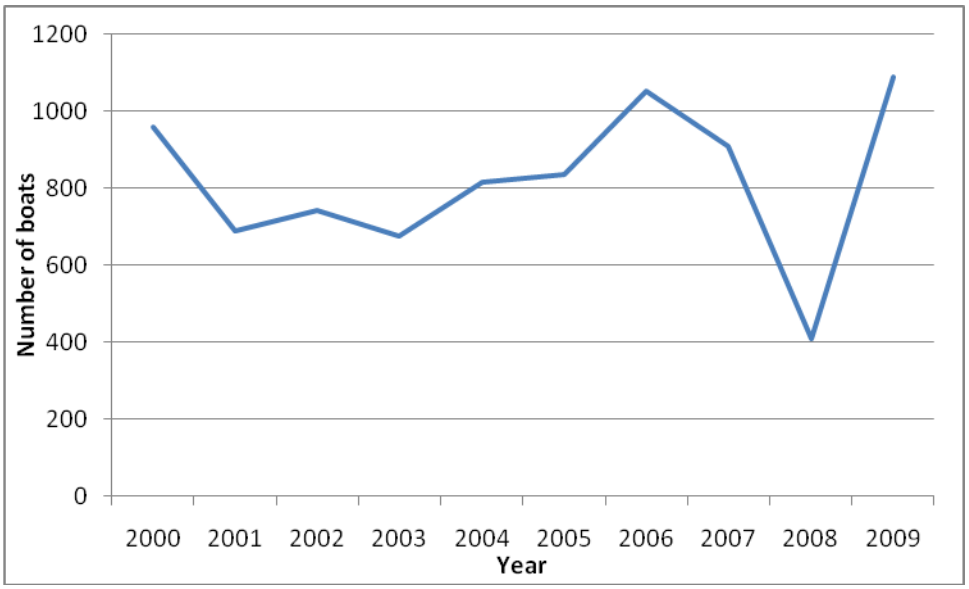


Figure 5: Annual total number of boats counted from all 29 congregation zones (standardised) from 2000-2009

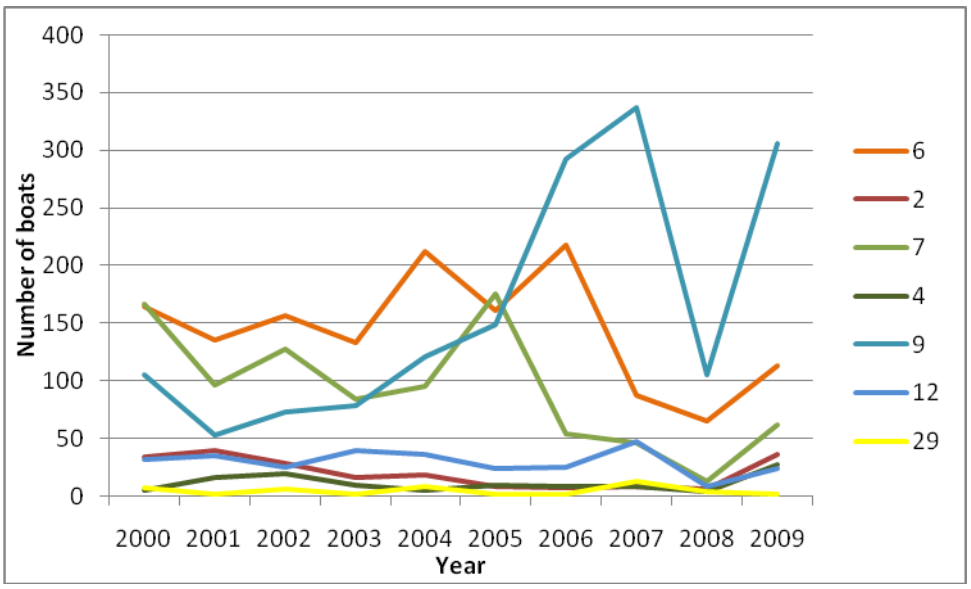


Figure 6: Annual total boats counted (standardised) for selected congregation zones 2000-2009

Further statistical analysis may be possible to fully normalise this data, although it is difficult to estimate the likely value of such a process. At present, Table 8 presents the best data available as a time series, with raw data converted to the equivalent of a standard number of surveys each month.

Table 8: Standardised annual boat counts in congregation zones 2000-2009

Zone	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
1	3		6	6	6	3	4	9	4	16
2	34	39	28	16	18	8	7	8	6	36
3	1	1	2				1			2
4	5	16	19	9	5	9	8	8	4	27
5	68	55	68	83	89	73	62	72	34	144
6	164	135	157	133	212	161	218	87	65	113
7	166	96	128	84	95	175	54	46	13	62
8	19	9	16	7	11	9	11	10	10	29
9	105	53	73	78	121	149	292	337	105	306
10	35	18	19	23	20	26	32	40	14	34
11	76	47	54	38	37	44	47	18	16	18
12	32	35	25	40	36	24	25	47	8	24
13	33	12	16	14	21	21	19	19	19	17
14	17	12	23	20	8	21	63	22		30
15	10	1	1	3	4	2	5	8	3	5
16	62	36	25	43	16	27	71	15	9	26
17	8	9	5	8	11	13	23	10	23	41
18	12	1	3	4	4	4	4	16	4	17
19		2	5	3	5	5	7	19	5	16
20		3			3		1	5		7
21	5				3		3		4	5
22					2	1	1	3	2	
23	82	74	46	46	54	44	44	48	36	81
24	11	10	9	6	11	9	19	6	9	21
25	4	1	2	2	3		10	30	2	6
26		14	5	6	9	4	6	10	2	4
27								1	4	
28		6	2	1	3	1	13	3	4	
29	7	2	6	2	8	2	2	13	4	2
Total	**959**	**687**	**743**	**675**	**815**	**835**	**1052**	**910**	**409**	**1089**

There is not a simple calculation or calibration value that can be used to convert these observations into an estimate of actual number of visits to the islands, particularly given the approximation required to standardise the data. Given that the surveys are undertaken over a period of approximately two hours, the number of boats counted is likely to be an underestimate for the total number for the day, which again lacks a calibration.

However, notwithstanding the above caveat and with a degree of caution, it can be suggested that Table 9 shows a possible minimum number of visits during the period April – October each year. This is calculated by multiplying the standardised counts (which would account for 7 days per month) into a daily figure (i.e. multiplying by 30/7) – this obviously introduces errors because the original survey design took into consideration a weighting for weekend surveys, which has not been followed during the data collection process, but this is the nearest approximation available. There are insufficient data available to calculate the number of people this actually represents (i.e. the number of people per boat is unknowable with current data collection methods).

Table 9: An estimate of the number of boats (minimum) visiting islands Apr-Oct

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Estimate	4110	2940	3180	2890	3490	3580	4510	3900	1750	4670

There is also some seasonal variation in the use of the congregation zones as shown in Figure 7. However, it is not clear what might affect the use of these places at different times of year other than prevailing weather conditions, which would make it difficult to predict potential changes in the use of different congregation zones.

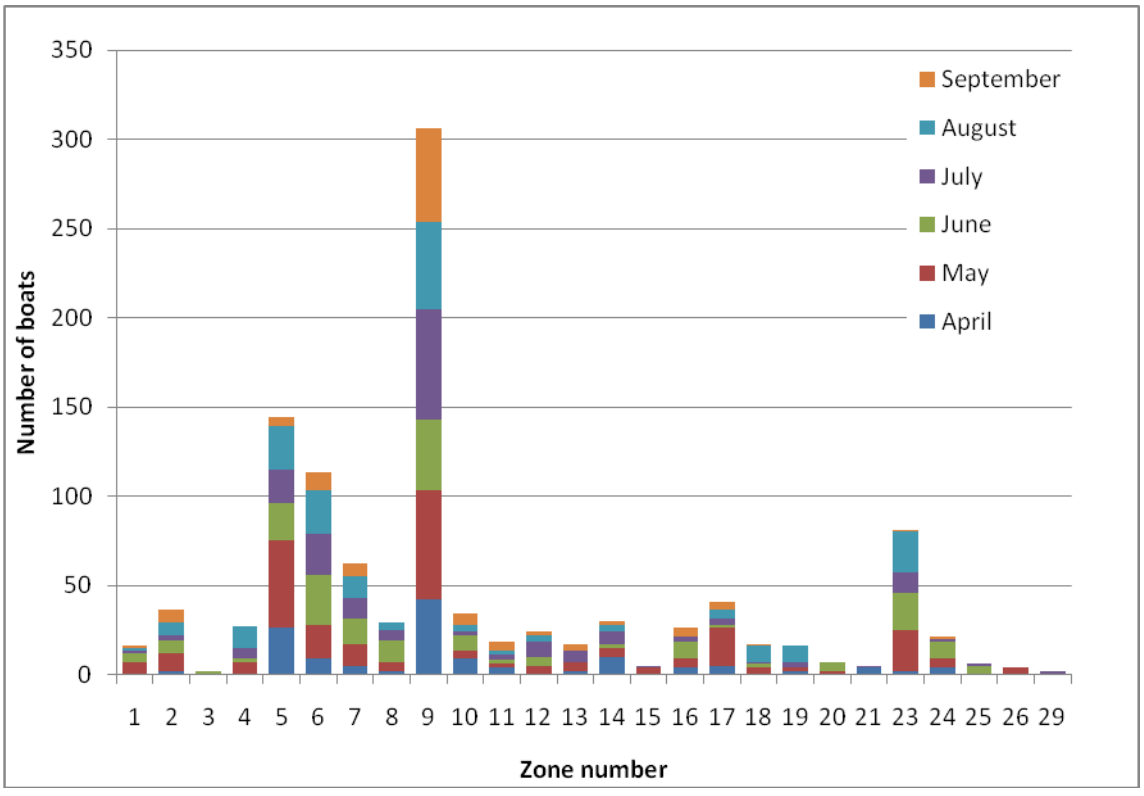


Figure 7: Seasonal variation in the use of congregation zones (2009 data)

Zone 2 was the site of an osprey nest from 2005 to 2008 and the Ranger Service implemented a visitor management regime to avoid disturbance to the breeding pair – signs were installed on the island and ranger patrols helped to ensure compliance with the request to avoid the area. The boat-stopping data for zone 2 (see Figure 8) demonstrates the effectiveness of this approach and the reduction in boat traffic in this area.

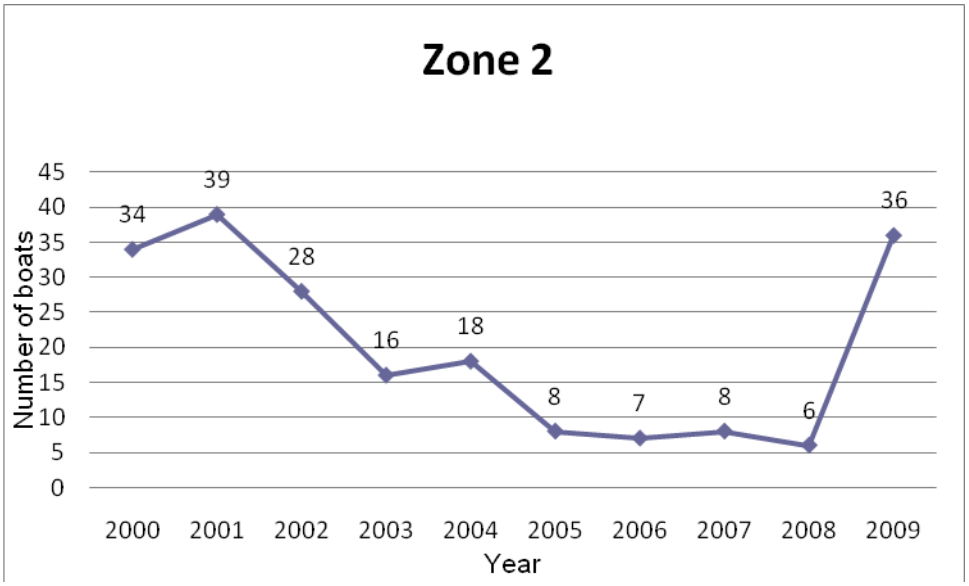


Figure 8: Boats moored at Zone 2 from 2000-2009

Comparing the number of boats stopped at selected zones as shown in Figure 6, the patterns do not appear to be sufficiently different to suggest a displacement of visitors away from Zone 2 to other zones. However, this has not been tested statistically as the actual numbers displaced are very low and combined with the lack of confidence in the data, it is not possible to demonstrate any change caused by displacement.

In 2009 the boat stopping survey was extended to include observations of people, dogs and activities taking place around the congregation zones. There were some issues with the collection of these additional data, particularly with the use of spreadsheets where people recorded things in different ways and it was not possible to ascertain actual values for some observations (i.e. the data were recorded as a yes/no value rather than a quantity).

The observations cannot be used to estimate the total number of people or dogs using a zone (it is impossible to accurately correlate the people with which boat they used and not all the people are likely to be in view). However, this additional information is designed to build up a picture of how people are behaving and could be used in conjunction with the on-island survey to establish impacts.

People, fires and tents

Figure 9 to Figure 11 show the observed number of people and the activities that are likely to be causing greatest impact (overnight camping and fires). The numbers of fires and tents are relatively low, but there is anecdotal evidence from the ranger service that some of the tents are long term encampments. This could lead to greater impact through continuous disturbance (e.g. of capercaillie during the nesting and brood period) although it may lead to some 'habituation' of some species to disturbance – there is no available data on this possibility.

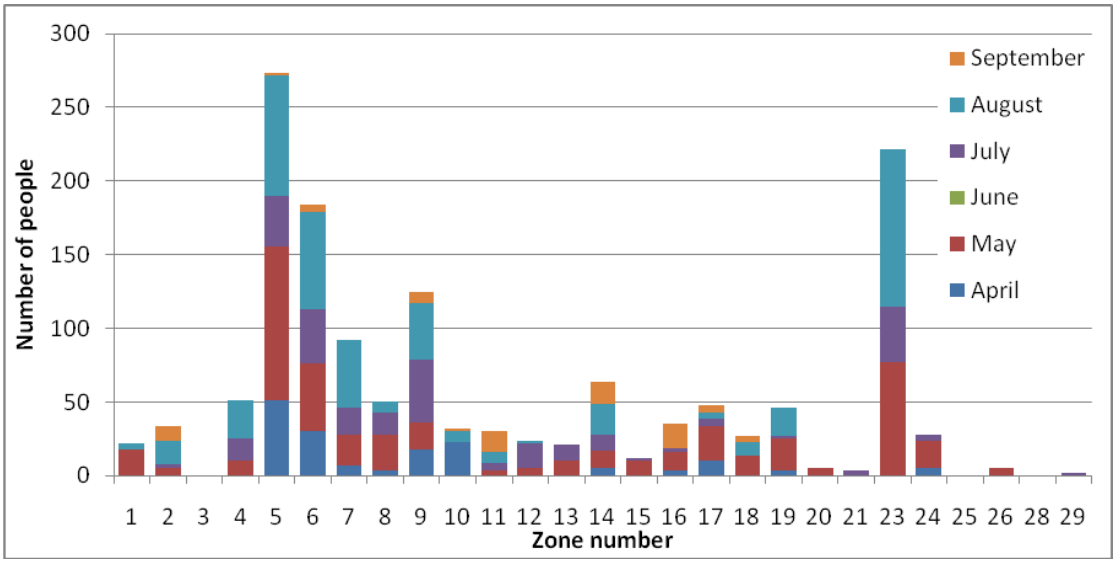


Figure 9: Total number of people visible in each zone, by month, in 2009

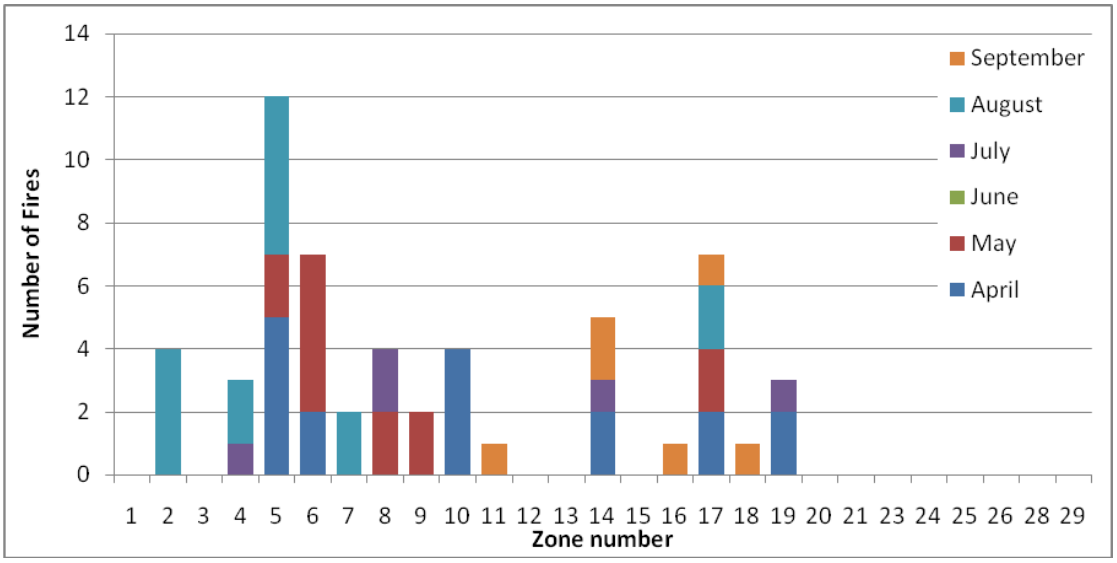


Figure 10: Total number of fires / BBQs visible in each zone, by month, in 2009

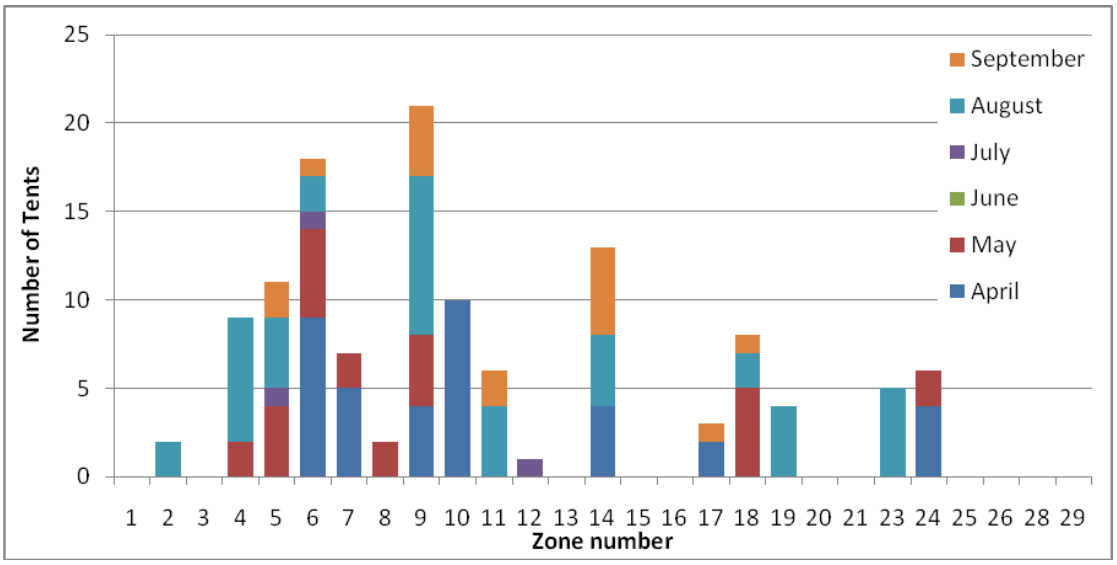


Figure 11: Total number of tents visible in each zone, by month, in 2009

Dogs observed in congregation zones

Figure 12 shows the total number of observations of dogs under control (defined as a dog within 3m of a person and not running) on a monthly basis.

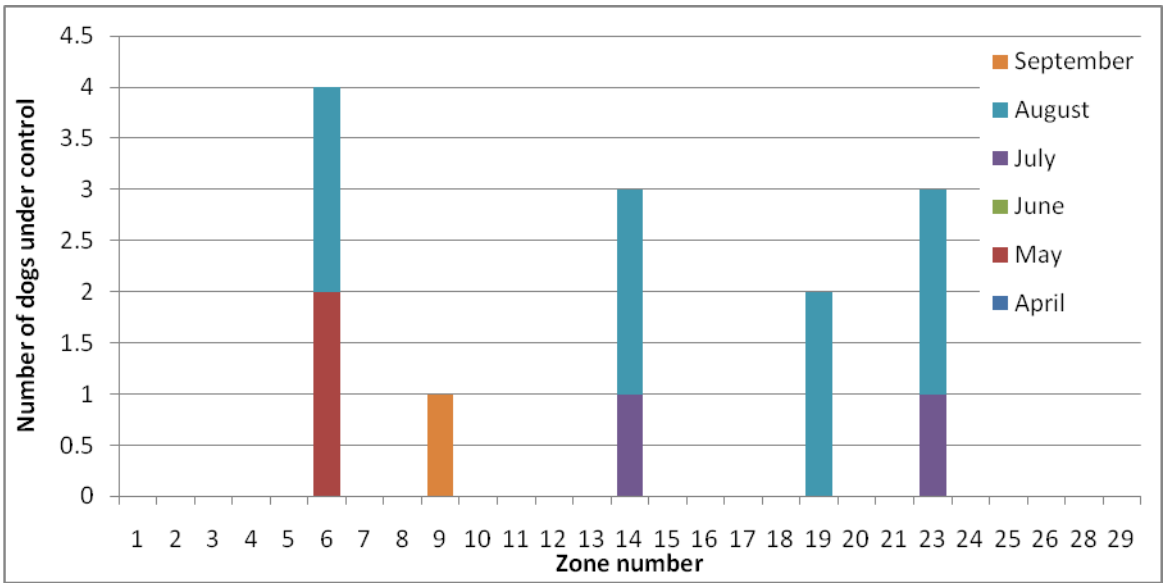


Figure 12: Total number of dogs (under control) in each zone, by month, 2009

This compares reasonably favourably with the number of dogs recorded as not being under control (Figure 13), which represents a total of 14 dogs.

