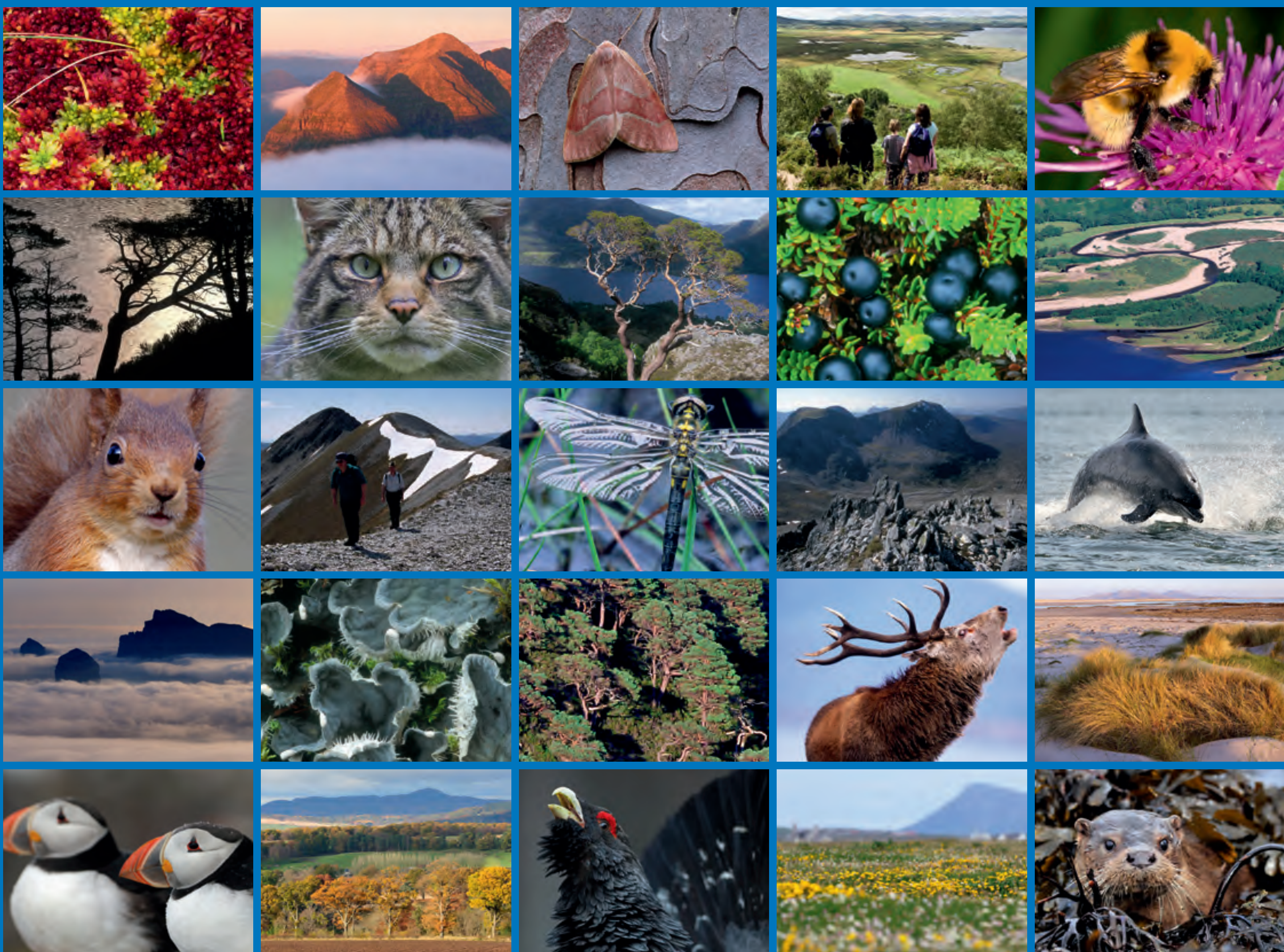
Scottish Natural Heritage
Commissioned Report No. 933

Assessing the nature and use of corvid cage traps in Scotland: Part 3 of 4

Trap operation and welfare



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COMMISSIONED REPORT

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Assessing the nature and use of corvid cage traps in Scotland: Part 3 of 4

Trap operation and welfare

For further information on this report please contact:

Ben Ross
Scottish Natural Heritage
Great Glen House
INVERNESS
IV3 8NW
Telephone: 01463 725245
E-mail: ben.ross@snh.gov.uk

This report should be quoted as:

Campbell, S.T., Hartley, F.G. & Fang, Z. 2016. Assessing the nature and use of corvid cage traps in Scotland: Part 3 of 4 – Trap operation and welfare. *Scottish Natural Heritage Commissioned Report No. 933.*

COMMISSIONED REPORT
Summary

Assessing the nature and use of corvid cage traps in Scotland: Part 3 of 4 – Trap operation and welfare

Commissioned Report No. 933
Project No: 13747
Contractor: FG Hartley, DWMB, Science & Advice for Scottish Agriculture
Year of publication: 2016

Keywords

Corvids; cage traps; catch; by-catch; bait; behaviour; welfare.

Background

This survey was commissioned by SNH to inform their regular review of four General Licences which allow the control of corvid birds for various purposes. It specifically aimed to improve understanding of the way in which the set and bait used in Larsen-mate, Larsen and multi-catch traps affects catch. Also to identify any significant welfare concerns of the traps and the trapping process with respect to target and non-target species caught.

Main findings

- A Larsen-mate trap, Larsen trap and multi-catch (all commercially sourced), were set in close proximity at three different sites around a lowland arable farm. One site was within a mixed woodland shelter belt; one site was in a quiet grassed area, 20 metres from a building and 15 metres away from a young mixed plantation, wood and scrub area; the last site was adjacent to an established hedgerow in an open arable field.
- While set, all traps were monitored 24 hours a day using CCTV cameras. Sections of footage were analysed when traps were triggered, or circumstantial evidence suggested a need (e.g. bait disappearance). Random sections of daytime footage were also analysed for general activity levels around the traps.
- In 1601 trap days, a total of 138 corvids, 9 buzzards, 4 blackbirds, 1 small passerine, and 1 squirrel triggered traps, and were therefore identified as a catch. Of these, 12 corvids, 2 buzzards, 3 blackbirds, the small passerine and the squirrel escaped by their own means. These traps are therefore considered relatively selective.
- Between 25 and 30% of target species caught in multi-catch traps escaped, despite a modification put into place to try and reduce this issue.
- Buzzards, the only raptor caught, were only trapped when meat bait was set in the traps. Buzzards were caught in all trap types. One buzzard was caught three times.
- ‘Small passerines’ were the most commonly identified species group seen in and within one metre around the traps. In all cases, these birds were able to escape from the traps, often through the mesh, with various levels of ease depending upon the mesh size.
- For other bird species, different types of escape pattern were observed from Larsen-mate and multi-catch traps, some with behavioural impacts on trap rate of target species. Target birds did not appear to escape from Larsen traps.

- For crows, the use of a decoy bird provided the highest catch rates, followed by meat; egg and bread gave similar catch rates, while for magpies, the use of a decoy bird provided the highest catch rates, followed by eggs, bread then meat. Similarly, decoy birds (jackdaw or magpie) also provided the highest catch rates for jackdaws, followed by bread baits (meat and egg baits were ineffective; grain baits were not used in this study).
- Detailed behavioural analyses were conducted on carrion crows and magpies, the two main species caught. Birds trapped overnight were most active in the first daylight period, less active in the second daylight period and least active at night. In magpies, a short burst of activity was recorded around dusk. The main behaviour observed was walking/pacing in the trap, although other key activities were identified that could be interpreted as likely escape behaviours. Birds were equally active whether caught in the morning or afternoon.
- There were differences between individuals and possibly between species in their behaviours, particularly when caught in different trap types. These differences may to some extent be associated with the amount of available space each species had within a given trap type.
- Buzzards exhibited lower activity rates than other species analysed.
- Veterinary examination of all euthanized corvids determined that 21% of corvids suffered no injury prior to death; 78% had minor or moderate injuries, not believed to be detrimental to their survival had they escaped; and 1% had serious (life threatening) injuries.
- The most common injury was minor bill abrasion (70% of birds), which was probably related to the trap mesh size and construction. In the majority of cases, no serious injury concerns were raised by the traps used in this study, irrespective of the time left in the trap (within the legal restrictions).
- Most trapped birds were in reasonable body condition, and disease was detected in 6% of birds examined. It seemed unlikely that traps were selecting birds in particularly poor condition, although without further information on background levels of disease in untrapped birds in the area, there remains some uncertainty around this.
- Two birds became entangled in Larsen-mate traps during the trapping process, although both disentangled themselves.
- The most serious welfare issue that arose was when a bird was attacked by fox while trapped overnight. Various strategies that could be adopted to mitigate this risk are discussed.
- Further consideration is given to the advantages and disadvantages of possible changes to the traps and the terms and conditions of use, including the use of home-made versions of such traps.