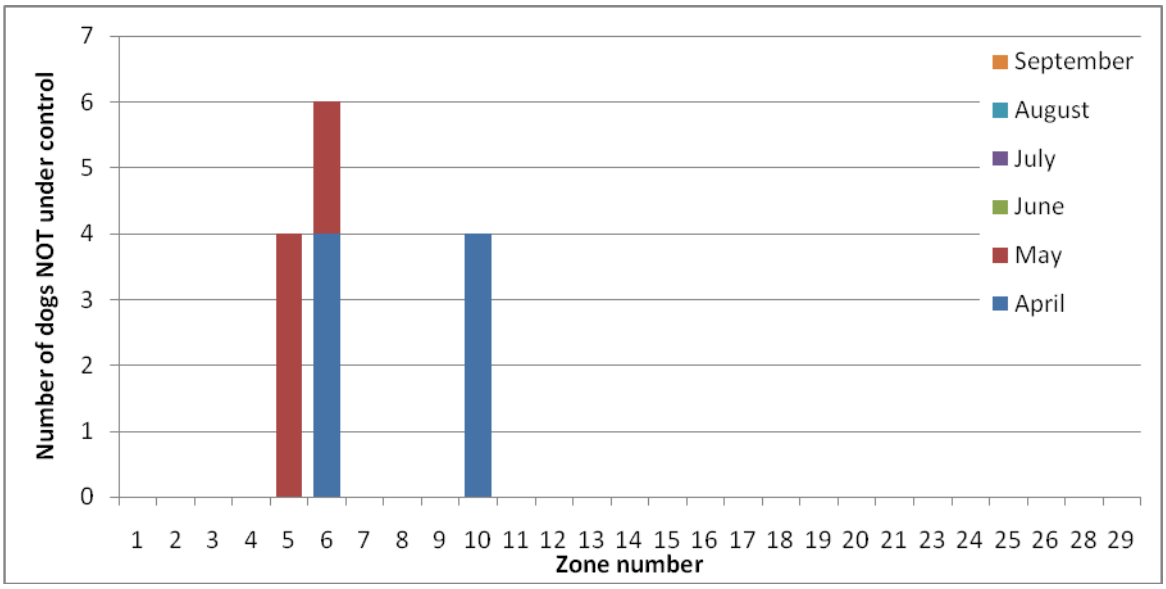


Figure 13: Total number of dogs (not under control) in each zone, by month 2009

However, it is possible that the presence of dogs, even under control, may have an impact on capercaillie during the lek or nesting periods (see section 3.5.3) and the records indicate that there were dogs present, including some not under control, during these periods.

3.1.3 Attitudinal survey

A total of 107 questionnaires were completed, giving a 20% confidence interval (i.e. 10% standard deviation) with 95% confidence level. The responses come from people representing 220 adults, 100 children and over 20 dogs. If additional questionnaires were completed this would reduce the

margin of error, requiring around 380 responses to produce a 5% confidence interval (which is an accepted convention).

The survey did not reveal any useful information about patterns of boat use on the loch itself, but it did show that 35-55% went ashore on one or more island within the study area during their visit, representing 114 adults, 59 children and 9 dogs.

Despite an ongoing promotional campaign within the National Park to respect the environment (as part of 'Respect the Park'), of the 34 respondents who had a fire or barbeque, 4 individuals admitted to collecting dead firewood. Although this is a small proportion of the total number of visitors it is very likely to be an underestimate, and suggests that even people who are prepared to take part in a survey (and therefore perhaps less likely to deliberately act irresponsibly) remain unaware of the issue of deadwood collection.

It is not possible to determine how many people camped overnight as there were very few responses that included the time spent on the islands – it is not clear whether this information was not collected or whether it was withheld.

Many respondents wanted to see additional facilities on the islands, including better / more moorings and toilets. Although it is beyond the scope of this study to make recommendations about visitor facilities that might improve the quality of experience, there are likely to be implications for the designated habitats and species of any additional infrastructure. The provision of additional moorings on or near the islands is likely to increase the number of boats landing (figures from Port Bawn on Inchcailloch might corroborate this assertion). Conversley the provision of toilets might reduce the fecal contamination on the islands.

In attempting to understand differences in the way the surveys were conducted, unfortunately the paper responses were not marked to show which ones were self-completed and therefore it is not possible to effectively compare the different methods, and the sample sizes would be too small to give confidence to the comparison.

3.1.4 On island survey

Individual records and images from the congregation zones are presented in Annex 5. The strategic survey of the congregation zones highlighted evidence of fires at almost all of them (the exceptions being 'formal' jettys). There are also signs of tree cutting in and around all of these zones, with very little deadwood lying on the ground. Each island has at least one latrine site, suggesting that overnight camping is occurring on all islands on a frequent basis. A per-island summary of the findings from the strategic survey is included below, along with data from the boat-stopping survey for relevant zones. These are shown in Figure 14 to Figure 20 to provide an indication of the popularity of these zones over time and through the 2009 season.

Inchtavannach

In the area of the narrows there are signs of heavy use by visitors, including multiple fire sites. On the western side of the island there are fewer signs of visitors, possibly as a result of the sight lines from Luss giving a reduced sense of 'remoteness'. Zone 9 appears to be used as a long term 'encampment' and is to a certain degree self-policing as a result. There appears to be an ongoing relationship between the users of this zone and the tenant farmer including, anecdotally, the occasional supply of firewood.

On this island, zones 12 and 15 are being monitored annually as part of the on-island survey. Information for levels of boat activity within these zones is included in Figure 14 and Figure 15.

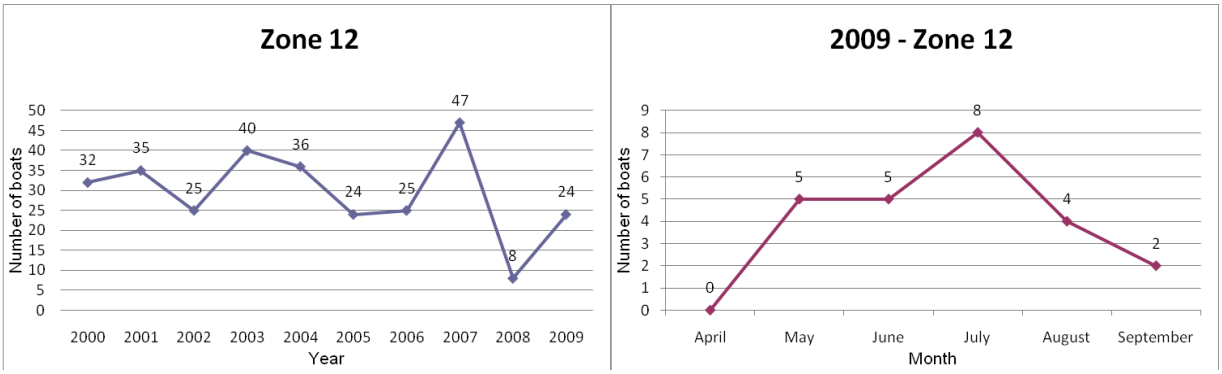


Figure 14: Temporal distribution of boats at Zone 12

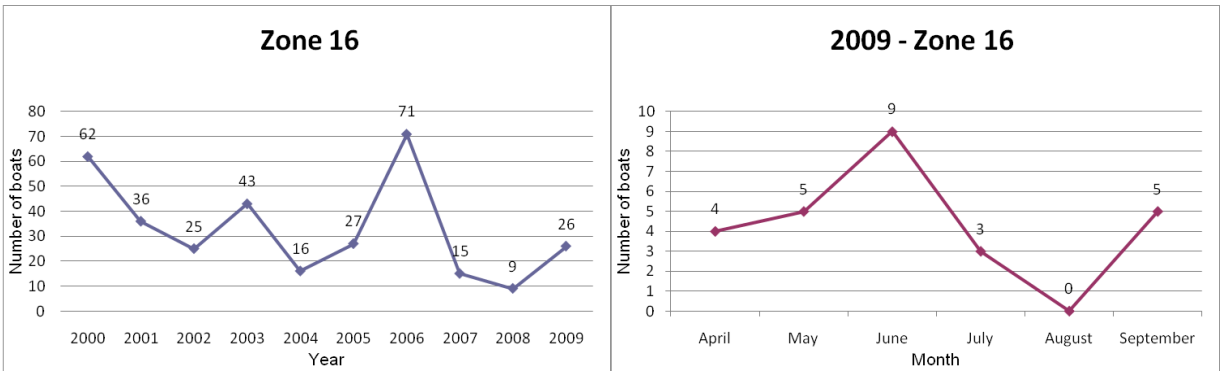


Figure 15: Temporal distribution of boats at Zone 15

Inchconnachan

As well as camping, the island also appears to be visited by people searching for wallabies and also has a more developed 'network' of paths than the other islands. Many of the congregation zones appear to be popular camp sites, with multiple fire sites and latrines. One group of visitors who were present during the island survey in October 2009 had set up camp with a portable generator and may have been cutting previously felled trees with a chainsaw (this was only heard in operation).

On this island, zones 2 and 14 are being monitored annually as part of the on-island survey. Information for levels of boat activity within these zones is included in Figure 14 and Figure 17.

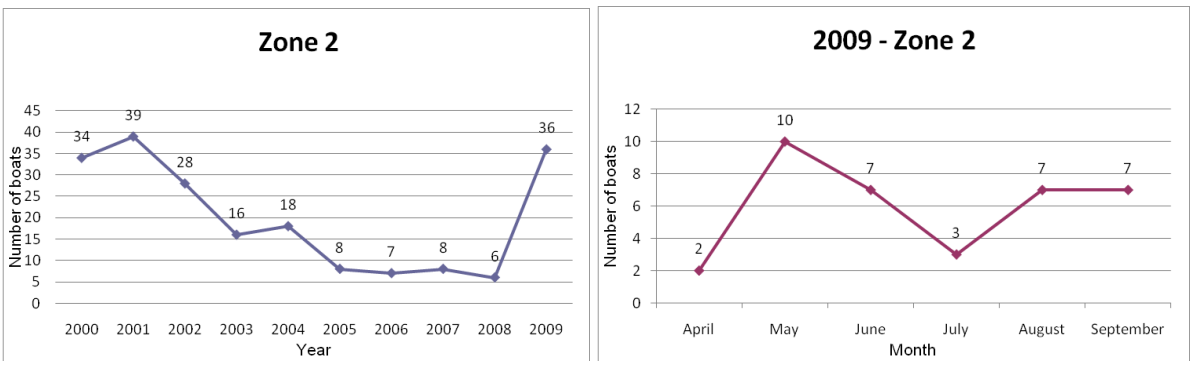


Figure 16: Temporal distribution of boats at Zone 2

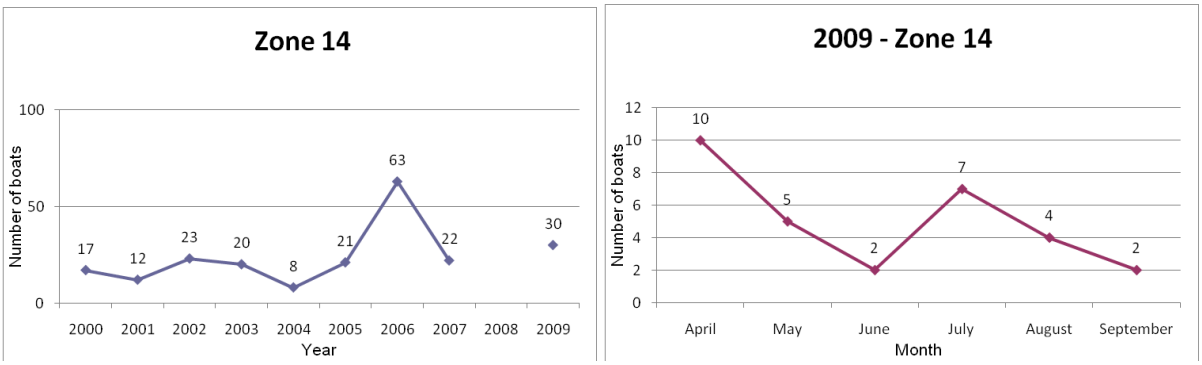


Figure 17: Temporal distribution of boats at Zone 14

Inchmoan

The congregation zones include extensive sandy beaches leading to widely dispersed impacts along the shoreline. These beaches are popular camping areas and there is an 'established' latrine site in the abandoned castle. There are, however, no paths leading inland, suggesting that disturbance in the interior of Inchmoan is much less than the other Luss islands. Recent bracken control, under the auspices of habitat management for woodland management and capercaillie, may change this situation by allowing easier access in the open areas of the island.

On this island, zones 7 and 4/26 are being monitored annually as part of the on-island survey. Information for levels of boat activity within these zones is included in Figure 18 and Figure 19.

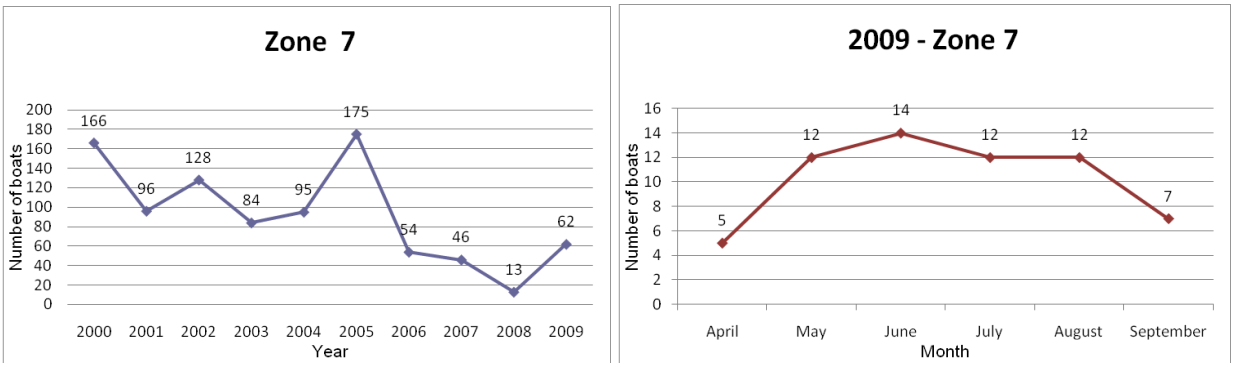


Figure 18: Temporal distribution of boats in Zone 7

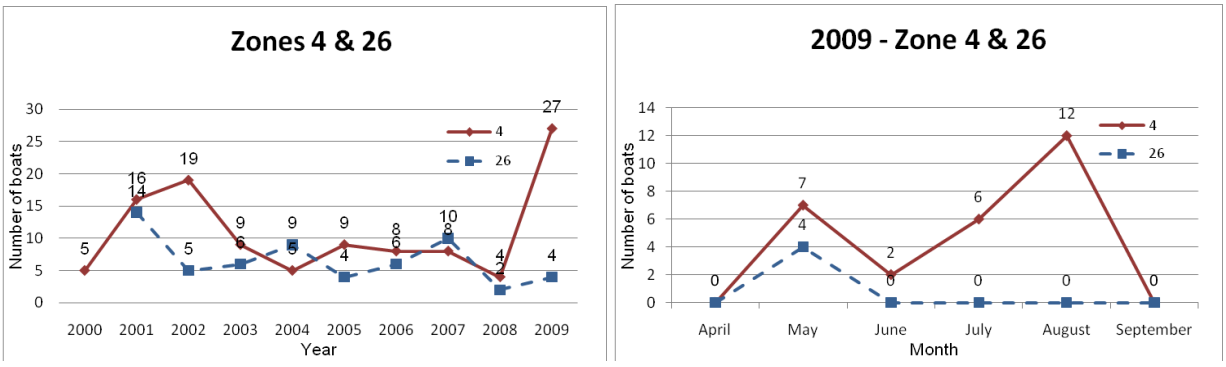


Figure 19: Temporal distribution of boats in Zones 4 and 26

Inchcruin

The congregation zones on Inchcruin tend to be smaller than the other islands, but still have signs of fires, tree cutting and shoreline erosion. One of the zones appears to have been used intensively within the last season, with the most obvious signs of recent tree felling (boats are not counted at this congregation zone).

On this island, zones 29 and 31 are being monitored annually as part of the on-island survey. Information for levels of boat activity within zone 29 is included in Figure 20 (no boat stopping data is recorded for zone 31).

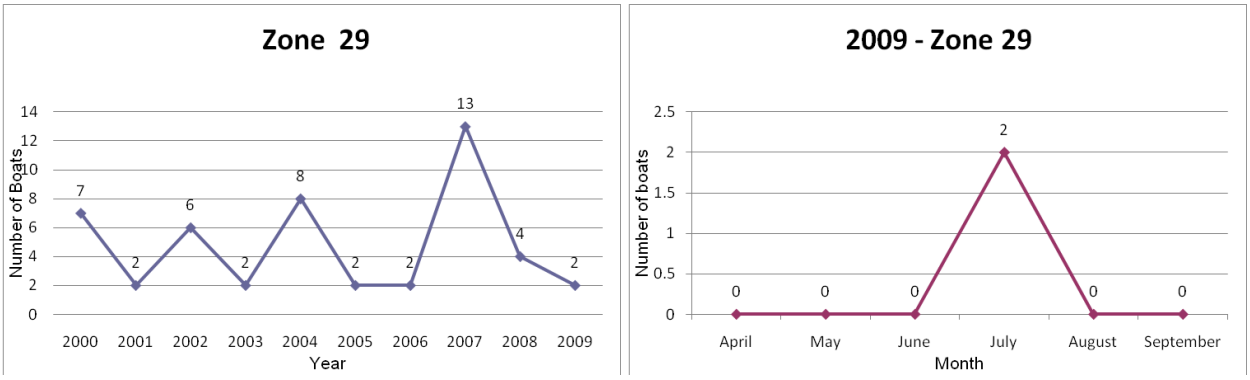


Figure 20: Temporal distribution of boats at Zone 29

Inchlonaig

One of the congregation zones is reported to be popular with water skiers and has a steep beach – it is not clear whether this has extended as a result of water ski activity. Other zones on the island have restricted access to large boats owing to the rocky shoreline and have small fire sites that appear to be 'low impact' camping.

Inchcailloch

The formal campsite at Port Bawn is actively managed, has composting toilets and there is frequent ranger presence on the island. There were a greater number of informal fire sites in 2009, and this may have been caused by the removal of barbeque facilities. There is no associated rise in tree cutting, suggesting that people are accustomed to bringing fuel, but the presence of multiple fire sites may act as an unintended encouragement for other visitors to have fires using locally collected wood.

3.1.5 Endrick Mouth weekly monitoring

The Crom Mhin Bay area is consistently used by coarse anglers throughout the year. In spring and summer, their activity includes overnight camping, damage to trees, fires, litter and defecation. They also wade out into the water and may leave fishing line. Their preferred area is quite confined and any expansion of their activity and increase in their geographical distribution would be a cause for concern.

Walking and dog-walking is light throughout the area, largely owing to difficulty of access. The ground at the entrance to the reserve at Balmaha is poached by cattle and often wet; likewise the end of the Shore Wood path on the other side of the Endrick is stoutly fenced and encompasses wet, tussocky ground unattractive to the average walker. There is apparently a small amount of local use of the Balmaha side, but this is considered insignificant.

3.2 Data collation and Geographical Information Systems (GIS)

The stakeholder workshops at the start of this project provided a useful list of potential data sources. However, sourcing this data took a considerable amount of time and persistence. As an outcome from this project, it is clear that there is potential for greatly improving the coordination and collation of all the data collected for Loch Lomond. This is also highlighted as a problem in the NES review of ecological impacts of boating and associated activities on Loch Lomond and its shores (2005). We therefore recommend that consideration is given to establishing a data repository for Loch Lomond to ensure that useful information can be shared between all those with an interest in the loch.

MO-2 LLTNPA should establish a data repository for information collected on Loch Lomond, the islands and the NNR. Ideally this should incorporate data in a map based format wherever possible to allow for easy comparison of datasets. Responsibility for on-going management of the data resource should be delegated to specifically named people within the National Park Authority.

To assist with the compilation of data within this project and with the process of analysing both the recreational and the habitat and species data, a 'GIS project' was established. This brought together a number of layers of data and enabled the project team to undertake spatial comparisons between datasets. The GIS layers are provided as one of the deliverables of this project and it is recommended that it is kept up to date as part of the central data repository for Loch Lomond information .

3.3 Analysis of recreational activities occurring within the study area

From the information collected during the on-island survey and the time series of data collected during the boat-stopping survey, it is clear that there are a range of recreational activities taking place within the study area. In order to assess whether or not these activities are leading to an associated impact on the designated habitats and species, it is helpful to categorise activities occurring within the study area to allow a comparison of habitats' / species' sensitivity to each activity type.

Based on an initial analysis of the recreational data collected during 2009 and on anecdotal evidence collected by both the ranger service and the project team during field work, a list of recreational activities occurring frequently within the study area was produced. This list was as follows:

Human presence – geographically close – occasional: this includes people passing in close proximity to the species / habitat in question (within a few metres), but only on an occasional basis, probably equating to no more than three or four people per day

Human presence – geographically close – frequent: this includes people passing in close proximity to the species / habitat in question, but on a frequent basis, probably equating to several people per hour

Human presence – geographically distant – occasional: this includes people moving at a distance of greater than fifty metres from the habitat / species in question, but only on an occasional basis, probably equating to no more than three or four people per day

Human presence – geographically distant – frequent: this includes people moving at a distance of greater than fifty metres from the habitat / species in question, but on a frequent basis, probably equating to several people per hour

Human presence on the water: this includes people moving on the water, using either powered or self-propelled craft

Human presence in the air / aerial disturbance: this includes the use of powered craft in the air, but flying at relatively low altitudes e.g. microlights. It does not include commercial airliners and other planes flying at high altitudes.

Fires: this includes the lighting of any fire or barbeque, regardless of size

Wood cutting: this includes cutting / sawing / hacking at live timber, including the use of power-saws

Foraging for wood: this includes searching for both live trees that can be cut and picking up dead wood

Dogs under close control (occasional): this includes dogs kept on a lead or within 3 metres of their owners which are not running and are passing on an occasional basis, probably equating to no more than three or four dogs per day

Dogs under close control (frequent): this includes dogs kept on a lead or within 3 metres of their owners which are not running and are passing on a frequent basis, probably equating to several dogs per hour

Dogs running free (occasional): this includes dogs which are not on a lead, are away from their owners and which may be running but are passing on an occasional basis, probably equating to no more than three or four dogs per day

Dogs running free (frequent): this includes dogs are not on a lead, are away from their owners and which may be running but are passing on a frequent basis, probably equating to several dogs per hour

Exploring off path / stravaiging: this includes crossing reasonably large areas of ground but without using an obvious path. It is likely to include people exploring the islands and searching for wildlife, or trying to walk around the edge of an island

Overnight camping: this includes any overnight stop based on land, which may be a one-off or may be part of a longer term stay

3.4 Habitat and species sensitivities to recreational activities

For each recreational activity, an assessment of the sensitivity of individual species and habitats to that activity was then completed. This evaluation is summarised in Table 10. In some cases this evaluation is based on particular reference within the scientific literature. However, in many cases there is no published research into the particular combination of activity and species / habitat, so the evaluation has been based on the professional opinion of the study team, taking into account published literature on comparable activities in other locations. A ‘certainty’ rating has therefore been added to each sensitivity – in general this is high when the sensitivity is based on published research and low when it is based on comparable activities or personal observations.

The information summarised in Table 10 has been used to consider each habitat and species in more detail, looking at its sensitivity to recreational activities in general and focusing on those recreational activities to which it is considered to be most sensitive. As highlighted previously, in most, if not all cases, there will be multiple variables which could be impacting on habitats and species, one of which is recreational activities. In general it is not possible to separate out the

different variables without conducting resource intensive research to control all other factors. Within each species / habitat, we have highlighted where other factors are likely to be having a significant impact, but we have provided analysis and recommendations on how to manage and / or monitor recreational activities which may be impacting on that species / habitat.

Table 10: Habitat and species sensitivities to different recreational activities

	Sensitivity to the activity							
Activity	**Otter**	**Capercaillie**	**Osprey**	**Water fowl**	**Greenland white-fronted geese**	**Nesting waders**	**Aquatic macrophytes**	**Atlantic oak woods / wet woodlands[1]**
Human presence – geographically close – occasional	Low *(high certainty)*	Medium *(high certainty)*	Low *(high certainty)*	Medium *(high certainty)*	Medium *(high certainty)*	Medium *(high certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Human presence – geographically close – frequent	Medium *(high certainty)*	High *(high certainty)*	High *(high certainty if activity not constant over time)*	High *(high certainty)*	High *(high certainty)*	High *(high certainty)*	Medium (high certainty)	Not sensitive *(high certainty)*
Human presence – geographically distant – occasional	Not sensitive *(high certainty)*	Low *(high certainty)*	Not sensitive *(high certainty)*	Low *(low certainty)*	Low *(low certainty)*	Low (low certainty)	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Human presence – geographically distant – frequent	Not sensitive *(high certainty)*	Medium *(high certainty)*	Low *(high certainty)*	Low *(low certainty)*	Low *(low certainty)*	Low *(low certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Human presence on the water	Medium *(high certainty)*	Not sensitive *(low certainty)*	Low *(high certainty)*	Medium *(high certainty)*	Low (low certainty)	Low (low certainty)	High for floating leaved species *(high certainty)*	Not sensitive *(high certainty)*
Human presence in the air / aerial disturbance	Unknown	Unknown	Low *(high certainty)*	Low *(low certainty)*	High *(low certainty)*	Low *(low certainty)*	Unknown	Unknown
Fires	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Medium *(low certainty)*
Wood cutting	Medium *(low certainty)*	Medium *(high certainty)*	Unknown	Not sensitive	Not sensitive	Not sensitive	Not sensitive *(high certainty)*	Medium *(high certainty)*
Foraging for wood	Medium *(low certainty)*	High *(high certainty)*	Not sensitive	Not sensitive	Not sensitive	Not sensitive	Not sensitive *(high certainty)*	Low *(high certainty)*

Dogs under close control (occasional)	Medium *(low certainty)*	Medium *(high certainty)*	Low *(low certainty)*	Medium *(low certainty)*	Medium *(low certainty)*	Medium *(high certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Dogs under close control (frequent)	High *(low certainty)*	High *(high certainty)*	High *(low certainty)*	High *(low certainty)*	High *(low certainty)*	High *(high certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Dogs running free (occasional)	Medium *(low certainty)*	High *(high certainty)*	Low *(low certainty)*	Medium *(low certainty)*	Medium *(low certainty)*	Medium *(high certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Dogs running free (frequent)	High *(low certainty)*	High *(high certainty)*	High *(low certainty)*	High *(low certainty)*	High *(low certainty)*	High *(high certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Exploring off path / stravaiging	Not sensitive *(high certainty)*	High *(high certainty)*	Low *(high certainty)*	Not applicable	Not applicable	Low *(low certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*
Overnight camping	Not sensitive *(high certainty)*	Medium *(high certainty)*	Low – high location dependent *(high certainty)*	Not applicable	Not applicable	Low *(low certainty)*	Not sensitive *(high certainty)*	Not sensitive *(high certainty)*

[1] *Information is scarce about the effects of human recreation impacts on this habitat. However, as a general rule, we would expect the important bryophyte populations to be far more sensitive to impacts than the higher plants*

3.5 Capercaillie

3.5.1 What are the 'characteristics' of the species / habitat?

Capercaillie is a large woodland bird that nests on the ground. Breeding involves the cock birds gathering and displaying competitively to hens at established 'lek' sites in the spring. Having previously become extinct, capercaillie were reintroduced from Scandinavia and Bavaria to the highlands of Scotland in the 1800s.

The capercaillie is a priority species under the Biodiversity Action Plan that inhabits native pinewoods and upland oakwood, both of which are priority habitats. The capercaillie is listed on Annex 1 of the Birds Directive and Appendix II of the Berne Convention. In the UK capercaillie are protected under Schedule 1 of the Wildlife and Countryside Act (1981) and the Nature Conservation (Scotland) Act (2004).

A national survey is currently underway (winter 09-10) to give an updated estimate of the number of birds present in Scotland, having last been surveyed in 2003-04 (Eaton *et al,* 2007). The 2003-4 survey resulted in a population estimate of 1,980 individuals (95% confidence limits 1,284–2,758). While this value is 84% higher than that of 1999 survey (1,073 individuals), it lies within the wide confidence limits of that survey (549–2,041) so the 2004 figure does not constitute a statistically significant increase.

3.5.2 Capercaillie in Loch Lomond

Four of the islands on Loch Lomond (Inchtavannach, Inchconnachan, Inchcruin and Inchmoan) are designated as part of the Loch Lomond Special Protection Area for birds because of their population of breeding capercaillie. This capercaillie population is a south-westerly outlier and was estimated at around 30-40 birds in 2000 (based on March counts by Waltho, 2000) i.e. 3-4% of the UK's remaining population. Information on the birds found on the islands is relatively good, as a result of counts of the main Loch Lomond islands taking place in March since 1992 and July since 1999. Earlier surveys and casual records show frequent sightings of birds, up to 19 individuals on a given day. However, since 2003, despite more intensive and rigorous lek and sign surveys, the numbers have dramatically reduced, with sightings of no more than 3 birds on any given day. In the 2010 lek survey, no birds were found on the islands and evidence of birds was found on only one island. A few casual sightings of individual birds on the islands and nearby mainland have occurred subsequently, so some birds appear to still be present.

Differences in coverage and count conditions, plus annual variation in the population, make it difficult to statistically identify any long-term trends in the study area. However, SNH and RSPB are in agreement that numbers have crashed and there is now likely to be only a remnant population of capercaillie on the Loch Lomond islands. The precarious status of the capercaillie population was noted in the Loch Lomond SPA predator surveys (Reynolds et al 2005).

3.5.3 Are capercaillie sensitive to disturbance by recreation and how has that sensitivity been measured?

Key findings and recommendations from two relevant Scottish reports (Marshall, 2005; Ruddock and Whitfield, 2007) on capercaillie were as follows:

- The level of disturbance is dependent on the specific conditions, number of people in the group, disturbance regularity and noise levels.
- Lek and brood rearing times are when disturbance is most critical to capercaillie.

- Loose dogs allowed to range off tracks are a disturbance threat throughout the year.
- Good quality habitat that provides cover can mitigate the effects of disturbance.
- Frequent activity causes more disturbance than infrequent activity, and irregular more so than regular disturbance (independent of the activity type).

Research carried out in the winter 2003/04 at Abernethy and Glenmore (Summers et al 2007) tested the extent to which capercaillie avoid using trees (for feeding and roosting) near to forest tracks. Tree use was always less close to tracks and track avoidance increased with increased human use. The effective loss of habitat caused by disturbance amounted to 1 hectare per 64-82m of track. In semi-natural forests with high track densities (approx 2.25km per km^2) such as these, this effectively represents 20-30% habitat loss. This may in turn mean that the area of forests used by capercaillie, in winter at least, is limited by disturbance.

Other research, carried out in the French Pyrenees, looked at winter populations between 1989 and 1997 following the construction of a cross-country ski centre in 1988. The local population in the ski area declined at an average of 9% per year compared to a stable control population away from skiing activity. It was calculated that 18% of the capercaillies' total winter range in this area was lost (Brenot & Menoni 1999).

In a study of three Alpine regions, capercaillie were observed to remain near areas of high disturbance rather than be displaced, but to become scarcer in the locality as individual birds die (Meile 1981). This suggests a detrimental effect of long-term disturbance, but does not acknowledge other factors that may have been involved such as habitat degradation.

While nest disturbance may have an impact on breeding success, disturbance of broods by dogs is more likely to occur (Storaas *et al* 1999). Disturbance of hens with broods is particularly serious in that their feeding is disrupted, and separation from the hen may increase the likelihood of predation or exposure affecting the chicks. (Porkert 1978).

The dominant cause of disturbance to adult red grouse is free ranging dogs and it has been shown that they are seven times more likely to be disturbed (flushed) when dogs are not on a short leash (Hudson, 2009). The confidence with which this may be applied to capercaillie is not known.

The presence of mountain huts and associated humans in the Bavarian Alps attracts corvids (which will take eggs from exposed nests and will also take small chicks) and therefore may conflict with conservation efforts for threatened species such as grouse (Storch and Leidenberger 2003).

3.5.4 Potential capercaillie sensitivity to species interactions

The Reynolds report provides useful recommendations for management of potential predators. Those constituting the main concern on the islands are carrion crows (*Corvus corone*) and goshawk (*Accipiter gentilis*). Carrion crows, which will predate the eggs if females are disturbed from the nest are in evidence on the islands. If any control of their numbers is to be made within the SPA this will require an assessment of the impacts and an evaluation of the efficacy of proposed methods. There is currently no evidence of breeding goshawk on the islands. If they were to start breeding or feeding regularly there, it would be unlikely that lawful control would be possible, given their conservation status in the UK.

There is limited information on the presence of mammalian predators on the islands, but in the 2004 predator survey, signs of fox (*Vulpes vulpes*) and pine marten (*Martes martes*) were not

found, suggesting that they are only very occasional visitors. Anecdotal evidence suggests that the pine marten is extending its range around Loch Lomond and if so, there are potential negative impacts on capercaillie breeding success on the mainland. The Reynolds report recommends that the presence of weasels and stoats be monitored on Inchmoan and Inchconnachan, where the potential for them to take capercaillie eggs was acknowledged. Grey squirrels (*Sciurus carolinensis*) may take capercaillie eggs and the report notes that they have been recorded on Inchmoan and in 2003 on Inchconnachan. They were formerly common on Inchtavannach, but by 2004 were reduced in numbers and only rarely seen. The native wildcat (*Felix sylvestris*) is probably absent as there have been no recent local records.

The North American mink (*Mustela vision*) began to colonise the islands from 1971 (Mitchell 1983). Mink pose a relatively low risk to capercaillie populations given their preference for aquatic prey (Reynolds et al, 2005). However, mink trapping should continue on estates bordering Loch Lomond to limit potential dispersal to the islands. Although there is currently evidence of few mink using the islands, and that usage is irregular, it would be appropriate to monitor the islands periodically to detect any increase in numbers.

Hedgehogs eat the eggs of ground nesting birds and were detected on Inchtavannach in 2004. The Reynolds report states that hedgehogs should be removed from the SPA islands as soon as they are detected, and either humanely destroyed or translocated to appropriate mainland sites. This would require ongoing monitoring of their status, and the report stated that this should be a priority for the island's management. However, given that hedgehogs are likely to colonise the islands naturally and can therefore be considered native, it is unlikely that such measures would be taken forward.

The spread of both bracken and rhododendron can also be considered threats to the capercaillie population given that both reduce the quality and area of ground habitat available (particularly reducing blaeberry). There is extensive rhododendron removal underway and some bracken treatment has been carried out, with plans for this to continue on some of the islands owned by Luss Estates.

3.5.5 Potential Impacts on this species as a result of recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, the professional knowledge of the project team and the potential activities identified for the study area, the impacts shown in Table 11 could affect this population.

Table 11: Potential recreational impacts on capercaillie

Activity	**Impacts during lekking period** (1 March – 15 May)	**Impacts during brood rearing period** (21 April - 31 August)
Human presence – geographically close - occasional	Moderate	Moderate
Human presence – geographically close - frequent	Significant	Significant
Human presence – geographically distant - occasional	Minimal	Minimal
Human presence – geographically distant - frequent	Moderate	Moderate
Wood cutting	Moderate	Moderate
Foraging for wood	Significant	Significant
Dogs under close control (occasional)	Moderate	Moderate
Dogs under close control (frequent)	Significant	Significant
Dogs running free (occasional)	Significant	Significant
Dogs running free (frequent)	Significant	Significant
Exploring off path	Significant	Significant
Overnight camping	Moderate	Moderate

The capercaillie on the Loch Lomond islands are a small population at the western edge of their Scottish range, inhabiting oak woodland rather than their usual Scottish habitat of pinewoods. Surveying has revealed continued breeding on the islands, however individual counts vary from year to year. These counts are not strictly comparable due to the inconsistency in the time of year (which influences detection rates); the recording of weather conditions (for instance they are less likely to flush in winds of greater than force 4) and the absence of observer effort records on the (confidential) capercaillie data sheets.

The current lek counts, brood counts and casual observations undertaken on the islands are not statistically comparable with the previous drive counts. However, the LLTNPA have been liaising closely with SNH and the RSPB over the capercaillie population and all three organisations are in agreement that the population appears to have crashed alarmingly in recent years. It is important to note that due to the small numbers of birds involved, and their restricted range, any increases in visitor and dog pressure can only have a detrimental effect.

The distribution of sites where people congregate on the islands overlaps to some extent with the location of capercaillie as surveyed over the past decade - see Figure 21 (1995-2008) & Figure 22 (2009) both **confidential – available separately as Annex 6**).

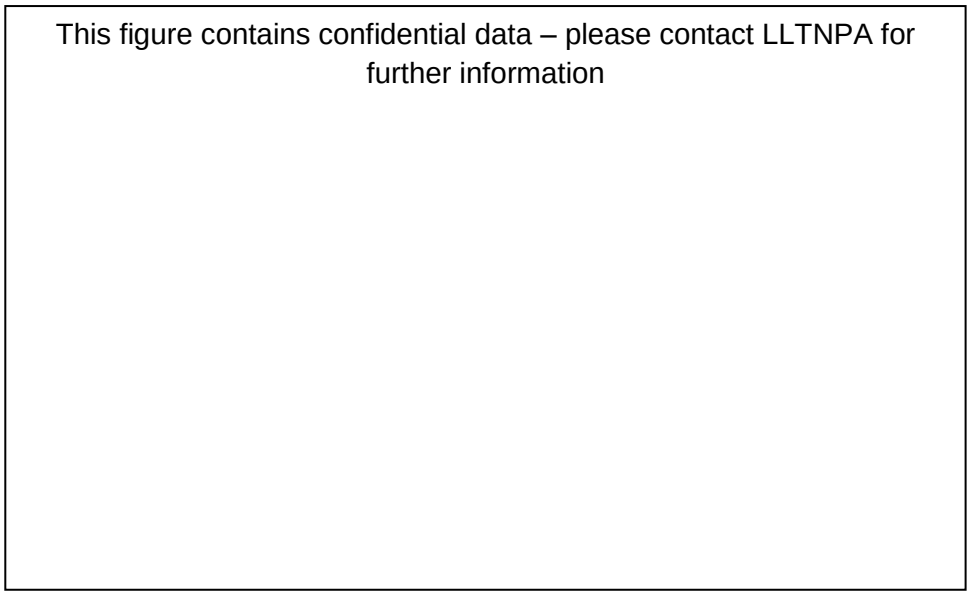


Figure 21: Records of capercaillie 1995-2008 (CONFIDENTIAL – see Annex 6)

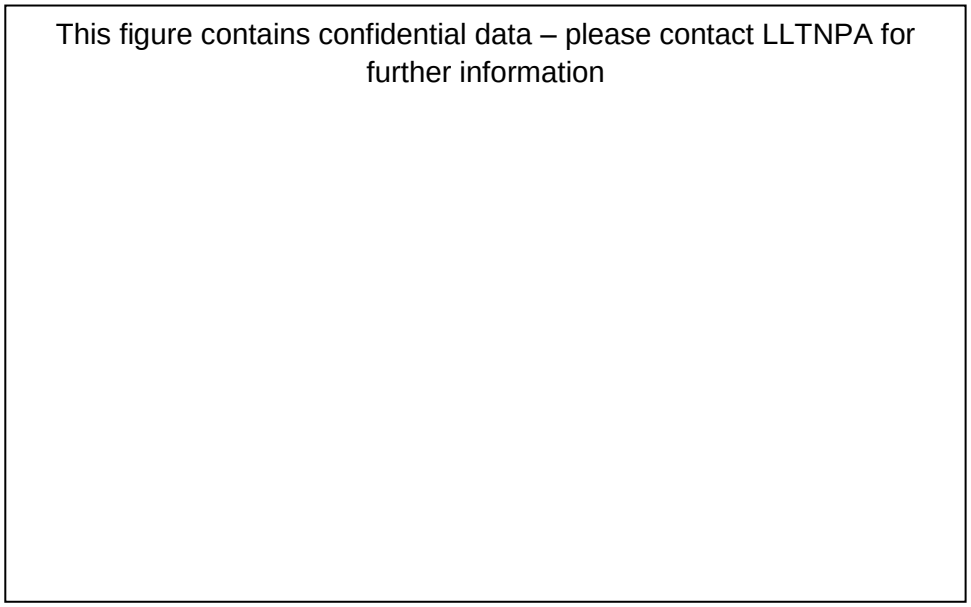


Figure 22: Records of capercaillie 2009 (CONFIDENTIAL – see Annex 6)

The frequency and extent to which people and their dogs roam through potential capercaillie habitat will determine the level of disturbance of the birds. As described in detail in the Capercaillie Species Action Plan report there are periods within which capercaillie are particularly sensitive: lekking (1st March – 15th May), nesting (21st April – 15th June) and brood rearing(15th June – 31st August).

The attitudinal survey of boat users demonstrates that visitors are taking dogs on the islands and a number of dogs have been observed as part of the boat stopping survey, increasing the risk of disturbance. Anecdotal evidence suggests that some visitors believe that it is acceptable to allow dogs to roam free on the islands as they are within a 'confined' area.

From the information collected during the on-island survey it is apparent that human exploration of the interior of an island is more likely to be occurring on Inchconnachan as it has the most developed informal path network. This could potentially be attributed to people searching for wallabies, which are well known to inhabit Inchconnachan (and people were encountered during

survey work who confirmed they were on the island with the specific intent of spotting wallabies). This activity potentially affects capercaillie between their lekking period through to brood rearing, but is likely to be most frequent during the brood period (after 15th June) as this coincides with the beginning of school holidays and therefore more frequent visitor activity.

Capercaillie that frequent Inchmoan are likely to be least disturbed as visitors seem less inclined to move away from the congregation zones on this island – there are no paths on the island except ones around the shoreline linking some of the congregation zones.

3.5.6 Risk assessment for capercaillie disturbance

Given that the capercaillie population appears to have declined catastrophically within the Loch Lomond islands in recent years, it is considered appropriate to establish potential management actions which may reduce the impact of recreational activities on this species. The following risk assessment process has been undertaken to produce management recommendations. This assessment does not take account of the fact that capercaillie on these islands may behave differently to those in a large continuous woodland area.

Risk assessment by geographical area of the islands

Without needing to publicly identify the actual locations of lek or nest sites on the islands it is possible to identify areas on the islands where capercaillie are potentially at risk of disturbance by visitors at different stages in the capercaillie breeding season. The Capercaillie Biodiversity Action Plan Group (CBAPG 1995) guidance provides distances and seasons for 'buffer zones' and we have used these figures in this assessment, although they have been adjusted for recent guidance for land managers.

The precautionary principle has been followed by assuming there could be a lek on any of the four Luss islands within the study area. If a hypothetical 1km radius exclusion zone were to be placed around the midpoint of each island (with management and recreation avoided between 1st March and 31st May), as recommended by the CBAPG guidance for leks in typical pinewood situations, a sizeable part of Loch Lomond and the adjacent shore would become out of bounds, as shown in Figure 23. Given the scale of the islands and their intensity of use this is clearly impractical.

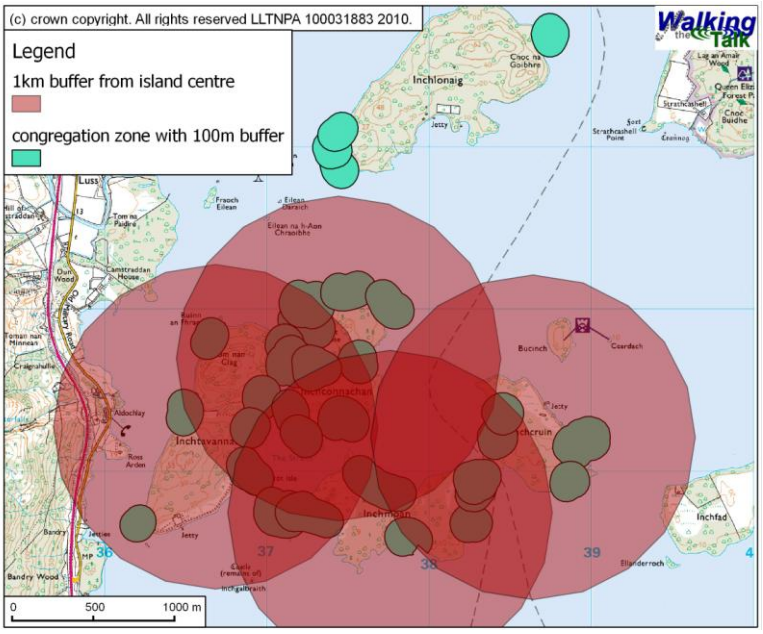


Figure 23: Hypothetical 1km exclusion zone from island centres, showing 100m buffer zones around each congregation zone

As this is not an acceptable exclusion zone, an alternative method for risk assessing the geographical area of the islands was considered. Summers et al (2007) suggests that capercaillie tend to avoid woodland within 100m of frequented paths. If a 100m buffer zone were to be drawn round each of the known visitor 'congregation zones' it is possible to calculate the areas remaining on each island for 'undisturbed' capercaillie during the brood rearing period (15th May – 31st August) as shown in Figure 24 (this assumes that people are unlikely to move beyond these smaller buffer zones on a frequent basis).

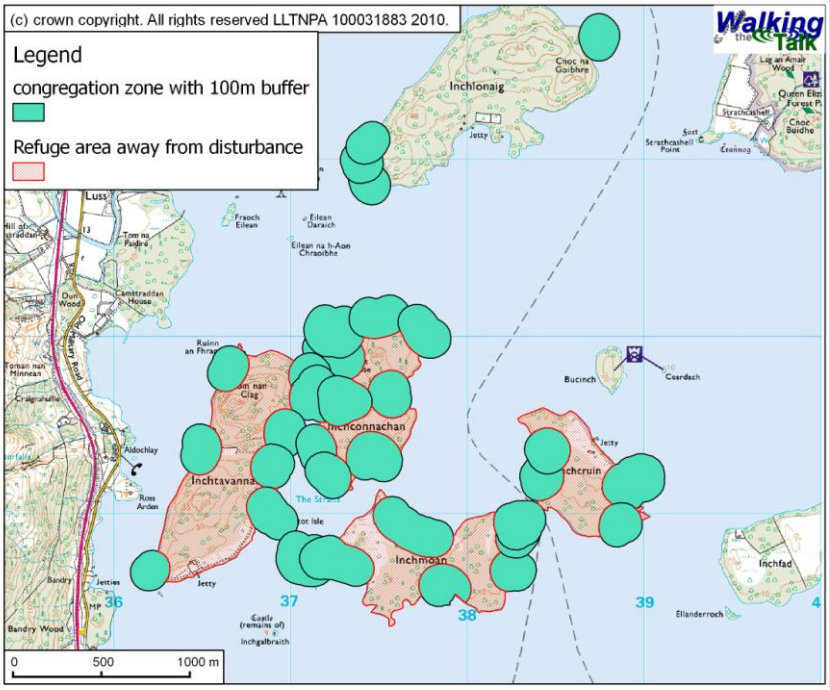


Figure 24: Potential 'refuge' areas available during brooding (21st April - 15th August)

The 'refuge' areas on the four islands included in Figure 24 have been estimated using GIS and these are listed in Table 12. This estimate does not factor in the suitability of habitat as a potential resource (the area is reduced on Inchtavannach for example by open grazing areas).

Table 12: Refuge areas as a proportion of total island area

Island	Approximate total area (Hectares)	Approximate refuge area (Hectares)	Proportion of island remaining as refuge
Inchtavannach	63.0	43.8	70%
Inchcruin	28.6	17.1	60%
Inchmoan	45.9	25.6	56%
Inchconnachan	42.2	13.0	31%

The maps shown in Figure 23 and Figure 24 identify a potential issue for the management of visitors on Inchconnachan where the large number of visitors, congregation zones, and paths (not shown on the maps) leave a minimal undisturbed area on the island. Therefore there is a high likelihood of visitors causing disturbance to breeding capercaillie on Inchconnachan at any time between 1st March and 31st August.

Risk assessment by activity

The RSPB has an agreement with the Scottish Orienteering Association which outlines that forestry blocks with active lek sites should not be used for orienteering between 15th March and 31st August. However, casual recreation by visitors on the islands is not considered to be comparable with orienteering in terms of disturbance throughout the islands and therefore this guidance has not been used to influence the risk assessment.

Dogs

Loose dogs allowed to range off tracks have been identified as a pressure to which capercaillie are particularly sensitive. Visitors to the islands who bring dogs are therefore likely to have a significant impact on the capercaillie. Lek and brood rearing times are when capercaillie are most sensitive to disturbance and therefore one option is to prevent any dogs from accessing the islands throughout this period (1 March – 31st August). This is probably an unacceptable option from a visitor perspective and would be both difficult and costly to enforce. However, it is clear that some restriction on dog activity within the islands is required to avoid significant impacts on the capercaillie resulting from recreational activities. A compromise solution is proposed whereby dog access to the islands is completely restricted during the lekking period (1st March to 15th May) and only dogs under close control are allowed during the brood rearing period (15th May to 31st August).

Camping

It is possible that camping could have a higher impact than casual recreation, particularly where there is continuous occupation of an area with associated human exploration and movement. Additionally, campers with accompanying dogs may cause a higher impact, as highlighted above. As with dogs, one option is to ban camping from all the islands from 1 March to 31 August. However, it is unlikely that this would be accepted by the public and would be costly and difficult to enforce. Therefore a similar compromise solution is proposed whereby camping is prohibited during the lekking period (1 March to 15 May) but permitted during the brood rearing period (15 May – 31 August).

3.5.7 Conclusions and recommendations

Although there is not statistically conclusive evidence of a terminal decline of the local capercaillie population it is sufficiently small and fragile to require early intervention rather than to continue monitoring until there is statistically robust data. The legal protection afforded by the relevant European Directives also places a duty on the Scottish Government to ensure that the species remains in favourable condition. Whilst it is beyond the scope of this research to determine all the factors that could influence the survival of this population it is possible that actions to reduce the potential for disturbance by recreational activities are a high priority and would be a positive step for the conservation of capercaillie in Loch Lomond.

Some of the disturbance to capercaillie in Loch Lomond is accidental and could be avoided if visitors were better-informed prior to visiting the islands. The provision of clear, simple guidance setting out the risks to the birds and how to minimise impacts would help the many responsible visitors to limit disturbance. Such guidance should make particular reference to the sensitivities during relevant parts of the breeding season and the recreational activities that pose greatest risk to breeding capercaillie. We are aware that the provision of guidance will increase overall awareness of the existence of a capercaillie population on the islands, but without guidance, few visitors will be aware how they can minimise damage and accidental disturbance will continue. Following the submission of the first draft of this report, a trial of a new leaflet (Caper Hotel) took place during the summer of 2010 and this could potentially be continued or extended, with minor revisions to the content.

In conjunction with the provision of guidance, and on the basis of the risk assessment outlined above, it is considered reasonable to use a combination of restrictions based on geographical area and activity to prevent significant impacts on the capercaillie population from recreation.

As capercaillie are particularly sensitive to disturbance by dogs, we recommend a prohibition on people taking dogs to Inchtavannach, Inchconnachan, Inchmoan and Inchcruin during the lek period (from 1st March to 15th May). From May 15th through to August 31st, on Inchtavannach, Inchmoan and Inchcruin, people should be allowed to take dogs but asked to keep their dogs under close control (which for some breeds, such as spaniels, may require them being on a short lead) whilst within a congregation zone, and requested not to allow dogs outwith these areas. For the island of Inchconnachan, which has a more developed path and congregation zone network, with an associated reduction in the area of undisturbed habitat available to capercaillie, the prohibition of dogs should remain in force until the end of August (i.e. the end of the breeding period).

As camping can also cause moderate impacts on capercaillie, we recommend prohibiting camping on all four islands during the lekking period (from 1st March to 15th May), on the basis of the 1km exclusion zone. However, as this is before the start of the main holiday period, this restriction should not affect the majority of visitors to the islands.

These proposed restrictions are summarised in Table 13:

Table 13: Proposed activity restrictions in the islands

Period	Island	Dogs running free	Dogs under close control	Camping
Lek period (1st March to 15th May)	Inchconnachan	prohibit	prohibit	prohibit
	Inchtavannach	prohibit	prohibit	prohibit
	Inchmoan	prohibit	prohibit	prohibit
	Inchcruin	prohibit	prohibit	prohibit
Brood rearing period (15th May to 31 August)	Inchconnachan	prohibit	prohibit	Okay
	Inchtavannach	prohibit	Okay	Okay
	Inchmoan	prohibit	Okay	Okay
	Inchcruin	prohibit	Okay	Okay

While such restrictions may be controversial to many, it may be possible to enact them within the scope of the Land Reform Act (Scotland) 2003, if it was deemed necessary to exclude areas from public access for a defined period for the purposes of conservation of designated species. Looking at the wider implications for the local breeding population, the potential access restrictions could be applied to other islands and the mainland as necessary, in line with recorded breeding attempts and availability of suitable habitat. Legal advice should be sought by the LLTNPA before any such action is taken and any access restrictions considered by the Local Outdoor Access Forum.

Given the likely controversy of any decision to pilot access restrictions, a promotional campaign highlighting the rationale for prohibiting dogs and camping should be made a priority. Without such publicity regarding the plight of the capercaillie on the islands (and the positive management steps being taken to protect them) it is likely that a public reaction against seemingly draconian measures would occur. It would be important to separate the issue of disturbance to capercaillie from any measures to reduce anti-social behaviour.

It should be noted that such actions may not be sufficient to fully address the decline of capercaillie on the Loch Lomond Islands, given that this is likely to be caused by a combination of factors.

3.5.8 Monitoring recommendations

MO-3 ***Improve the monitoring of capercaillie to ensure that changes in population and breeding status can be identified with confidence.***

3.5.9 Management recommendations

MA-1 ***Instigate a comprehensive campaign to develop and promote clear guidance on how to avoid disturbance to capercaillie, potentially using the 'Caper Hotel' leaflet used in summer 2010 as a basis for this guidance.***

MA-2 ***Consider the legal and public relations implications of any restrictions of access as outlined in section 3.5.6 and Table 13***

MA-3 ***Undertake a pilot phase of restricting certain activities during defined time periods / geographical areas (as outlined in section 3.5.6) and assess the outcomes.***

MA-4 ***If there is reasonable evidence of risk to the breeding population from recreational activities, work with land owners and local stakeholders to expand the access restrictions to other islands and the mainland.***

MA-5 ***Review the risk assessment and implementation of management actions in liaison with SNH and RSPB on an annual basis***

3.6 Otter

3.6.1 What are the 'characteristics' of the species / habitat?

Otters are semi-aquatic mammals whose numbers declined sharply in the UK in the mid twentieth century. However, most reports on otter numbers and distribution within the UK in the past 25 years relate to their increase in number, particularly in the south and east. Improvements in water quality have resulted in an increase in the UK's otter population however those in rural Scotland were generally less affected by the pollution related decline than elsewhere. In response to improved water quality in many rivers in the UK, otter numbers are now recovering strongly. Within Scotland, both numbers and range have also increased, with the most recent Scotland-wide survey (2003-4) reporting that the species can now be considered ubiquitous (Strachan, 2007).

On inland waters male and female otters occupy overlapping territories (the males' territories generally overlapping with two or more females') along rivers or shorelines. They take predominantly aquatic prey although rabbits, amphibians and rodents also form part of their diet, depending on relative availability (Kruuk *et al* 1998). The species is protected as a European Protected Species under the Habitats Regulations 1994.

3.6.2 Otters in Loch Lomond

Otters are known to be present within the Loch Lomond area with 18 live otter sightings (unknown recorders) between 2003 and 2007, five of these being pairs of otter. These sightings were concentrated around the Endrick Mouth and some of these may be the same individuals counted more than once. There have also been 12 otters reported dead on roads around Loch Lomond between 2000 and 2007. Two of these were on the A811 to the south of the loch between Balloch and Drymen, and 10 on the A82 between Balloch and Tarbet.

3.6.3 Are otters sensitive to disturbance by recreation and how has that sensitivity been measured?

Otters often occupy sites in urban areas and in highly disturbed waterways where they appear to be unaffected by human activity.

Radio-tracking research on otters on Loch Davan (Aberdeenshire) reviewed in Kruuk *et al* (1998) reveals reed beds to be favoured as resting sites (although cover from any vegetation or rocks will suffice) and that the selection of resting sites is unrelated to proximity to feeding areas or human disturbance. However, resting areas were not restricted to banks and otters were often observed to rest several hundred metres from water.

Recent work for English Nature carried out by Chanin (2003) refers specifically to anthropogenic disturbance in relation to field research on radio-tagged otters in Aberdeenshire in the 1990s (Durbin, PhD thesis, Aberdeen). It was found that a common response to the sounds of anglers or walkers with dogs was for otters to move to a position where they can see the origin of the disturbance, then dive and swim underwater for approximately 50m before surfacing and resting on the bank for five to 30 minutes, then resuming their previous activity.

Much of the available research on otters has been carried out on coastal otters (e.g by H. Kruuk in Shetland), population recovery following pollution related declines in England and the physiological impact of Polychlorinated Biphenyls and other pollution. There has been no research that we can identify which explicitly attends to the impact of disturbance on otters, with findings often reporting successful breeding close to human habitation and no quantification of the risk of dogs to cubs, or boat disturbance on hunting success. It appears that the main anthropogenic risk to otters within the UK now is collisions with cars.

The possible introduction to Scotland of the fatal salmonid parasite *Girodactylus salaris* has received an increasingly high profile recently and could have a potential impact on one of the otter's food sources. The main concern is with equipment used for angling and boating – principally canoeing - that has been used abroad (particularly in northern Europe) and may carry larvae of the parasite.

3.6.4 Potential Impacts on this species from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, the professional knowledge of the project team and the potential activities identified for the study area, the impacts shown in Table 14 could potentially affect this population.

Table 14: Potential recreational impacts on otters

Activity	Impact during breeding period	Impact during foraging
Human presence – geographically close - occasional	Minimal	Minimal
Human presence – geographically close - frequent	Moderate	Minimal
Human presence on the water	Moderate	Moderate
Dogs under close control (occasional)	Moderate	Minimal
Dogs under close control (frequent)	Moderate	Moderate
Dogs running free (occasional)	Significant	Minimal
Dogs running free (frequent)	Significant	Moderate

The location of otter holts on the Loch Lomond islands as displayed in Figure 25 is interesting in terms of their proximity to existing human congregation zones, but it is difficult to say anything about current status and implications for their population. It is not possible to definitively answer questions such as whether otters are avoiding holt sites because of disturbance, or feed less successfully (leading to measurably lower productivity) because of boat disturbance. However McCafferty (2005) concludes that the otter population on Loch Lomond is stable, possibly still increasing, and that the only otter mortalities directly attributable to humans are vehicle collisions on roads around Loch Lomond.

On the basis of information collected during the literature review, it is concluded that disturbance of females while breeding and removal of shoreline vegetation (which provides both shelter and holt sites) are likely to be the only pressures caused by recreational activities that could affect otters on Loch Lomond. Figure 25 shows that holts are found both very close to and further away from congregation zones, as well as the tracks and trails recorded during the capercaillie predator survey. The holt adjacent to Zone 6 was recorded during a survey undertaken in 2003 (Strachan 2007) and it is not clear if this holt is still in use. However, assuming that it was in use at least in 2003, and probably subsequently, we can study the boat-stopping data for that zone to ascertain the extent of human presence. As can be seen from Figure 26, the zone is popular for recreational activities, with 157 boats recorded at the zone during 2002 (standardised figures as defined in section 3.1.2). Given that otters were using the holt in 2003, it is reasonable to suggest that the

current level of recreational activities is not impacting on them. However, it is recommended that the holt at zone 6 should be checked to see if it is still in use. If it is, then it provides further evidence that the otter remains unaffected by recreational activities, even in close proximity to its holt.

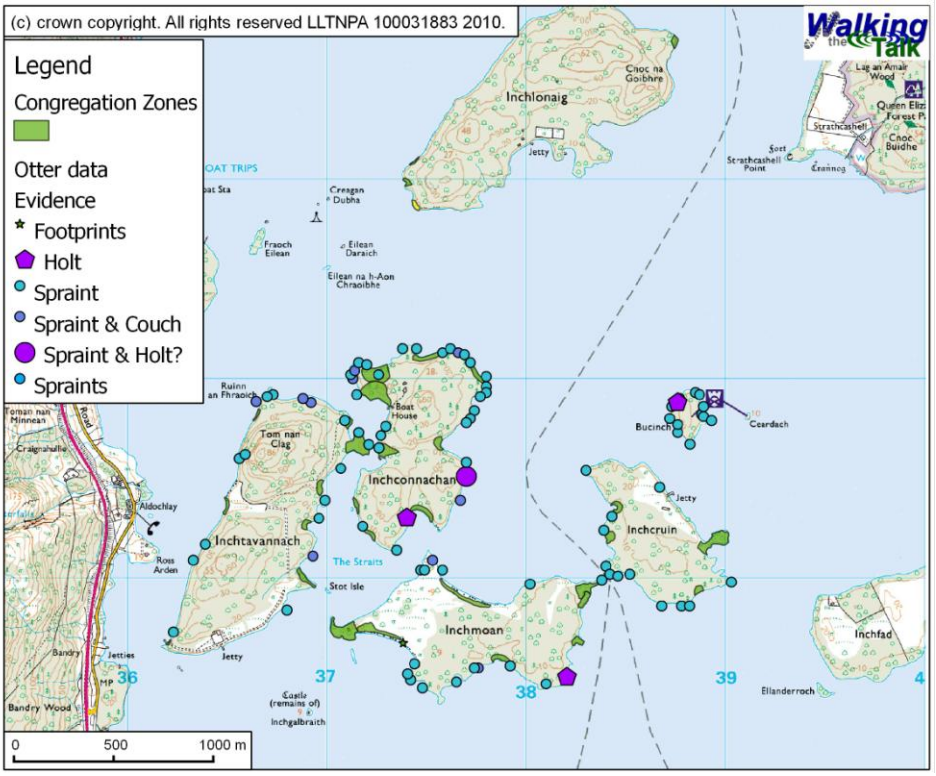


Figure 25: location of otter holts and spraint records within the study area

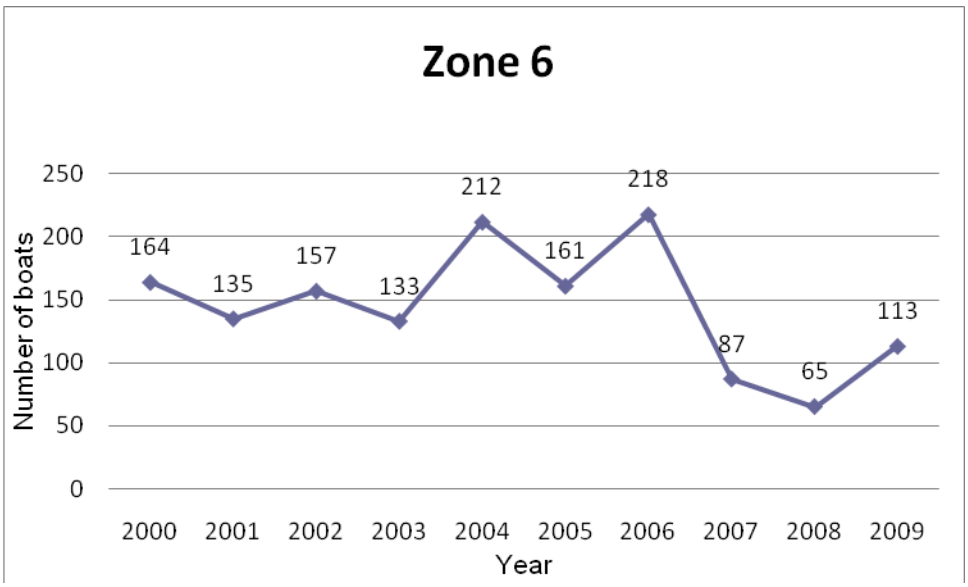


Figure 26: Number of boats recorded at zone 6 (Inchconnachan) 2000-2009

Holt sites are likely to be in the roots and lower limbs of shoreline trees and section 3.11.4 looks at the overall impacts of recreational activities on the island woodlands. This section concludes that damage is occurring to the woodland habitat, but only to a relatively small percentage of the total woodland area. However, it highlights that certain NVC categories are being more significantly affected, in particular the alder woodland classes (W4 and W11b) which tend to occur around the

edges of the islands. These are likely to be the woodland areas which otters will use for holts and therefore any significant damage from recreational activities is of concern.

It was also clear from the survey work that tree cutting activity was not concentrated solely along the shoreline, but also spread inland. In many cases the trees which were targeted along the shoreline were small coppiced alders which would be unlikely to form a suitable holt location. However, it is important to note that damage to the woodland habitat has the potential to have a 'double negative' effect with impacts on both the woodland habitat and potential otter habitat. Monitoring of wood-cutting is one element within the on-island survey protocol (see section 2.4.4), but it is time-consuming to monitor and difficult to obtain reliable figures. However, despite these issues, it is recommended that the monitoring of wood-cutting should continue on an annual basis as part of this survey. Additionally it is suggested that additional measures to discourage people from cutting trees, such as those highlighted in section 3.11.6 should be considered if the monitoring shows increased tree cutting activity.

This leaves the issue of dogs being under close control during the breeding season. A number of management measures for both human and dog presence have been suggested in section 3.5.6 to limit impacts on capercaillie. These measures are likely to be adequate to also address risks to breeding otters.

3.6.5 Conclusions and recommendations

Otters continue to survive and breed in and around Loch Lomond. There is no evidence of immediate threat to their survival resulting from human disturbance at the islands and Endrick Mouth, but any increased disturbance of holt habitat by humans should be discouraged. Continued monitoring of recreational damage to shoreline trees should be undertaken around congregation zones to allow any increases in damage to be recorded. If increased damage is recorded, additional management actions should be considered.

3.6.6 Monitoring recommendations

MO-4 Monitor the holt at zone 6 to see if it is still in use.

MO-5 Monitor tree-cutting and fire activity within the annual on-island survey so that habitat loss due to cutting, burning or erosion is identified.

3.6.7 Management recommendations

The management recommendations suggested to limit the impacts of dogs on ground nesting birds should also address risks to breeding otters. If tree cutting appears to be increasing, additional management actions, such as education campaigns and the provision of ready-cut fuel to campers should be considered in the future.

3.7 Osprey

3.7.1 What are the 'characteristics' of the species / habitat?

Ospreys are large, fish-eating birds that breed in Scotland and winter mainly in western Africa. They are heavily protected in the UK under Schedule 1 of the Wildlife and Countryside Act (1981) and the Nature Conservation (Scotland) Act (2004). Ospreys were largely lost as a breeding species in Scotland at the end of the 19th century but made a well-recorded come-back from around 1958, initially within Speyside but fairly quickly spreading to other parts of Scotland. The Scottish population is considered healthy enough to support chick removal for introduction programmes in England and Spain.

3.7.2 Ospreys in Loch Lomond

The Loch Lomond area was colonised by ospreys during the 1980s, if not before, and the species is now regularly seen fishing the loch in the summer months. The population at the southern end of Loch Lomond seems stable and contributes to a national picture of a continuing gradual increase and spread of range – there are currently some 200 pairs in Scotland so the study area population represents around 2% of the Scottish population. During 2009, there were four osprey pairs known to be nesting in or using the study area as feeding ground. This includes a pair that had been using an old pine on Inchconnachan for several years but moved onto nearby Bucinch in 2009, probably as a consequence of wind-damage to the original nest tree. However, in 2010, they moved back to the original tree on Inchconnachan. The Ranger Service has spent considerable time protecting this pair from unintentional disturbance since they first nested on Inchconnachan in 2005. The SNH NNR team and the LLTNPA ranger service monitor a further two of the four pairs while a local estate keeps an eye on one pair. Productivity is known for at least three of the pairs and is very good, so the breeding population is stable or gradually expanding.

3.7.3 Are osprey sensitive to disturbance by recreation and how has that sensitivity been measured?

Most of the relevant research described here has been undertaken in the US – there are no UK specific studies, but also no reasons to expect the results to differ.

Ospreys can be extremely tolerant of human activity (Poole 1981) but nests that are further away from human activities are, on average, more productive than those subject to regular and frequent disturbance (Van Daele & Van Daele 1982). Several comprehensive reviews of disturbance effects on ospreys exist (e.g. FMB ONMR 2006, Ruddock and Whitfield 2007). In essence, these conclude that disturbance impacts are variable, but may be most severe when atypical disturbance events occur during territory settlement, egg laying and early chick phases (Poole 1981, Van Daele and Van Daele 1982, Hagan 1986). Such events may force parents to leave the nest for long periods resulting in chilling and mortality for eggs and chicks. Ospreys are more likely to be tolerant of predictable disturbance and may habituate to human presence.

The rapid approach of boats can cause birds to take off from the nest and research in Florida has found an average flush distance of 49.5 +/- 21.8m for a jet ski approach and 57.9 +/- 22.2m for a boat with an outboard motor (Rodgers and Schwikert, 2002). This led the authors to suggest a 150m buffer zone around nests for powered craft.

In contrast, ospreys appear to habituate to regular overflights by planes and research by Trimper *et al* found that the presence of aircraft didn't affect nest attendance by the birds (Trimper *et al*, 1998). However, it should be noted that this was for jet aircraft and not microlights.

Although not backed up by experimental evidence, many studies conclude that a buffer where human activity is minimised for 200 - 400m around a nest is good practice (FMB ONMR 2006). Other studies have looked at the impact of forestry operations on osprey nests and have suggested a no-cut zone within a 61m radius of the nest (Rodrick and Milner, 1991 in Ruddock and Whitfield, 2007). However, these studies are not directly comparable with the tree cutting activity which takes place on the islands as they are considering the impacts of clear-felling rather than sporadic cutting of individual trees.

3.7.4 Potential impacts on this species from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, discussions with site staff and the activities identified for the study area, the impacts shown in Table 15 could affect the local populations.

Table 15: Potential recreational impacts on osprey

	Period		
Activity	**Impact at feeding**	**Impact at nesting**	**Impact at other periods**
Human presence-geographically close-occasional	Minimal	Minimal	N/a
Human presence-geographically close - frequent	Minimal	Moderate	N/a
Human presence-geographically distant -frequent	Minimal	Minimal	N/a
Human presence on the water	Minimal	Minimal	N/a
Human presence in the air	Minimal	Minimal	N/a
Fires	None	Significant	N/a
Wood cutting	None	Significant	N/a
Dogs under close control (occasional)	None	Minimal	N/a
Dogs under close control (frequent)	None	Minimal	N/a
Dogs running free (occasional)	Minimal	Moderate	N/a
Dogs running free (frequent)	Moderate	Significant	N/a
Overnight camping	None	Significant	N/a

The literature suggests that ospreys can be extremely tolerant of human activity, but that disturbance impacts may be most severe during territory settlement, egg laying and early chick phases. Ospreys tend to be faithful to a territory, but can be forced to abandon a nest site through disturbance. The pair that used Inchconnachan may continue to use Bucinch as an alternative if disturbed from their original site. The other three nest sites are all “on the mainland” and less likely to be disturbed.

At Loch Lomond, disturbance is frequent on the islands, but rare to non-existent ashore. Impacts are therefore localised, with the birds able to habituate or adapt by moving nest sites. However, it

would be prudent to continue to monitor breeding success and any dramatic changes that occur should be investigated.

3.7.5 Conclusions and recommendations

There is no evidence that recreational disturbance causes more than local impacts that do not threaten the viability of the local or national population. Indeed the species has colonised Loch Lomond in the face of considerable recreational activity. But the osprey is an iconic, as well as protected, species and the Ranger Service should continue to promote its conservation by advising people to avoid loch-side nest sites.

3.7.6 Monitoring recommendations

MO-6 ***Ensure coordinated annual monitoring and reporting of all nest sites continues and is included in the central data repository***

3.7.7 Management Recommendations

MA-6 ***Advise visitors, e.g. at the boat slipway or other launching sites, of any sensitive osprey nest site that they should avoid.***

MA-7 ***If the Inchconnachan site continues to be used, then the present exclusion measures should be continued during the breeding period.***

3.8 Nesting waders

3.8.1 What are the 'characteristics' of the species / habitat?

This broad species description has been assumed to include the range of wading bird and gull species have been recorded within the study area. Breeding wader numbers have declined significantly over the last 20 or 30 years, as ground has been drained and improved for agricultural and forestry purposes, with a concomitant decrease in game-keeping. Species which have been affected within Scotland include curlew (*Numenius arquata*), lapwing (*Vanellus vanellus*), redshank (*Tringa totanus*) and snipe (*Gallinago gallinago*).

3.8.2 Nesting waders in Loch Lomond

Curlew, lapwing, redshank, snipe and oystercatcher (*Haematopus ostralegus*) still breed in small numbers in the wet grassland and marshes of the Endrick Mouth and common sandpipers (*Actitis hypoleucos*) still breed at Loch Lomond. The populations of nesting waders are not of national or international importance but are of regional significance.

Detailed wader breeding performance has been monitored at Endrick Mouth in the past and breeding bird surveys are still undertaken; wetland bird survey counts have taken place here and more widely around the loch though to a variable standard. Breeding duck and gulls were monitored across the loch in 1987 and 1991 but apparently not subsequently. Parts of the Endrick Marshes and adjacent islands are also designated as a Ramsar site due to their importance as a breeding area for water birds.

3.8.3 Are nesting waders sensitive to disturbance by recreation and how has that sensitivity been measured?

In general there has been little work done on disturbance to waders and gulls in lowland situations. In the UK research has largely focused on the uplands, such as the Peak District National Park.

Relevant national references include work undertaken by Anderson in 1990, investigating moorland recreation and wildlife in the Peak District. Her literature review concludes that curlew are the most sensitive nesting wader in the uplands, followed by golden plover (*Pluvialis apricaria*), common sandpiper and dunlin (*Calidris ferruginea*). There is possibly a correlation between increasing levels of recreational disturbance and reduced numbers of golden plover, curlew and redshank. An indirect effect of recreation could be increased trampling reducing invertebrate food sources. Crucially golden plover numbers appear to have declined in the most popular recreational areas and remained stable or possibly increased elsewhere.

In 2005 Finney concluded that golden plover avoid areas of high disturbance when movements are unpredictable, but that the effects of disturbance are significantly reduced by providing a well managed path surface that walkers will naturally keep to and thus reduce/curtail wandering off path into plover territory. However, hardening of the path surface does not necessarily affect dog behaviour.

A report to the Ramblers Association in 1990 reviewed impacts (Sidaway 1990) on golden plover, common sandpiper and curlew and offers a concise review of the work on waders in the Peak District. Evidence of the effects of disturbance are drawn from a decline in golden plover numbers as recreational activities increased at Kinder Scout and Snake Pass, whilst numbers increased in less disturbed areas further north. However, it concluded that climate appears to be a more critical factor in population decline. Common sandpipers nest around loch shores and the favoured feeding areas for chicks (shingle beaches) are also popular with anglers and picnickers. Traffic management schemes led to the closure of some beaches for recreational activity with a resultant

recovery of sandpiper nesting success here. Disturbance in June is critical in the Peaks and at that time the Park was advising anglers how to recognise agitated behaviour of birds and to move approximately 50 yards away. Sidaway also quotes van Zanden's work on curlew, which suggested that curlew are the most sensitive waders to disturbance and indeed could be used as an indicator of recreational impact. Dotterel (*Charadrius morinellus*) studies in the Cairngorms by Watson and others confirm that this species is very confiding and tolerates people and dogs; one area contained both the highest density of breeding birds and the highest level of recreational disturbance but here breeding success was high due to high soil fertility and the abundance of invertebrates on which the birds feed.

The distribution of shoreline waders has also contracted and Watson *et al* (1988) reviewed the decline of shore waders at Loch Morlich. Waders were monitored in May and June from the 1930s through to the 1980s. Numbers of common sandpiper and oystercatcher declined dramatically during the 1950s, and lapwing, curlew and redshank in the early '60s. At the same time, nearby populations of common sandpiper at Loch an Eilein and Loch Gamhna declined far less severely; these lochs suffer less public pressure, evidenced by less trampling damage and no roads, car parks and lay-bys. The declines on Loch Morlich were put down to a combination of disturbance by anglers, walkers, bathers and others; habitat impoverishment from trampling leading to poorer invertebrate food supply; habitat destruction by car parks, lay-bys, roads and jetties on the north shore, and by a wide footpath around the rest of the loch; and probably robbing of eggs and chicks by more crows and gulls foraging on the shore.

The Birds of Scotland (SOC, 2007) suggests that predation by mink is the major concern for nesting colonies of gulls. Whilst recreation is likely to have an influence, it is discounted as being significant

3.8.4 Potential Impacts on these species from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, the professional knowledge of the project team and the recreational activities identified for the study area, the impacts shown in Table 16 could potentially affect these populations.

Table 16: Potential recreational impacts on nesting waders

	Period		
Activity	**Impact at nesting**	**Impact at feeding**	**Impact at other periods**
Human presence-geographically close-occasional	Minimal	Minimal	Minimal
Human presence-geographically close - frequent	Significant	Minimal	Minimal
Human presence-geographically distant-occasional	Minimal	Minimal	Minimal
Human presence-geographically distant-frequent	Minimal	Minimal	Minimal
Human presence on the water	Minimal	Minimal	Minimal
Human presence in the air	Moderate	Minimal	Minimal
Dogs under close control (occasional)	Moderate	Minimal	Minimal
Dogs under close control (frequent)	Significant	Moderate	Moderate
Dogs running free (occasional)	Moderate	Moderate	Moderate
Dogs running free (frequent)	Significant	Moderate	Significant
Exploring off path / stravaiging	Minimal	Minimal	Minimal
Overnight camping	Moderate	Minimal	Minimal

Waders are seen as being susceptible to human disturbance and the work listed above would suggest that this can be and probably has been significant in the Loch Lomond setting. Ringed plover (*Charadrius hiaticula*) may have been lost and common sandpiper numbers restricted by recreational pressure; John Mitchell (pers. comm.) remarked on the historic loss of nesting waders and terns from Inchmoan. However, attempting to do anything about this on Loch Lomond, rather than on other nearby water bodies, may not result in any significant gains. It may be more useful to have a broader review of their populations across the Park rather than just within the designated sites.

An adapted common bird census is carried out within the Endrick Mouth section of the study area, usually with two surveys per year being completed. Survey work has been more sporadic around the shore of Loch Lomond. In both cases it is debatable whether sufficient information is being gathered to evaluate the likely impact of current recreation activities.

Some wader species, such as redshank and lapwing are confined to the wet meadows and marshes of the Endrick Mouth. Here recreation is by and large restricted to linear walking routes that cause minimal disturbance and fishing in the Crom Mhin Bay area.

This area is consistently used by coarse anglers throughout the breeding season; their activity includes overnight camping, damage to trees, fires, litter and defecation. They also wade out into

the water and may leave fishing line. Their preferred area is quite confined and there is some evidence that redshank have failed to breed within this preferred area.

Walking and dog-walking is light throughout the area, largely owing to difficulty of access. The ground at the entrance to the reserve at Balmaha is poached by cattle and often wet; likewise the end of the Shore Wood path on the other side of the Endrick is stoutly fenced and encompasses wet, tussocky ground unattractive to the average walker. There is apparently a small amount of local use of the Balmaha side, but this is considered insignificant.

It is likely that there is some breeding displacement from the Crom Mhin area at present, but this is small in comparison to the overall size of the site. Further encroachment of recreation, or an increase in its intensity, could increase impacts on nesting waders. However the current extent of species monitoring may not pick this up, so an enhanced monitoring programme is recommended. This should include alignment of breeding bird monitoring zones with recreational monitoring zones at Endrick Mouth (as established in the revised weekly monitoring survey – see section 2.4.3); increase coverage of breeding bird survey to include recording of wader alarm calls andcontinue recording disturbance events.

With regard to the shoreline waders, the LLTNPA may wish to consider a wider review of the breeding status and performance of shore-line species across the water bodies within the national park, perhaps harnessing volunteers after the current Bird Atlas survey work by rangers and volunteers concludes in 2011.

3.8.5 Conclusions and recommendations

The scientific literature suggests that nesting waders are susceptible to human disturbance, both on the shore-line and in pastures. Around the loch's shore-line the pressure is regular and at times intense; it is suggested this has historically had a significant impact on nesting wader distribution and numbers. In the wet grassland at Endrick Mouth, there is frequent but localised disturbance from anglers and occasional disturbance from walkers. The former probably has a significant impact on nesting wader distribution at Crom Mhin. The latter has minimal impact and currently no management action is required.

3.8.6 Monitoring Recommendations

MO-7 ***Tie in breeding bird monitoring zones with recreation monitoring zones at Endrick Mouth***

MO-8 ***Increase breeding bird survey coverage in June/July to pick up wader chick/alarm calls (this can be done during the day)***

MO-9 ***Record all disturbance events and any visible impacts within the weekly monitoring programme and record any changes in recreational activity and location***

MO-10 ***Consider enhancing recreational monitoring coverage at Crom Mhin, and elsewhere if possible, at weekends***

MO-11 ***Consider a wider review of shore-line nesting wader performance across the Park***

3.8.7 Management Recommendations

MA-8 ***Continue to discourage access development within the wet grassland/marsh areas of the Endrick Mouth***

3.9 Waterfowl and Greenland White-fronted geese

3.9.1 What are the 'characteristics' of the species / habitat?

A range of ducks and geese can be included within this broad species description. The species being considered include Greenland white-fronted geese, mallard (*Anas platyrhynchos*), wigeon (*Anas penelope*) and teal (*Anas crecca*), with small numbers of pochard (*Aythya farina*), shoveler (*Anas clypeata*) and tufted duck (*Aythya fuligula*) also present. The UK is an important wintering ground for all these species - some also nest here, but only in small numbers in comparison to breeding populations further north in Iceland and Scandinavia. Numbers of these species within the UK are generally stable or increasing, with the exception of mallard – their decline has been attributed to warming winter temperatures further north and east (SOC, 2007).

The world population of Greenland white-fronted geese more than doubled from 1980 to the turn of the century but has since declined, currently at the rate of 8% per annum (SOC 2007 and greenlandwhitefront.org). It is estimated that 60-65% of the world population winter in Scotland. Breeding rates in Greenland are low and insufficient to match annual mortality. The expansion of competitively dominant Canada geese on the breeding grounds is thought to be a major cause of this decline in productivity.

3.9.2 Waterfowl and Greenland white-fronted geese in Loch Lomond

A number of species spend the winter on Loch Lomond, notably over 200 Greenland white-fronted geese which roost and partially feed in the vicinity of Endrick Mouth. Greenland white-fronted geese are the principal reason for designation of the Endrick Mouth area of Loch Lomond as a Special Protection Area (Stroud et al 2001). This flock first appeared in 1960/61 and gradually increased in numbers to around 100-140 during the late 1970s and early 1980s. Numbers then increased again in line with national counts peaking at 450 in 2002. Numbers have since fluctuated as birds have foraged more widely across agricultural land away from the immediate Endrick Mouth area. This, in combination with the species preference for un-drained and unimproved hollows, has made achieving an accurate count quite challenging. The population was thought to have stabilised at the 250-300 level, around 2% of the Scottish population, though most recent counts suggest a continuing decline to 200-220, around 1% of the population.

The winter population for other waterfowl species at Endrick Mouth fluctuates around 200 mallard; 200 teal; 200 wigeon and lesser numbers of the other species. Whilst these are locally significant, individually they do not reach qualifying criteria for national or international importance. However, taken together, the assemblage of species breeding in the water margins and damp grassland are recognised an important feature of the site and contribute to nationally important breeding assemblages.

3.9.3 Are waterfowl and Greenland white-fronted geese sensitive to disturbance by recreation and how has that sensitivity been measured?

Wintering wildfowl may be subject to disturbance whilst feeding or roosting, resulting principally in displacement from preferred areas (e.g. Bélanger and Bédard 1989, Gill et al 1996). Interpreting and assessing the consequences of such behavioural responses is rather challenging (Gill et al 2001). Disturbance can result in both lower food intake rates and higher energetic costs for waterfowl (Bélanger and Bédard 1990), costs that can result in lower fat reserves before spring migration and ultimately may lead to decreases in breeding success (Madsen 2008). Generally, however, the consequences of disturbance events can often be minimised by wildfowl, through use of the resources in the most disturbed areas at alternative times (Gill et al 1996). It is likely that many previous estimates of impact on wildfowl are overly pessimistic (Gill et al 2001). These are

likely to include the earlier studies of disturbance impacts on Russian white-fronted geese at Slimbridge (Owen 1972) which concluded that disturbance strictly limited the habitat available for the species. However, only through intense study can the impacts of disturbance (in terms of population) be separated from the effects of disturbance (the behavioural response) and a precautionary approach has been urged in the case of priority species and populations.

Specific studies on Greenland white-fronted geese have only been carried out during moult on the breeding grounds (Glahder and Walsh 2006) and concluded that large impacts are possible at this particularly vulnerable stage. However, it seems that this study is of no direct application to behaviour during the winter period.

3.9.4 Potential Impacts on waterfowl from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, the professional knowledge of the project team and the activities identified for the study area, the impacts shown in Table 17 could affect the local populations.

Table 17: Potential recreational impacts on waterfowl

	Period		
Activity	**Impact at feeding**	**Impact at roosting**	**Impact at other periods**
Human presence-geographically close-occasional	Minimal	Minimal	Minimal
Human presence-geographically close-frequent	Moderate	Significant	Moderate
Human presence-geographically distant-occasional	Minimal	Minimal	Minimal
Human presence-geographically distant-frequent	Moderate	Minimal	Minimal
Human presence in the water			
Dogs under close control-occasional	Minimal	Minimal	Minimal
Dogs under close control-frequent	Moderate	Significant	Moderate
Dogs running free-occasional	Moderate	Moderate	Moderate
Dogs running free-frequent	Significant	Significant	Significant
Human presence in the air	Minimal	Moderate	Minimal

There is no evidence that disturbance is having anything but a localised impact on species numbers and distribution at the Endrick Mouth. The species occur largely along the shore edge between Crom Mhin and Net Bay and inland through the marshes and on Wards Pond. They are susceptible to human presence and will fly up when approached to within approximately 100-150m, usually flying round to relocate nearby. Infrequent disturbance therefore has little impact and this probably also applies to occasional overflying by micro-lights and other low-flying aircraft. However, the regular presence of anglers at Crom Mhin does lead to an absence of species, e.g.

grazing wigeon, in the immediate location. The wider impacts of disturbance would become significant only if access, and particularly by out-of-control dogs, become more frequent. Currently there is little pedestrian access into the marshes and shoreline most frequented by these species.

3.9.5 Conclusions and Recommendations

The scientific literature suggests that, whilst wintering wildfowl may be subject to disturbance when feeding or roosting, it is difficult to assess the consequences of any behavioural responses. It is now felt that many previous estimates of impact have been overly pessimistic and that impacts are often minimised by wildfowl maximising resource use outwith disturbance times. Disturbance impacts are likely to be minimal and localised at Endrick Mouth currently. However, we recommend a modification to the current monitoring protocol to ensure any impacts are picked up timeously. This should include recording all recreational activity beyond Crom Mhin (i.e. into the marshes/down the Endrick and along the shore at Net Bay) whether disturbance happens or not and recording time spent in the field so that future analysis can measure change against monitoring effort. These changes are incorporated within the revised monitoring protocol developed for the Endrick Mouth area (see Annex 3).

3.9.6 Monitoring Recommendations:

MO-12 Continue monthly waterfowl counts

MO-13 Implement the revised monitoring protocol for Endrick Mouth area to monitor and record all disturbance events and impacts to waterfowl during routine weekly visits and bird counts

3.9.7 Management Recommendations:

MA-9 Liaise with National Park Access Officer to ensure no formal access development is undertaken beyond from the Balmaha area onto the NNR at and beyond Crom Mhin. Similarly ensure no formal access development beyond the end of the existing, formally improved and managed Shore Wood Path at the Net Bay Viewpoint.

3.9.8 Potential impacts on Greenland white-fronted geese from recreational activities at Endrick Mouth

Table 18: Potential recreational impacts on Greenland white-fronted geese

	Period		
Activity	**Impact at feeding**	**Impact at roosting**	**Impacts at other periods**
Human presence – geographically close - occasional	Moderate	Minimal	Minimal
Human presence – geographically close - frequent	Significant	Moderate	Moderate
Human presence – geographically distant – occasional	Minimal	Minimal	Minimal
Human presence – geographically distant - frequent	Moderate	Minimal	Minimal
Human presence on the water	None	None	None
Human presence in the air	Significant	Moderate	Minimal
Dogs under close control (occasional)	Moderate	Minimal	Minimal
Dogs under close control (frequent)	Moderate	Moderate	Moderate
Dogs running free (occasional)	Moderate	Significant	Moderate
Dogs running free (frequent)	Significant	Significant	Significant

There is no evidence that disturbance is currently having any significant impact on the white-fronted geese population at Endrick Mouth. The main roost site at Wards Pond is next to a private road to Woodend cottage which appears to be used regularly by locals for dog-walking. The resident at Woodend also drives down this road with full head lights on as well as having an un-shaded light outside the cottage at dusk. However, this does not appear to interfere with incoming roosting geese (including pink footed geese that have been recorded settling close to the cottage). Recreational use may increase significantly if the gate, sign and padlock were to be removed from the bridge over the river at Woodend – the path network on the other bank is heavily used by horse-riders as well as dog-walkers. The LLTNPA's access officer confirmed that there are currently no plans to "open up" this route owing to the difficult road junction on the Balloch road.

SNH is developing proposals for new facilities for wildlife watching at this site – any such developments will need to take account of the potential for disturbing birds at this key roost site.

Disturbance at the feeding grounds is minimal and agricultural in origin. The only recreational disturbance might arise from the informal path around the Aber Bog and the viewpoint beyond the end of the formal Shore Wood path. This could be closed in winter – it is currently very wet and uninviting to walkers.

Over-flying by micro-lights, helicopters and all sizes of planes causes alarm and disturbance to geese flocks elsewhere – for example, as observed by members of the project team whilst working at Aberlady Bay Local Nature Reserve in East Lothian. Currently this is an infrequent cause of

disturbance at Endrick Mouth, though there has been a recent incident of power paragliding activity over the reserve and this clearly has the potential to become more significant.

3.9.9 Conclusions and recommendations

The scientific literature indicates that wintering geese may be subject to disturbance whilst feeding or roosting, resulting principally in displacement from preferred areas. Recreational disturbance to Greenland white-fronts at the Endrick Mouth is believed to be low level and any impact is probably localised and small. However, in order to ensure that any impacts are identified as soon as possible, we would recommend a number of changes to the monitoring regime at this site. These should include ensuring complete coverage of the relevant area by plotting roosting sites from Duncryne ahead of monthly goose counts. It should also include recording all recreational activity beyond Crom Mhin (i.e. into the marshes/down the Endrick and along the shore at Net Bay) whether disturbance happens or not and recording time spent in the field so that future analysis can measure change against monitoring effort.

3.9.10 Monitoring recommendations:

MO-14 Continue national goose survey counts; ensure complete coverage by plotting roosting sites from Duncryne ahead of monthly counts

MO-15 Monitor and record all disturbance events and impacts during counts and other routine work; record time spent in the field so that future analysis can measure change against monitoring effort

3.9.11 Management recommendations:

MA-10 Liaise with National Park Access Officer regarding any future change in access provision

MA-11 Ensure any developments at Wards Pond do not lead to increased disturbance

3.10 Aquatic macrophytes

3.10.1 What are the 'characteristics' of the species / habitat?

Aquatic macrophytes are large (i.e. visible to the naked eye) rooted plants found in the littoral zone of aquatic systems. They are usually divided into three categories:

- Submerged – growing beneath the water surface e.g. pondweeds (*Potamogeton* sp)
- Floating leaved – mostly growing beneath the surface but with leaves that float on the surface e.g. water lilies
- Emergent – rooted beneath the surface but with much of the plant growing above the water e.g. rushes such as *Juncus effusis*

They are often highly sensitive to changes in water chemistry and within Scotland a number of species have been lost from loch and river waters, often as a result of eutrophication (nutrient enrichment).

3.10.2 Aquatic macrophytes in Loch Lomond

Within Loch Lomond, aquatic macrophyte growth was estimated to cover about 1% of the loch's total surface area (Murphy et al, 1994). Vegetation is excluded from some areas due to the substrate type and as a result of natural wave action in exposed areas. However, in more sheltered areas there are a range of wetland plant communities which included submerged, floating-leaved and emergent macrophytes. Vegetation growth is limited by light penetration at certain depths – estimated to be about 4.5m in Loch Lomond by Idle in 1979 (in Murphy *et al* 1994) and as much as 6-9 metres by Mitchell (2001). The vegetation is considered to be similar to that occurring in oligotrophic – mesotrophic lakes in Scandinavia. Loch Lomond supports a range of plant communities along gradients between oligotropic and eutrophic conditions and between deep water through to alluvial woodland. (Murphy *et al*, 1994). The Loch Lomond Ramsar site is designated in part because the loch supports a number of rare and endangered plant species as well as having high species diversity. Since the 1970s *Elodea canadensis* (Canadian pondweed) has invaded the loch and is now extensive, particularly in the deeper waters.

In common with all aquatic vegetation, the community of macrophytes found within Loch Lomond is likely to change in response to changing water chemistry. In particular, increasing nutrient levels in the water can limit species diversity and may allow algal blooms to develop which can be a threat to submerged macrophyte growth.

The Scottish Environment Protection Agency's (SEPA) Water Framework Directive classification for 2008 classified the macrophytes within the south basin of the loch at moderate status. The 2008 data showed that the number of taxa found and the numbers of functional groups were lower than would be expected in this type of loch. Algae and invasive species (*Elodea canadensis*) also lowered the classification. SEPA have attributed this to pressure from elevated phosphorous levels, partly as a result of sewage inputs. Measures are expected to be put in place to tackle these issues and therefore the classification of the loch is predicted to improve in the future.

3.10.3 Are aquatic macrophytes sensitive to disturbance by recreation and how has that sensitivity been measured?

Macrophytes are sensitive to recreational disturbance through direct physical action (contact with boat propellers or trampling) and through indirect impacts (increases in water turbidity and wave action from boat wash). Direct physical action can result in the entire plant being uprooted, or shorter sections of stem being pulled off. Changes in turbidity can cause light levels to drop,

which has an impact on the growth of submerged vegetation, whilst wave action can cause erosion of substrates, reducing plant stability and growth, and potentially also increasing water turbidity. There is also potential for boat traffic to bring in introduced species, although this may be less likely in Loch Lomond as many loch users will only use their boats on Loch Lomond and don't transfer them elsewhere.

Mosisch and Arthington (1998) reviewed recent literature on freshwater ecosystems and power boating and highlighted the lack of relevant research done in British waters, especially on lakes. More recent information has been summarised in an ecotourism book by Mosisch and Arthington (2004).

Impacts of physical action

Outside the UK, direct physical action of boat propellers was measured through exclusion plots of mesh fencing by Asplund and Cook (1997) in Wisconsin. They found that excluding motor boats from the plots significantly increased macrophyte biomass, coverage, and shoot height compared to adjacent areas. They found that plant canopy height was reduced by between 20-50cm due to boat activity, although it is unclear whether this is due to direct cutting by propellers or as a result of stunted growth.

Murphy and Eaton (1983) highlighted the loss of floating leaf canopies of yellow water-lily (*Nuphar lutea*) and arrowhead (*Sagittarias agittifolia*) from the centre of canal channels, probably because propeller action had broken up the leaves and stems. They suggest that floating leaved plants have a greater vulnerability to propeller damage, putting them at a competitive disadvantage. They also found that abundance and biomass of submerged macrophytes were negatively correlated with boat traffic, particularly at high levels of traffic (greater than 2000 boat passes per year), but associated this mainly with turbidity.

Different mooring systems can also cause physical damage to the loch bed immediately around them. For example, Ostendorp et al (2008) showed that conventional moorings with an anchor chain and buoy have a swinging circle of $87m^2$, where they found the vegetation free area had increased by 122% compared to reference sites and phytomass was reduced by 14.6%. Physical damage can be reduced by using different styles of mooring, such as the hook-buoy type.

Impacts of wave action

Tivy (1979) considered that wind-generated waves were the most important factor in shoreline erosion in Loch Lomond. However, wave action at the shoreline can potentially be increased by boat traffic. The mean wave height on the loch has been estimated as around 11cm (Pierce 1997 in NES, 2005) and around 8cm (Pierce, 2004) so waves from boats that are less than 11cm in height are unlikely to cause additional erosion (NES, 2005). The Coastal Engineering Manual estimates that a 7 metre long cabin cruiser travelling at approximately 11 km/h (7 mph) would create a wave of 20 cm height at 30 metres distance from the vessel and 10cm height at 150 metres distance (cited in Murphy et al, 2006). Interestingly, Hodges (1991) noted that power boats, due to their design, create very few waves when operating at speed (e.g. when towing a water skier) - because they are planing on the surface of the water. Larger slower craft, such as pleasure cruisers and ferries, plough through the water and usually create larger waves, which have a greater risk of eroding banks and associated vegetation, including aquatics in the shallower shoreline waters. However, such erosion processes are highly complex and the various reviews suggest contradictory evidence as to the impact of vessels on vegetation.

Jupp & Spence (1977) tried protecting plants at Loch Leven from wave action with the use of Perspex tubes and found an increase in biomass. They attributed 80% of the end-of-season

biomass differences to effects of wave action (but note that this is natural wave action, not waves from boats). They also highlighted that wave action can alter the sediment accumulations in different areas of a loch with consequent variations in nutrient availability. In the case of Loch Leven, wave action resulted in a fine clay sediment with higher nutrient levels accumulating on the north shore, whilst only sandy, nutrient poor sediments accumulated on the east shore.

Aspland and Cook (1997) also highlight the effects of continual scouring and shifting of sediments by boats, which they suggest can reduce colonisation and early summer survival of some plants. They suggest that temporary boating restrictions during the early summer period may increase establishment success for some plants.

Turbidity impacts

There appears to be conflicting evidence for the impacts of turbidity on submerged plants. Aspland and Cook (1997) also created some exclosures with solid plastic to avoid increases in turbidity from boat traffic, but found macrophyte growth wasn't significantly affected. In contrast, Murphy and Eaton (1983) considered that the reduction in macrophyte growth with high boat traffic is due to increased turbidity. Eriksson *et al* (2004) also found that the presence of species sensitive to poor light conditions was negatively correlated with the presence of marinas, whilst those species that thrived in nutrient rich turbid habitats were positively correlated with marinas.

Trampling / erosion

Walking, dragging boats and grazing can all potentially reduce the stability of the shoreline substrate. This directly removes vegetation which makes the shoreline more susceptible to subsequent erosion by wave action. So 'natural' erosion from wind generated wave action can be increased through recreational activities such as trampling and boat launching.

Tivy (1979) highlighted how abrasion or scouring can result from the informal launching and beaching of boats. The effects can make a break in emergent vegetation or create a small 'embayment' which tends to be reused for beaching and for picnicking. These areas are also more susceptible to wave erosion as loose material is moved up and down the bare area.

3.10.4 Potential impacts on these species from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarise above, the professional knowledge of the project team and the potential activities identified for the study area, the impacts shown in Table 19 could potentially affect this group of species.

Table 19: Potential recreational impacts on aquatic macrophytes

Activity	Submerged macrophytes	Floating-leaved macrophytes	Emergent macrophytes
Human presence – geographically close – frequent	Minimal	Minimal	Moderate
Human presence on the water	Moderate	Significant	Moderate

Potential impacts on the aquatic macrophytes within the study area are the result of a variety of factors. These factors are considered in more detail below:

Shoreline erosion

As highlighted above, there is potential for emergent vegetation to be impacted by shoreline erosion. It should be remembered that shoreline erosion is a natural feature of a dynamic loch situation and that areas of both erosion and deposition should be expected. Shoreline erosion could potentially be caused by wind generated waves; by fluctuations in water level; by physical abrasion (for example from human and livestock trampling) and by waves generated by boat passage.

According to Pierce (2004) the frequency of waves within the loch is relatively high when compared to marine coasts, with crests typically occurring every 0.6 to 1.8 seconds. Variations in wave height and frequency will also occur as a result of changes in wind conditions within the loch, particularly as lakes generally show a quick wave response to increased wind speeds.

Fluctuations in water level can also contribute to shoreline erosion and may cause more susceptible areas to be exposed to, or removed from, the erosive power of the waves. The water level within Loch Lomond has been monitored by SEPA at their Ross Priory monitoring station and shows that levels have varied between 7.39m and 10.37m in the last five years (Dec 04 – Dec 09). Fluctuations from day to day can be as high as 20 to 40cm, although are more usually between 1-10cm.

Given the frequency and size of wind-driven waves within Loch Lomond, it is unlikely that waves from boat wash are a significant contributor to shoreline erosion. A boat travelling within the study area at approximately 11km/h could be expected to produce a wave which will be of a comparable height to the average wave, although the size declines rapidly with distance from the boat. However, the number of boat produced waves is likely to be far outnumbered by the number of wind driven waves and only some of these boat passes will be close enough to the shoreline for the boat-generated wave to reach the shoreline at a significant height.

It is therefore reasonable to assume that, given the frequency of wind driven waves; the extent of shoreline submerged and exposed by fluctuations in water level; the current densities of boat traffic within the study area and the distance from the shoreline of many of these boats, boat-generated waves are not a significant component of any wave erosion. This is also the conclusion that Pierce reaches in her 2004 study, where she states that “numbers (of boat wakes) were so small as to be negligible in the context of the wave records.”

The only part of the study area where this may not be the case is within the Narrows, where boat passes are likely to be more frequent and where many boats will be passing close to the shoreline. It is therefore considered important to monitor shoreline erosion within this area in the future and this was included within the monitoring protocol designed as part of this project (see section 2.4.4).

Physical abrasion and trampling of shoreline vegetation is also a potential impact as a consequence of recreational activity. This type of damage is frequently seen in river systems where livestock enter the water to drink. During the on-island survey, the shoreline of congregation zones was examined to see if this type of damage could be seen. In general, there was limited evidence of any abrasion and trampling, from either humans or boats. This is probably due to the sediment types which are present in these areas – most congregation zones are close to a beach and any shoreline recreational activity tends to take place where there are sand and gravel sediments. As highlighted by Murphy *et al* (1994) these sediment types are a rather poor habitat for emergent plant growth and are often completely bare. Areas with more luxuriant growth tend to be those with greater deposits of silt and mud, but these areas are generally less attractive for recreational activities – people don’t want to paddle in mud. However,

it is considered important to continue to monitor this potential impact, and hence the congregation zone survey method includes the measurement of a vegetated shoreline parameter.

Impacts on submerged and floating leaved vegetation

Other researchers have recorded the potential recreational impacts of turbidity on submerged aquatic vegetation and direct physical action (cutting and damage by boat propellers) on floating-leaved vegetation. Previous studies have made estimates of the volume of boat traffic which appears to reduce the total submerged macrophyte standing crop, with Murphy and Eaton (1983) suggesting a critical range of around 2000 - 4000 movements per hectare per metre depth per year. It is difficult to compare this directly with the Loch Lomond situation due to the variations in boat densities within the study area. However, if the area within the Narrows is considered and assumed to have an area of 34.8 hectares and an average depth of 1m (potentially a significant under-estimate), this would translate to a critical range of 69,600 boat movements per year, or around 460 movements per day for six months of the year. It is unlikely that this number of boat movements is currently experienced within the Narrows. It should also be remembered that studies such as that of Murphy and Eaton looked at canal water bodies, where natural water turbulence may be significantly less than that experienced in Loch Lomond. It is therefore unlikely that boat passes make as much difference to water turbidity except within very still areas of the loch.

Within the Narrows, several stands of white water-lily have been monitored by the National Park rangers since 2002. This monitoring has included measuring the size of the stands, as well as recording number of blooms in some years. The size of the stand has fluctuated over the years, but with records only collected for a maximum of eight years, it is not possible to discern any trends within the data. Number of blooms decreased dramatically in 2007, but appears to have returned to previous levels in 2008 and 2009.

Figure 27 shows the maximum area of two water lily stands – one (Stand A) located at Swing Bay adjacent to Inchtavannach and one located near boat stopping zone 14 adjacent to Inchconnachan. The maximum area of the stand has been calculated using the measurements recorded for the width and length of each stand – in reality the stand will not be a uniform square shape, but using a relative overall area rather than a single dimension avoid meaningless comparisons between different shaped stands. Also included in Figure 27 are the boat stopping figures for zone 14 for the same years. Although this doesn't provide a precise measure of the number of boats which will have passed directly through the water lily stand, it may give an indication of the relative levels of boat traffic within the area each year.

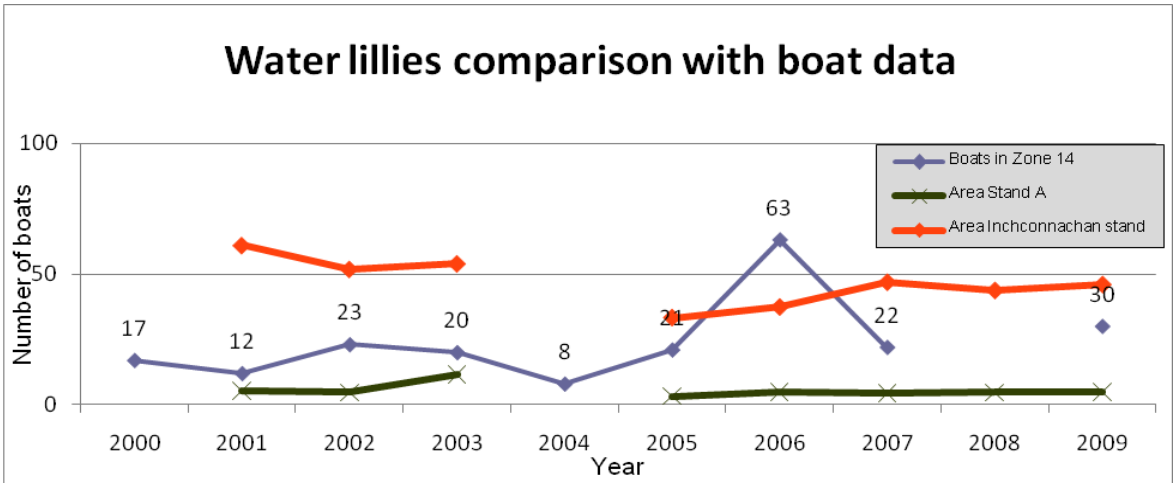


Figure 27 - Water lily stand sizes and boat numbers in adjacent zone

Based on this data, it is not possible to detect any obvious correlation between indicative boat traffic levels and the spatial extent of the water lily stands. This is partly due to the limited data availability – for example, the missing records from 2004 make it harder to evaluate the impact of high boat numbers in subsequent years. In order to allow more meaningful comparisons in the future, it is therefore recommended that LLTNPA rangers should continue to collect data on the size of the water lily stands on an annual basis. However, it is also recommended that only information on the size of the stand is collected – in the past additional information on number of blooms and petals has also been collected. Whilst this may provide interesting information, it is unlikely that the data can be analysed in any meaningful way – these physiological functions could be affected by a wide range of other parameters (e.g. water chemistry, water temperature, sunlight hours, thermal time etc). Unless data are also collected on these other parameters, it is questionable whether collecting additional data is a worthwhile use of staff time. Collecting basic data on stand size will enable further comparisons to be made with boat traffic with minimal resources. In order to reduce resource requirements, we would suggest that only two stands need to be measured – ideally those located in the bays at zone 13 and 14 as these are closest to the boat stopping survey zone and most likely to get through traffic.

Given the current level of boat traffic and the lack of any significant trends in the size of the exposed stands of white water-lily, it appears that impacts on submerged and floating leaved macrophytes are currently minimal. However, it is possible that macrophyte community composition is changing as a result of recreational pressures. For example, if boat traffic in areas such as the Narrows is affecting water turbidity, there may be an increase in floating leaved plants at the expense of submerged plants. Without a full species survey, repeated at regular intervals, it is not possible to establish whether or not this is occurring. Even with such data, it will be difficult, if not impossible, to establish whether or not species changes are a result of recreational activities or other factors, most notably increasing nutrient levels in the water.

As SEPA are required to monitor macrophytes within Loch Lomond as part of the Water Framework Directive (WFD), it is not considered necessary to undertake additional monitoring. However, it is recommended that LLTNPA ensure they receive copies of the macrophyte data which is collected. Should the expected improvement in classification not occur, despite the introduction of measures to reduce phosphorous levels in the loch water, further monitoring and consideration of the potential impacts of turbidity should be undertaken. An early step in this consideration should be to establish whether or not boat traffic results in any increase in turbidity levels, which may be high anyway due to wind turbulence.

3.10.5 Monitoring recommendations:

MO-16 ***Implement the monitoring protocol as specified at the congregation zones to include measurement of shoreline vegetation along with the use of fixed point photography to record any significant changes.***

MO-17 ***Monitor the size (width and length and then calculate potential maximum area) for the water lily stands in zones 13 and 14 on an annual basis.***

MO-18 ***Ensure that SEPA's macrophyte classification data is collated within the central data repository for the loch.***

3.11 Atlantic oakwoods / wet woodlands

3.11.1 What are the 'characteristics' of the species / habitat?

Atlantic oakwoods are remnants of the forest which once spread throughout Europe's Atlantic fringe where the relatively warm and damp climate results in moist, humid woodlands with a significant bryophyte cover.

3.11.2 Atlantic oakwoods / wet woodlands in Loch Lomond

The Loch Lomond Woods Special Area for Conservation (SAC) is of European importance for its Atlantic oakwoods - it includes the mainland oakwoods adjacent to the loch along with some of the islands. Pedunculate oak, rather than sessile oak, is locally abundant, and in places the oak stands are replaced by ash-elm stands or by alder at wet sites, notably by the loch edge. In addition the bryophyte communities are likely to be of high conservation value.

Upland oakwood is a UK Priority Habitat and the Loch Lomond Woods SAC is one of three sites representing the Annex 1 habitat 91A0 - old sessile oak woods with *Ilex* and *Blechnum* - in the most bryophyte-rich zone in the UK, the south-west Highlands.

The oakwoods of the park form one of the largest areas of semi-natural woodlands in Britain and were designated as an SAC not only for their exceptionally diverse and extensive area of Western acidic oakwoods but also for the otter populations that have holts in woodlands adjacent to the loch. As a result, many of the woods are under conservation management because they form a rare habitat that supports many unusual, rare or endangered animal and plant species.

The Loch Lomond Woods SAC is 1454 ha in area and comprises the following SSSIs:

- Conic Hill (61.5 ha)*
- Craigrostan Woods (94.5 ha)
- Endrick Mouth and Islands (451.1 ha)*
- Glen Falloch Woods (88.4 ha)
- Glen Loin (67.5 ha)*
- Inchlonaig (74.8 ha)*
- Inchtavannach & Inchconnachan (104.3 ha)*
- Pollochro Woods (307.2 ha)
- Rowardennan Woodlands (505.6 ha)
- West Lochlomondside Woodlands (504.4 ha)*

Notes:

a. Only part of the asterisked SSSIs have SAC status.

b. The island SSSIs of Inchmoan and Inchcruin were designated for their blanket bog and capercaillie population respectively and therefore are not part of the SAC per se*. However, both sites have woodland habitat that is subject to pressure from visitors and so they are included in this section of the report.*

The ancient woodland sites, which have had woodland cover for at least 250 years, are the richest woodland habitats but they form only 8.5% of the woodland cover of the National Park.

Of these ancient woodland sites, the island of Inchlonaig is notable because of its large area of ancient oak woodland, within which there are approximately 800 - 900 mature yew trees representing the largest yew wood known in Scotland. Like many woodlands in Scotland, deer appear to be an important factor in limiting woodland regeneration, except here the culprit is fallow deer rather than the red deer and domestic herbivores found elsewhere. Nevertheless, it is

important to note that regeneration of oak trees here and elsewhere is also strongly inhibited by heavy shade from the closed canopies of trees, under-storey plants (e.g. rhododendron) or, in more open areas, bracken.

Information supplied by SNH for Habitat Condition Monitoring carried out in 2005 concluded that the 'Endrick Mouth and Islands' SSSI was the only SSSI in the Loch Lomond Woods SAC that was in favourable overall condition, although this too had declined to unfavourable status by 2008 due to the negative impacts of deer grazing.

3.11.3 Are oakwoods sensitive to disturbance by recreation and how has that sensitivity been measured?

Most of the published information about human impacts on oak woodlands refers to American habitats (including the control of invasion of grazing land by oak species) and cork oak in Europe. There is very little information on the sensitivity to visitor impacts of the ground flora or the canopy species in British Atlantic oak woodlands. In terms of the trees themselves, most of the Scottish oak woods have been historically managed by coppicing. This indicates the considerable resilience of oak -and associated species such as alder and, to a lesser degree, birch - to physical damage (e.g. by visitors cutting or breaking off branches).

Regeneration of woodland is strongly – and negatively - influenced by the amount of canopy cover, whether of the trees themselves or of under storey species such as bramble (*Rubus fruticosus*) and bracken (*Pteridium aquilinum*) (Harmer & Morgan, 2007; Palmer et al., 2004). Reduction of canopy cover usually promotes regeneration, counterbalanced to a degree by herbivore browsing, and so the removal of some branches, or whole trees, could actually be beneficial (although clearly visitors should not be encouraged to undertake the latter!). The wounds caused by cutting and / or hacking of branches may leave the trees susceptible to attack from fungi.

Also of possible concern is Sudden Oak Death - a disease caused by the fungus-like pathogens *Phytophthora ramorum* and *P.kernoviae* – although sessile and pedunculate oaks seem to be fairly resistant. Outbreaks have been associated with rhododendron plants, especially from garden centres and nurseries. Spread of these *Phytophthora* species is favoured by wet or humid conditions but each species is also capable of producing a long-lived resting structure which can contaminate soil, and can be spread around on boots, vehicle tyres and the feet of animals (Royal Horticultural Society website, 2009). In Loch Lomond the potential risk, though apparently small, is exacerbated by its proximity to large populations and several garden centres and the widespread presence of *Rhododendron ponticum* in or near the woodlands.

Other risks from visitors include the accidental introduction of alien species, especially along paths and well-used informal routes (Torn *et al*, 2009) and at landing sites. In the Loch Lomond area, these may include non-native species (e.g. pirri-pirri burr (*Acaena novae-zealandiae)* now found alongside some Forestry Commission trails in the Trossachs) as well as species that are native to the area but alien to the woodland habitat (e.g. some agricultural weeds). However, formal monitoring for alien species on and around trails could be resource-intensive and involve transects every 100m or so (Yu-Fai Leunga and Marion,1999).

The important bryophyte communities, both epiphytic (i.e. with no roots in the soil) and terricolous (i.e. with roots in the soil), are usually highly sensitive to nutrient levels (e.g. increases due to urination, defecation and ash from fires), air quality (e.g. wood smoke, even if low temperature) and, to a lesser degree, trampling. Clearly high temperature fires can be fatal, as can felling or lopping of the timber on which epiphytic bryophytes are present.

3.11.4 Potential impacts on these species from recreational activities in Loch Lomond

Based on the information collected in the literature review and summarised above, the professional knowledge of the project team and the activities identified for the study area, the impacts shown in Table 20 could affect the woodland habitat.

Table 20: Potential recreational impacts on woodland

Activity	Trees	Ground vegetation
Human presence – geographically close - frequent	No impact	Minimal impact from trampling damage; slight possibility of long-term impact from accidental introduction of seeds of alien species
Fires	Light overall impact from damage if fires lit close to individual trees. Potentially significant impact if fires escape into woodland	Localised death of plants. Potentially catastrophic impact if fires escape.
Wood cutting	Minimal impact from cutting branches. Moderate impact from felling trees capable of coppice regeneration (e.g. oak, alder).	None
Foraging for wood	Minimal overall impact but severe localised impact for saproxylic fungi, insects etc. (i.e. those associated with dead wood)	Minimal impact due to dragging of timber - conversely this can create niches for plant establishment
Exploring off path / stravaiging	Not sensitive	Minimal impact except where new paths develop
Overnight camping	Not sensitive	Potential local impact of eutrophication due to associated latrines

All of the Loch Lomond woodlands are susceptible, to some degree, to the impacts of visitors. However, islands are particularly attractive to visitors and, although there may be fewer visitors than at some sites on the mainland, their impacts are likely to be concentrated because of the limited number of places that can be accessed from boats. People also tend to be attracted to beaches and open grassland areas, especially for camping, which concentrates impacts further.

For this section of the report, it was agreed that Inchlonaig should be excluded because there are very few landing sites and the difficult topography means that tree cutting cannot be recorded accurately. Inchcailloch is also excluded as it is closely managed by SNH and so impacts there are likely to be atypical of impacts more generally. Consequently the information given here refers to the impact of visitors on woodlands on the Luss islands of Inchtavannach, Inchconnachan, Inchmoan and Inchcruin. The total area of these islands is about 180 hectares of which nearly 80% has been ascribed to a National Vegetation Classification (NVC) woodland class, or woodland mosaic, in previous surveys for SNH. The key broadleaf classes present are shown in Table 21.

Note that class W4a was present only as the primary component of mosaics, either with W4b or W17b as the secondary component, and these mosaics were present in almost equal amounts.

Table 21: NVC woodland classes present in study area (data supplied by SNH)

NVC class	Sub-community
W4	*Betula pubescens – Molinia caerulea* woodland
W4a	*Dryopteris dilatata - Rubus fruticosus* sub-community
W4b	*Juncus effusus* sub-community
W4c	*Sphagnum* sub-community
W11	*Quercus petraea - Betula pubescens - Oxalis acetosella*
W11a	*Dryopteris dilatata* sub-community
W11b	*Blechnum spicant* sub-community
W11c	*Anemone nemorosa* sub-community
W17	*Quercus petraea – Betula pubescens –Dicranum majus* woodland
W17b	Typical sub-community

The commonest type of woodland in the study area was W17b which, as a class, was confined to Inchtavannach and Inchconnachan where it was by far the dominant woodland type; other classes present on these islands were, respectively, relatively small areas of W4b and W11b. However, W17b was also the subsidiary component of mosaics with W4a woodland that constituted about one-third of the woodlands on Inchcruin. Elsewhere on Inchcruin, W11a predominated with a relatively small area of W4c as the only other woodland type. Mosaics of W4a and W4b made up approximately one-third of the woodlands on Inchmoan, where non-mosaic W4b and W4c were present in amounts similar to the other types of woodland.

According to the various accounts of woodlands adjacent to Loch Lomond, many were managed as coppice woodland, some as late as the early 1900s and it is likely that the islands discussed here were managed similarly to some degree. Indeed, all the major species that occur now (oak, birch and, along the waterside and in wetter sites inland, alder) re-grow freely from stumps following felling.

Comprehensive data on the status of woodlands on all four islands was not available but, interestingly, Site Condition Monitoring (SCM) of the Inchtavannach & Inchconnachan SSSI in 2005 showed that a medium to high volume of dead wood was recorded for 45% of samples, compared to the SSSI target of 60% of samples. However, these figures are for the woodland as a whole and the figures for areas surrounding congregation zones are not known, although we would expect there to be less dead wood in these areas due to scavenging for fires.

Monitoring impacts

Woodland or woodland mosaics occupied just over 90% of the total area of congregation zones. The proportion of woodland in the different NVC classes in these zones is compared with the data for the islands as a whole in Table 22.

Table 22: Area (ha) of woodlands in Luss islands study area according to NVC surveys and overlays of impact zones on NVC areas

	SNH - NVC		CONGREGATION ZONES		
NVC sub-class	Area (ha)	% of total woodland area	Area (ha)	% of total congregation zone woodland area	Congregation zone area as % of NVC woodland area
W17b	91.6	66.0	4.5	42.3	4.9
W11a	12.0	8.7	0.9	8.5	7.5
W11b	2.0	1.4	0.7	6.3	33.5
W4a mosaics with W17b and W4b	18.0	13.0	2.6	24.5	14.4
W4b	8.9	6.4	2.0	18.4	22.1
W4c	6.2	4.5	0.0	0.0	0.0
Total woodland	**138.8**	100.0	**10.6**	100.0	**7.7**

These results show that the woodland in congregation zones constituted nearly 8% of the total woodland area on the islands, though it must be stressed that this does not necessarily mean that there had been visitor damage on trees across the whole of that area. It is notable, however, that one-third of the relatively small amount of W11b woodlands occurred in congregation zones, all on Inchconnachan. Similarly the proportion of W4b woodlands in congregation zones was about twice that of the islands as a whole. This is the commonest class where alder is a major component and the high proportion of this woodland in congregation zones reflects its occurrence along the shoreline and in wetter areas. Hence any damage to W11b and W4b woodlands in congregation zones would affect a disproportionately large proportion of these woodlands on the islands as a whole.

The on-island monitoring simply counted the number of damaged trees in a sample of the congregation zones and does not provide any measure of the proportion of woodland habitat that is affected. To quantify the *intensity* of damage within each zones, in terms of the proportion of stems/trees damaged, would require considerably more time than resources allowed, with significant resource implications for on-going monitoring.

It is notable that none of the sites had dead wood recorded as present, which is consistent with the collection of dead timber for firewood - but visitors appear to be far more determined than just collecting dead firewood and come equipped to do so. Damage appears to be severe in some places. The survey records for 2009 show up to 54 felled trees and another 132 damaged trees in just one zone.

3.11.5 Conclusions and recommendations

It is clear that considerable cutting and felling of live timber and collection of dead firewood is occurring in the congregation zones. However, it is a value judgement whether or not damage to 8% of the total area of woodland on the islands is tolerable, particularly given that it is impossible to quantify the extent of that damage as a proportion of the biomass. As highlighted above, this impact becomes more serious for species such as alder where a disproportionately high number of trees might be affected. This is partly an aesthetic issue because the alders tend to fringe the islands but is also a potentially major conservation issue because alders have an unusually high number of specific associations with some fungi and probably other lower plants and invertebrates as well. Whether or not such species are present in the Loch Lomond woodlands has not been thoroughly researched. In addition, alders – like other shoreline trees – have an important mechanical function because their roots help to stabilise the shore line and buffer it against wave action.

It could be argued that the felling and cutting of trees away from the shore is not a major issue because the woodlands may have been managed as coppice in the past, and some plant and insect species will benefit from the more open habitats. Indeed, felling can provide useful openings for woodland regeneration, helping to create a more uneven age structure. The report by NES (2005) considers felling to be of low impact in the Loch Lomond area generally and it seems unlikely that the use of dead wood for barbeques or campfires would result in a significant loss of dead wood habitat in the area as a whole. Nevertheless, the apparent levels of visitor impact suggest that any regeneration, either as seedlings or from coppice stumps, would be short-lived (it will always be easier for visitors to gather a lot of small tree stems/limbs than to deal with whole trees) and levels of seedling establishment are poor given current browsing levels.

The SCM assessments of 2005 indicated that the presence of dead wood across the islands generally is below the SSSI management targets. However, these are to some degree subjective targets and the volume of dead wood is rarely quantified. Within that context, the low frequency of dead wood in the congregation zones is unlikely to be a serious issue for the islands as a whole because the zones constitute only a small proportion of the total woodland area. As with the standing timber, dead wood in communities W4b and W11b might be disproportionately reduced but this is only likely to be important for the alder component of W11b. Even then the evidence suggests that species dependent on dead alder timber are less specific than those associated with the live trees.

It is important to remember that Western Atlantic woodlands also have high conservation value for their bryophyte communities. While information is relatively scarce about the effects of human impacts on these communities we would, as a general rule, expect them to be far more sensitive to impacts than the higher plants. For example, even low temperature smoke from a fire might damage or kill epiphytic bryophytes while high nutrient inputs from excrement - which might promote growth in higher plants - could kill terricolous bryophytes.

3.11.6 Management recommendations

It is not advisable to make blanket recommendations for the management of visitors and woodland in the congregation zones on the four islands because the zones vary widely in their context (geography, species composition, level of impact etc.). Decisions need to be made against a clear set of criteria for individual sites. The resultant management, if it is to be practicable, may well differ from that laid out for each SSSI as a whole and could involve some ‘hard engineering’. For example, it may be worth accepting that a few selected areas of woodland could be sacrificed as ‘honey pot’ sites to attract visitors away from the more sensitive areas. Action may then be taken to make ease of access to those sensitive areas more difficult, though this would be difficult in the

case of 'wild' camping by canoeists. Provision of a natural-looking hearth would help to reduce the risk of fires escaping and a (non-ostentatious) supply of timber from general woodland management may reduce cutting or scavenging of dead wood over a wider area. The management regime on Inchcailloch, with an area at Port Bawn zoned for camping, is an example of this type of management practice.

3.11.7 Monitoring recommendations

MO-19 ***The monitoring of tree cutting within the on-island survey should be implemented as recommended, despite the difficulties of obtaining absolute numbers.***

MO-20 ***If additional resources are available in the future, it would be useful to have some idea of the species of tree being felled or damaged. This could be relevant for example where pines or exotic conifers form part of the woodland and may be being targeted for their better burning qualities.***

MO-21 ***The importance of the loss of, or damage to, trees in congregation zones relative to an SSSI as a whole cannot be assessed without some idea of tree density in each zone. Although not part of the on-going monitoring work, consideration should be given to undertaking a one-off assessment of this would be useful, even if it was an indicative estimate (this could be an interesting project for senior school pupils or a volunteer group).***

4 Evaluation of SNH guidance on monitoring sensitive sites

The project brief also included a requirement to use and evaluate guidance produced by SNH entitled 'Monitoring access and recreation at sensitive natural heritage sites'. This document was produced in 2006 and aims to provide advice and practical guidance to help site managers plan and implement the survey / monitoring of access and recreation at sensitive sites.

The guidance sets out a series of steps which can be followed to establish a monitoring strategy for individual sites. The project team reviewed the guidance at the start and end of this project, to evaluate the extent to which it has been applicable during the development and implementation of monitoring activities. As part of this evaluation process, some members of the project team also met with staff at Loch Leven National Nature Reserve to discuss their use of the guidance. Loch Leven has been used as a published pilot for the guidance, so it was helpful to undertake further discussions with staff several years after the original pilot work was completed.

Our evaluation of the guidance is divided into three key areas:

- The extent to which the guidance is practical and easy to use
- The applicability of the guidance to the Loch Lomond situation, including areas of overlap and deviation between the guidance approach and that taken by the project team
- Recommendations for potential improvements to the guidance.

4.1 Use and practicality of the guidance

In general the guidance is well-written and easy to follow. It uses a logical step structure which enables a user to split the required work into 'bite-sized' chunks. The toolkit section provides a useful summary of the pros and cons of different approaches to monitoring which would be useful during the very early stages of preparing a monitoring strategy. Case studies are provided throughout the text, which help to illustrate some of the key points, although in some cases they are rather general and seem to lack detail. The fuller case studies provided at the end of the document are more useful and help to illustrate the range of approaches which can be taken.

The guidance is pragmatic in recognising the limits of research and acknowledging that definite causal relationships between recreational disturbance and wildlife impacts may be very difficult, if not impossible to demonstrate. It recognises the potential resource limitations which are likely to be affecting site managers and accepts that all that may be needed is sufficient data to demonstrate trends and reasonable likelihood of effects. The project team felt that this was an important point which should be emphasised – it would be easy to devote many hours and significant financial resources to complex academic research, which may never be able to provide a statistically valid, unequivocal answer.

The guidance is only available in a web-based format and is separated into several different sections. This makes it difficult to access and somewhat cumbersome to download for future reference – it cannot be saved and accessed offline for example because all the hyperlinks between sections are absolute rather than relative. Whilst the principle of avoiding excessive paper copies of documents is sound, it is considered important to ensure that an easily downloadable PDF version of documents is available. A limited print run may also be useful for those site managers who need to refer to the document on an on-going basis or away from computer access.

4.2 Applicability of the guidance to the Loch Lomond situation

The guidance was used as a starting point for the work undertaken within this project. There are several areas where the project team followed the approach set out within the guidance, but other areas where it was necessary to modify the approach to fit the particular circumstances of this study.

The initial steps set out within the guidance include screening, background and developing objectives. To some extent these steps were undertaken by the client during the preparation of the project brief and therefore the project team had no involvement. However, in reviewing these sections of the guidance, we would question the value of preparing extensive background information on the site. In common with many site management plans, it is easy to get side-tracked into producing significant amounts of background information on a site, which may not assist greatly with the development of a monitoring protocol. We would therefore suggest that the guidance could be modified to reduce the emphasis given to the preparation of site background material.

In contrast, we would suggest that further emphasis is given to the need to review existing data sources. This has proved a time-consuming element of this project and it is difficult to be confident that all relevant data has been sourced. This may be a result of the large number of stakeholders involved in the Loch Lomond study area, but it is an important consideration during the initial stages of a project and would therefore benefit from a significant allocation of time at the outset. It would also be useful to include the need to evaluate some data sources at an early stage – in some cases we were able to source raw data but needed to analyse that data before we were able to establish whether it would be useful in this study. It is also important to ensure that good quality meta-data are associated and maintained with data sources, as this can assist with analysis and interpretation.

Equally, we would also suggest that additional emphasis should be given to the search for information on species sensitivity. To some extent this is rather 'glossed over' within the guidance and almost implies that this information is readily available. In contrast, finding relevant research for this study required a substantial amount of time and research. In many cases information on species sensitivity is simply not available and it would be useful to highlight this difficulty at an early stage in this guidance.

We would also suggest that the identification of issues and objectives should perhaps come at an early stage in the guidance. To some extent the objectives will guide the type of background work which is required and without a clear objective at an early stage it will be easy to gather irrelevant background information whilst missing vitally important background data. We would therefore recommend a re-ordering of the first three steps within the guidance, so that the identification of issues and objectives takes place at an earlier stage. This is the approach that was taken by the project team within this study, with the objectives guiding the type of background research undertaken.

Within this study, the project team followed a process similar to steps four and five of this guidance, with the preparation of a monitoring protocol, the collection and then subsequent analysis of data. The guidance usefully highlights the potential for staff and volunteers to take part in monitoring actions, which is important in engendering buy-in to the process. However, additional emphasis could be given to the need to collect data over longer time periods – in the majority of cases data will need to be collected for at least one year and probably longer.

The guidance makes some references to the importance of involving wider stakeholders, but it doesn't appear to include a reference to the importance of sharing data, although it does provide guidance on potential data storage approaches. We believe this is an omission and that any monitoring protocol should include not just data storage, but also information on a designated 'responsible person' who will manage that data and a process for ensuring the data is available for other stakeholders to use, and clear guidance relating to confidentiality issues with certain aspects of the data. In this way data can have 'added value' and there is a greater likelihood of data overlaps and gaps being spotted.

The final stage of step four within the guidance is to assess significance – this appears to be a crucial stage which is given relatively little emphasis. Within this study, assessing the significance of data has been a large part of the process, which has required input from all members of the team. This is also the element of a monitoring protocol which has the greatest potential to appear as a 'black box' and therefore clearer and more detailed guidance would be helpful. We recognise that the guidance is generic in nature and therefore cannot provide specific detail, but it is important that appropriate analysis of the collected data is not neglected.

4.3 Recommendations for improvement of the SNH guidance.

Based on our experience using this guidance during the development of this project, we would therefore make the following recommendations:

MA-12 ***Additional guidance should be prepared on the difficulty of sourcing information on species sensitivity – this could potentially include a list of likely sources. To some extent this is highlighted in the literature review, but not all site managers will read the full literature review and therefore this point may be missed.***

MA-13 ***An easily downloadable pdf version or hard copy of the guidance should be produced.***

MA-14 ***Emphasis on the preparation of site background information should be reduced, whilst emphasis on reviewing existing data sources should be increased.***

MA-15 ***The identification of issues and objectives should be placed at an earlier stage in the guidance.***

MA-16 ***Additional guidance should be prepared on the importance of collating and sharing data.***

MA-17 ***Additional emphasis should be given to the process of data analysis, with some pointers given to potential methods that can be used.***

5 Resource implications

This report contains information on the activities undertaken as part of this project. The timescale for this project was from December 2008 to April 2010, but, in many cases, data will need to be gathered and analysed over a much longer time period in order to identify long term trends. The monitoring protocol, as set out in section 2.4, should enable LLTNPA and SNH to collect suitable data. However, this monitoring protocol will need to be implemented over a period of years, along with the recommendations outlined within this report. To assist with this process, this section contains an estimate of the likely resource implications of this work.

5.1 Implementation of the monitoring protocol – resource implications

The monitoring protocol and associated recommendations cover four main areas. The likely resource implications of implementing this protocol are outlined below:

Launch data from the public slipways at Balloch and Millarochy Bay

Each boat launch has a corresponding record as a 'launch slip' and this information can usefully be transferred to a spreadsheet as part of the launch process, including the amount of time they spend on the loch. This information can be used to provide a fuller picture of the use of the loch without additional data collection, simply by utilising the existing data more effectively. It is anticipated that analysing this data would take less than a day per year although it is not possible to estimate the additional amount of time required to input the data from the launch records. However, if there is no intention to analyse the data collected at present, it would be advisable to review whether this information should be collected in the first place. The data categories for boat type also need to be standardised with other surveys to avoid confusion.

Attitudinal / behavioural survey of visitors

These surveys take approximately ten minutes to complete with each visitor. Ideally, surveys should be completed with at least 380 visitors in a year, in order to allow meaningful conclusions to be drawn. Guidance published by SNH on visitor monitoring suggests that it is possible to complete up to 15 responses in a 6 hour shift of dedicated data collection. This equates to between 25 and 35 days of time over the summer season. However, this survey could be run using the staff allocated to providing visitor information at the slipways and should require relatively little additional staff resource except for approximately one day for data entry and collation (the staff interaction time would be a total of 63 hours for 380 x 10 minute interviews, but this overlaps with time already spent engaging with visitors to provide them with key messages). Analysis of the data is likely to take seven hours, therefore this element of the monitoring protocol requires approximately one day of additional staff time.

The quality of data depends greatly on the number of surveys completed and the surveys completed in 2009 had a limited benefit in terms of the richness of data available for analysis. The people who took part are not likely to form part of the 'irresponsible' segment of visitors and therefore the data may be misleading if used independently. It is therefore questionable as to whether face-to-face surveying on Loch Lomond is a cost-effective method of understanding the impacts of recreation. If repeated, it is considered only necessary to undertake this attitudinal survey every 5 years in the same year as the strategic on-island survey. However, if any other visitor surveys are being undertaken that collect data about visitor behaviour on the loch or islands, then would be an advantage to include questions that can be directly compared with this dataset.

Modifications to the existing boat-stopping survey

These modifications have been incorporated within the existing survey, therefore no additional time should be required for survey work. However, we would recommend that the modified boat-

stopping survey should be continued with the additional observations in the congregation zones Providing that the database is used for data collection it is possible to create charts of the results at the press of a button. Further analysis of the survey data can be expected to take, at most, a day of staff time per year.

MO-22 Continue the modified boat-stopping survey as per the original protocol and with the additional observations in the congregation zones

On-island monitoring of impacts in congregation zones

Each congregation zone takes approximately one hour to survey. Nine zones were selected for annual monitoring, therefore at least nine hours of staff time will need to be allocated to completing the survey. Additional time should also be allocated to moving between survey zones, so at least two days of staff time will be required for the survey. For health and safety reasons and to ensure robust data, it is suggested that at least two members of staff undertake the survey, therefore four days of staff time should be allocated to completing this survey per year. A further two days should be allocated to the analysis of the data, leading to a total time requirement of six days per year. The baseline survey of all zones should be repeated every five years and can be expected to take a further five staff days to complete.

MO-23 Undertake the baseline survey of zones every five years and the selected zone survey every year.

Monitoring of impacts within the Endrick Mouth area

Data collection for the Endrick Mouth area has been incorporated within the existing weekly site checks, therefore no additional time is required. However, it is also recommended that data collection should be expanded into the weekend, although it is envisaged that this could be part of the routine LLTNPA ranger patrols in the area and therefore would not require additional staff resources. However, ensuring that the data is correctly recorded and analysed will take approximately two staff days per year.

Total resource implications for all survey work in terms of staffing levels are therefore likely to be: six staff days for LLTNPA staff and two days for SNH staff per year. A further seven days of LLTNPA staff time will be required every five years to complete the baseline survey.

Additional resource requirements for the survey work are limited. A database and GIS project for storing the data has already been created, but time and costs may need to be allocated to upgrading this system if software packages are changed.

5.2 Data collation – resource implications

A recommendation within this report is the establishment of a data repository for Loch Lomond to ensure that useful information can be shared between all those with an interest in the loch. It is possible that the GIS established as part of this project could be used as a starting point for this process.

This recommendation is likely to involve an allocation of staff time, which is estimated to be approximately eight staff days to establish the repository and inform all relevant stakeholders. Thereafter it is likely to require an allocation of approximately three staff days per year to remind stakeholders to supply data and maintain data as required. Without this specific allocation of staff time, it is likely that this task will continue to be neglected, potentially destroying a valuable data resource.

5.3 Overall resource implications

Table 23 and Table 24 provide a summary of staff time inputs which are likely to be required for implementation of the monitoring proposed within this report.

Table 23: Staff time summary

Item	Organisation	Staff time	Frequency
Analyse slipway launch data	LLTNPA	<1 day	Annual
Attitudinal survey	LLTNPA	2 days	Every 5 years
Analysis of boat stopping survey data	LLTNPA	1 day	Every year
On-island survey	LLTNPA	6 days	Every year
Baseline island survey	LLTNPA	5 days	Every five years
Analysis of Endrick Mouth data	SNH	2 days	Every year
Set up data repository	LLTNPA	8 days	One off
Maintain data repository	LLTNPA	3 days	Every year

Table 24: Total staff time allocations

Organisation	Frequency	Number of days
LLTNPA	One off allocation	8 days
LLTNPA	Every five years	7 days
LLTNPA	Every year	13 days
SNH	Every year	2 days

6 Conclusions

This study took place over a sixteen month period and involved a number of stakeholders as well as the project team and board. As this report shows, the study involved a number of different actions and therefore it is considered appropriate to assess the conclusions and outcomes of the study in light of the original project objectives.

Objective 1 - To undertake survey and assessment work over a calendar year; and

Objective 2 - To establish a baseline and repeatable methodology for the long term monitoring of recreation impacts on the islands and NNR

Both these objectives relate to the requirement to gather data on recreational activities and resultant impacts on habitats and species within the study area. As highlighted earlier, and within the SNH guidance, the conclusive establishment of direct impacts on wildlife requires extensive resources. Instead, this study set out to establish the extent of recreational activities within the study area, the sensitivity of selected species and habitats to those (or similar) activities and therefore the likely impact on those species and habitats within the study area.

This work has involved the collation and analysis of a broad range of data, gathered from a number of sources. During this process, it has become clear that data relating to Loch Lomond are stored in a number of locations and that there is no current co-ordination or collation of that data. This makes it unlikely that recreational impacts will be identified on an on-going basis, unless data are collated, interpreted and compared on a regular basis.

In addition to the collation of existing data, this study has included the adaptation of several existing survey methods to include the collection of additional recreational data at minimal cost. These adapted surveys should be continued and should be considered to form part of the methodology for the long term monitoring of recreational impacts.

As well as the adaptation of existing surveys, this study has also produced a monitoring strategy to gather data on the extent and type of recreational activities within the study area. This monitoring approach has been reviewed and modified as required based on trialling in the field. A monitoring 'training manual' has been produced which provides step by step instructions in how to undertake these surveys (Annex 4). This has been supplied as one of the deliverables of this project and can be used in future years to ensure that data is gathered in a comparable manner.

In conclusion, this study has involved survey and assessment work which has collated existing data as well as collecting new information. Based on the analysis of that data, along with experience gathered during field trials of the monitoring method, it has been possible to produce a monitoring methodology which will enable LLTNPA and SNH to gather long-term datasets on recreational impacts without needing to bring in additional external advice.

In the course of this study it has become apparent that the boat team section of the ranger service has a number of conflicting priorities that may need to be resolved in order to implement the recreational monitoring protocols effectively. The ranger service appears to be under pressure to act as a recovery service for visitors who have boat problems. Providing a safety backup for visitors may be a valid operational objective, but it appears that the ranger service is being expected by the public to provide a free service more akin to a road rescue than mountain rescue.

It is also possible that the provision of this type of service encourages a particular 'mind-set' to develop when people enter the loch area. If people are not encouraged to be self-reliant they may

also begin to expect a certain level of 'back-up' in other aspects of their recreational activity. For example, they may feel that littering is not an issue as 'someone' will be there to pick up after them. By providing what is effectively a boat recovery and support service, the study area is at risk of becoming more of a 'country park' than a wilderness area.

We recognise that operational issues are beyond the scope of this contract, but the current situation also makes effective planning for recreational monitoring very difficult. At the extreme, it has the potential to impact on the National Park Authority's ability to meet this aspect of its obligations under the Scottish Biodiversity Duty and to contribute to its statutory purpose of conserving the natural heritage which includes the protection of designated habitats and species. This is clearly demonstrated by the decreasing data run from the boat-stopping survey since 2006 and a failure to produce results within the scope of the original methodology. Individual rangers should not, however, be blamed for this situation as it is likely that the difficulty of retaining long-term focus on specific tasks in the face of changing external demands and management priorities may have contributed to the current situation.

It is therefore recommended that any future review of the ranger service objectives and strategic planning should place recreational monitoring as a high priority, to enable the National Park Authority to maintain a sufficiently detailed picture of visitor behaviour and impacts which can be used to make evidence-based policy decisions. Practical benefit should also accrue to the ranger service, who will have an increased skill base and be able to provide factual basis to support or counter the anecdotal evidence of recreational impact.

Objective 3 - To assess the numbers and behaviour of visitors to the Loch Lomond islands and National Nature Reserve

A number of techniques have been used to assess the numbers and behaviour of visitors. These are outlined in section 2.4 of this report. In addition, analysis of existing data sets, such as the boat-stopping survey, has provided an indication of longer-term trends in visitor numbers at each of the islands. However, absolute measures of numbers are difficult to estimate with the data available.

Indirect measures of visitor behaviour have also been assessed. This has included the use of the on-island survey, where data has been gathered on the extent to which visitors are having fires, using latrines and cutting wood. It appears that these activities are extensive throughout the islands and that visitors are frequently behaving in a manner which cannot be considered to represent responsible behaviour.

The attitudinal survey has also provided an indication of the types of behaviours occurring within the study area. Although this survey has only been completed with a sample of visitors, it provides an indication of the number of dogs being taken onto islands; the extent to which visitors are prepared to admit to lighting fires and gathering firewood etc. It is reasonable to assume that these numbers represent the minimum extent of these activities (i.e. more visitors engage in these activities but do not report it in surveys).

In order to improve estimates of total numbers visiting the islands it would be necessary to undertake calibration exercises. These are likely to be resource intensive (prolonged counts of boats and corresponding people at a sample of congregation zones) and may not provide any additional benefit to the monitoring protocol that has been developed to assess the impacts of those visitors. It is therefore considered more important to assess changes in the data that is being collected to detect *relative* variations in visitor numbers rather than seek an absolute number of visitors for each island.

Objective 4 - To assess the impact of these numbers and behaviour on a number of designated habitats and species found within the islands and NNR

For each selected habitat and species we have reviewed the scientific literature to establish the sensitivity of the species to particular activities. We have then analysed this information in conjunction with the activities which have been demonstrated to be occurring within the study area (through the data gathered in the recreational monitoring protocol). This enabled us to highlight particular time periods / geographical areas where there is a potential impact on a habitat and species from a recreational activity.

Section 3 demonstrates that there are a number of these potential impacts, affecting all the selected habitats and species. In response to these potential impacts, we have highlighted monitoring and management recommendations which could be put in place to either assess the extent of, or modify, the impact.

Objective 5 - To provide recommendations to appropriate management options for the islands and NNR

The recommendations we have given are based on our evaluation of potential impacts, as set out above. They are divided into monitoring and management recommendations, labelled as MO and MA respectively.

In terms of monitoring recommendations, there is considerable overlap between the habitats and species. In many cases it is clear that suitable potential monitoring data is already being collected, or existing data collection methods could be modified to enable suitable data to be captured. However, this data is either not being analysed with a view to considering recreational factors, or the data is being collected by different organisations and is not being collated and analysed on a regular basis. An over-arching recommendation is therefore to establish a central data repository so that datasets can be collated and compared. Additional specific recommendations of survey method modifications are included for particular species and habitats. We believe that implementing these recommendations will enable LLTNPA and SNH to monitor the impacts of recreational activities more effectively and to establish if additional management actions are required in the future. These recommendations are in addition to implementing the recreational monitoring protocol as set out in section 2.4.

In contrast, the management recommendations vary between species and habitats. Probably the most significant, and potentially controversial management recommendations relate to capercaillie and the exclusion of dogs from certain islands during key periods. These recommendations will require further legal consideration to confirm that they are acceptable under the Land Reform (Scotland) Act.

Objective 6 - To assess the applicability of SNH's guidance on 'Monitoring access and recreation at sensitive natural heritage sites' within the context of the Loch Lomond islands and NNR

This guidance was used by the project team during the establishment of the monitoring protocol and provided a useful starting point. It is set out in a logical structure and provides helpful pointers and suggestions. However, it is a generic document and, as such, was only applicable during the early strategic stages whilst the project team were establishing general aims and potential monitoring parameters. Once the work became more site specific (e.g. resolving the site-specific issues on ensuring robust and repeatable data collection etc), the guidance was less applicable, as would be expected.

A number of suggestions for improvements and modifications to the guidance have been provided. We believe that the incorporation of these suggestions would help to ensure the guidance is of maximum benefit to site managers and others involved in the monitoring of recreational impacts.

6.1 Policy and management implications of this report

The analysis of recreational data shows that in general the impact of visitors on the designated species and habitats is not the main influence on their respective statuses although it may contribute to overall impacts on quality and range. The notable exception is capercaillie, for which urgent action is required and changes to recreational use of the islands of Loch Lomond may have a significant influence. In considering the implementation of revised policy, it is recommended that consideration be given to the likely reaction of the public to access restrictions as outlined in section 3.5.6.

An additional consideration for the LLTNPA and SNH is the potential perception of recreational impact within the study area in terms of compliance with the Scottish Outdoor Access Code, the spirit of the Land Reform (Scotland) Act 2003, and various pieces of legislation that govern socially acceptable behaviour. Therefore, any policy or operational decisions taken to counteract antisocial behaviour should be implemented within this context, rather than using the conservation designations as a basis for action.

7 Deliverables

The following deliverables have been produced during this study:

- Literature review for specified habitats and species – now included within section 3 of this report.
- Training manual for the survey methodology – included as Annex 4.
- GIS project with the following datasets:
    - Aerial photography
    - Congregation Zone locations
    - Boat stopping data (total counts per season for each zone)
    - Capercaillie records from 1985 – 2008
    - Capercaillie records for 2009
    - Otter holts, sightings and signs
    - Habitats classification data (NVC)
    - Capercaillie risk assessment data
- Adapted recording sheet for Endrick Mouth – included as Annex 3
- Electronic database for recording data and associated photos – included as Annex 4

8 Annexes

Annex 1 – list of attendees at the experts' workshop

Annex 2 – specimen questionnaire

Annex 3 - recording sheet for Endrick mouth

Annex 4 - monitoring manual and field recording sheets

Annex 5 – database and photos

Annex 6 –CONFIDENTIAL Capercaillie maps

9 References

Adams, C, Tippett, R, Nunn, S and Archibald, G, 1992. The utilization of a large inland waterway (Loch Lomond, Scotland) by recreational craft', Scottish Geographical Journal, 108: 2, 113 — 118

Anderson, P, 1990. Moorland recreation and wildlife in the Peak District. Report to Peak Park Joint Planning Board

Asplund, TR and CM Cook. 1997. Effects of motor boats on submerged aquatic macrophytes. Lake and Reservoir Management 13:1-12

Bélanger, L and Bédard J, 1990. Energetic cost of man-induced disturbance to staging snow geese. Journal of Wildlife Management 54: 36-41.

Bélanger, L and Bédard J, 1989. Responses of staging snow geese to human disturbance. Journal of Wildlife Management 53: 713-719.

Brenot, J-F and Ménoni, E, 1999. Response of capercaillie population in relation to construction of a ski station in the Pyrenees. Abstracts of 8th International Grouse Symposium. www.wildlifebiology.com/2000/grouse%20abstracts.pdf

Capercaillie Biodiversity action Plan Group 1995 http://www.capercaillie-life.info/htm/bap/disturbance.php. Accessed April 2009

Chanin, P, 2003. Ecology of European Otter. Conserving Natura 2000 Rivers. Ecology Series No. 10. English Nature, Peterborough.

Dickinson, G, Drummond, J and Murphy, K, 1998. An approach to measuring recreational impacts on inland lochs. Commissioned report to Scottish Natural Heritage.

Eaton, MA, Marshall, KB and Gregory, RD, 2007: Status of capercaillie *Tetrao urogallus* in Scotland during winter 2003/04. - Bird Study 54: 145–153.

Eriksson, BK, Sandströmb, A, Isæusc, M, Schreiberd, H and Karåsb, P, 2004. Effects of boating activities on aquatic vegetation in the Stockholm archipelago, Baltic Sea. Estuarine, coastal and shelf science, v61, 339- 349

European Environment Agency website, http://glossary.eea.europa.eu/terminology/sitesearch?term=DPSIR, accessed May 2010

Finney, SK, Pearce-Higgins, JW and Yaldenet DW, 2005. The effect of recreational disturbance on golden plover. Biological Conservation 121, 53-63.

Forest Management Branch, Ontario Ministry of Natural Resources 2006. Forest management guide for the protection of osprey nests. ISBN 1-4249-0933-3

Gill, JA, Norris, K and Sutherland, WJ, 2001. Why behavioural responses may not reflect the population consequences of human disturbance. Biological Conservation 97: 265-268.

Gill, JA, Sutherland, WJ and Watkinson, AR, 1996. A method to quantify the effects of human disturbance on animal populations. Journal of Applied Ecology33: 789-792.

Glahder, CM and Walsh, AJ, 2006. Experimental disturbance of moulting Greenland White-fronted Geese *Anser albifrons flavirostris*. Waterbirds around the world. Eds. G.C. Boere, C.A. Galbraith & D.A. Stroud. The Stationery Office, Edinburgh, UK. p. 640.

greenlandwhitefront.homestead.com/69lochlomond.html - accessed April 2009 and 2010

Hagan, JM, 1986. Temporal patterns in pre-fledging survival and brood reduction in an osprey colony. Condor 88:200-205.

Hammer, R and Morgan, G, 2007. Development of *Quercus robur* advance regeneration following canopy reduction in an oak woodland. Forestry 80:2, 137-149

Hodges ,R, 1991 Riparian damage from boating. Aust. Planner 29, 101-6.

Hudson, P. http://www.countryside.gov.uk/WiderWelcome/NCAF/NCAF6_2.asp. Accessed April 2009

Jupp, BJ and Spence, DHN, 1977. Limitations of macrophytes in a eutrophic lake, Loch Leven: II. Wave action, sediments and waterfowl. The Journal of Ecology

Kruuk, H, Carss, DN, Conroy, JWH and Gaywood, MJ, 1998. Habitat use and conservation of otters (*Lutra lutra*) in Britain: a review. In *Behaviour and Ecology of Riparian mammals*, eds N. Dunstone and M.L. Gorman. Cambridge University Press.

Madsen, J, 2008. Impacts of disturbance on migratory waterfowl. Ibis 137: S67-S74

Marshall, K, 2005. Capercaillie and Recreational Disturbance Study, for Cairngorms National Park Authority, Forestry Commission Scotland and SNH.

McCafferty, DJ, 2005. Ecology and conservation of otters (*Lutra lutra*) in Loch Lomond and the Trossachs National Park. *Glasgow Naturalist* 24(3), pp. 29-35.

Meile, P, 1981. Skiing facilities in alpine habitat of black grouse and capercaillie. Grouse. Proc.2nd Int. Symp. on Grouse, 87-92. World Pheasant Association.

Mitchell, J, 1983. Strange Beasts on the Bonny Banks. Scottish Wildlife. 19:20-24.

Mitchell, J, 2001. Loch Lomondside. Harper Collins, London, UK

Mosisch, T D and Arthington, AH, 1998. The impacts of power boating and water skiing on lakes and reservoirs. Lakes & Reservoirs: Research and Management 3: 1-17

Mosisch, T D and Arthington, A.H, 2004. Impacts of recreational power-boating on freshwater ecosystems. In: Environmental Impacts of Ecotourism. Ecotourism Book Series, Volume 2. Ed R. Buckley. CAB International.

Murphy, KJ and Eaton JW, 1983. Journal of Applied Ecology, 20,713-729 Effects of pleasure-boat traffic on macrophyte growth in canals

Murphy, KJ, Hudson, KD and Mitchell J, 1994. Freshwater and wetland plant communities of Loch Lomond. Hydrobiologia 290, 63-74

Murphy, J, Morgan, G and Power, O, 2006. Literature review on the impact of boat wash on the heritage of Ireland's inland waterways. Heritage Council, Ireland.

Northern Ecological Services 2005. Review of ecological impacts of boating and associated activities on Loch Lomond and its shores. Aboyne, Aberdeenshire.

Ostendorp, W, Gretler, T, Mainberger, M, Peintinger, M and Schmieder, K, 2008. Mooring management on submerged vegetation, sediments and macro-invertebrates in Lake Constance, Germany. Wetlands Ecology and Management 17, no5, 525-541

Owen, M, 1972. Movements and feeding ecology of white-fronted geese at the New Grounds, Slimbridge. Journal of Applied Ecology 9: 385-398.

Palmer, SCF, Mitchell, RJ, Truscott, AM and Welch, D, 2004. Regeneration failure in Atlantic oakwoods: the roles of ungulate grazing and invertebrates. Forest Ecology and Management v192, 251-265.

Pierce, L, 2004. Lake Waves, Coarse Clastic Beach Variability and Management Implications, Loch Lomond, Scotland, UK. Journal of Coastal Research, Vol. 20, No. 2, 562-585

Poole, A, 1981. The effects of human disturbance on osprey reproductive success. Colonial Waterbirds 4: 20-27.

Porkert, J, 1978. The influence of human factors on tetraonid populations in Czechoslovakia. Woodland Grouse. Proc.Int. Symp. on Grouse, 74-82. World Pheasant Association.

Reynolds, P, Steward, M and Zisman, S, 2005. Loch Lomond Special Protection Area Predator Surveys. Capreolus Wildlife Consultancy

Rodgers, J and Schwikert, S 2002. Buffer-zone distances to protect foraging and loafing waterbirds from disturbance by personal watercraft and outboard- powered boats. *Conservation Biology*, 16, 216-224.

Royal Horticultural Society website. http://www.rhs.org.uk/advicesearch/Profile.aspx?pid=329. Accessed April 2009

Ruddock, M and Whitfield, DP, 2007. A Review of Disturbance Distances in Selected Bird Species. A report from Natural Research (Projects) Ltd to Scottish Natural Heritage.

Scottish Ornithologists Club, 2007. The Birds of Scotland.

Sidaway R, 1990. Birds and walkers. Report to the ramblers Association.

Storaas, T, Kastdalen, L and Wegge P, 1999. Detection of forest grouse by mammalian predators: A possible explanation for high brood losses in fragmented landscapes. - Wildlife Biology. 5: 187-192.

Storch, I andLeidenberger, C, 2003. Tourism, mountain huts and distribution of corvids in the Bavarian Alps, Germany. Wildlife Biology 9: 301-308.

Stroud, DA, Chambers, D, Cook, S, Buxton, N, Fraser, B, Clement, P, Lewis, P, McLean, I, Baker, H and Whitehead, S (eds), 2001. The UK SPA network: its scope and content. JNCC, Peterborough.

Summers, RW, McFarlane, J and Pearce-Higgins, JW, 2007. Measuring Avoidance by Capercaillies *Tetrao Urogallus* of Woodland Close to Tracks Wildlife Biology 13(1):19-27.

Strachan, R, 2007. National survey of otter *Lutra lutra* distribution in Scotland 2003–04. Scottish Natural Heritage Commissioned Report No. 211 (ROAME No. F03AC309).

Tivy, J 1979 in Shore erosion around Loch Lomond, Countryside Commission for Scotland

Törn, A, Tolvanen, A, Norokorpi, Y, Tervo, R and Siikamäki, P, 2009. Comparing the impacts of hiking, skiing and horse riding on trail and vegetation in different types of forest. Journal of Environmental Management 90: 3, 1427-1434.

Trimper, PG, Standen, NM, Lye, LM, Lemon, D, Chubbs, TE and Humphries, GW, 1998. Effects of low-level jet aircraft noise on the behaviour of nesting osprey. Journal of Applied Ecology, 35, 122-130.

United Nations Environment Programme website, http://www.unep.org/dewa/assessments/ecosystems/water/vitalwater/12.htm#13, accessed May 2010

Van Daele, LJ and Van Daele, HA, 1982. Factors affecting the productivity of Ospreys nesting in west-central Idaho. Condor 84: 292-299.

Van der Zande, AN, 1984. Outdoor recreation and birds: conflict or symbiosis. PhD thesis Leiden University.

Waltho, C, 2000. Capercaillie Monitoring on Loch Lomond during the 1990s. Unpublished report cited in Capercaillie Species Action Plan.

Watson, A, Nethersole-Thompson, D and Duncan, K, 1988. Decline of shore waders at Loch Morlich. Scottish Birds 15, 91-92.

Yu-Fai Leung and Marion, L, 1999. The influence of sampling interval on the accuracy of trail impact assessment. Landscape and Urban Planning v43: 4, 167-179