For further information on this project contact:
Ben Ross, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725245 or ben.ross@snh.gov.uk
For further information on the SNH Research & Technical Support Programme contact:
Knowledge & Information Unit, Scottish Natural Heritage, Great Glen House, Inverness, IV3 8NW.
Tel: 01463 725000 or research@snh.gov.uk

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Acknowledgements

We would like to extend our thanks and gratitude to the following individuals.

Jane Stirling for undertaking the behavioural recording of magpies, and to Fritha Langford (Applied Animal Welfare, SRUC) for discussions regarding behavioural recording and data collection. Also to Gemma Gibson and Jason Gilchrist (School of Life, Sport & Social Sciences, Napier University) for their assistance in creating the initial ethograms for behavioural observations. In particular to Nick Jonsson (Professor of Production Animal Health, University of Glasgow) for undertaking the corvid necropsies.

Also to farm staff, for assisting with access for trap setting and maintenance. Seonaidh Jamieson for assistance with data entry; David Kenyon for his support of the project, and especially to Eric Parker for his help with the organisation, logistics, technical assistance, fieldwork and pretty much everything else; may he have a happy retirement!

To the RSPB, especially Duncan Orr-Ewing and Staffan Roos, for buzzard tagging.

We are also grateful to Ben Ross, Jonathan Reynolds and the project steering group, Staffan Roos, Colin Shedden and Hugh Dignon for comments and discussions on the project.

1. INTRODUCTION

1.1 Background

This report is one in a series of four discussing the nature and use of the corvid cage traps used under general licences. Parts 1 and 2 consider practitioner use in the form of a questionnaire and a field survey (Reynolds, 2016; Hartley *et al.,* 2016), while this part covers field trials involving the traps, how they were set, their catch and the behaviour of trapped birds. Part 4 of the series (Review & Recommendations) includes a detailed literature review, which provides background to this and the other reports (Campbell *et al.,* 2016).

In the late 2000's, "Larsen-mate" traps, a single compartment corvid cage trap, came into use by some trappers. There was initial confusion over whether the trap was permitted under the general licences, but subsequent to the general licence consultation of 2012, SNH added both the "Larsen-mate" and the "Larsen-pod" traps to the relevant 2013 general licences. See Campbell *et al.* (2016) for details of the Larsen-mate. SNH recognised that there was a lack of evidence to support the assertion that the Larsen-mate did not pose any significant additional welfare risk to birds, over and above the traps that were already in use such as the Larsen and the large multi-capture cage traps. Furthermore, SNH was aware of the many concerns raised about the use of live capture corvid cage traps (for example: The Campaign Against Corvid Traps (2016)), Raptor Persecution UK (2012a) and as a result, commissioned this research project to increase knowledge into this area.

This report focuses on legal trapping activities typical of those conducted under the general licence, although where illegal activity borders legal trap use, then the report considers some potential issues. We cannot hope to mimic all trap users and situations but we believe the traps and techniques used are broadly representative of the types of interaction that some corvids are likely to have with traps operated in accordance with the terms of the respective General Licences. Welfare considerations of using the general licence traps are a particular issue addressed in this report and while factors affecting the catch are discussed, it is the behaviour of target and non-target species both in and around the traps and their interaction with the traps which is the primary focus.

1.2 Concerns about traps

Each year SNH regularly review general licences and undertake an open consultation on their content. The animal welfare organisation Onekind (2012) raised various concerns in their response regarding consultation for the 2013 licences, including the following: Birds are on the ground and could undergo '*stress and mental suffering*' due to predators (Larsen & Larsen-mate).

It's "*design and indiscriminate nature have the potential of causing great harm to any wildlife attracted to the bait*" which they further clarify by suggesting that animals such as foxes, badgers and pine martens could trap their heads or legs, or that animals could be blinded "*if the wire edge of the cage snaps across the animals face*" (Larsen-mate). That "*the bird's body may be caught in the cage, with the wings outside; alternatively, a bird trying to escape could be caught across the body or wings*" (Larsen-mate). No food and water for captured bird for up to 24hrs (Larsen & Larsen-mate). Potential abuse of the trap to catch raptors (Larsen-mate).

Concerns listed on the Raptor Persecution UK website (2012a and 2012b) included: the 'indiscriminate nature" of the traps. The lack of monitoring, particularly relating to the effect on target and non-target species. The ability to identify an individual trap user with the current database. Injuries inflicted on birds as the trap closes, whether the bird would be able to move in the trap and a lack of perch, water and shelter for captured birds (Larsen-mate).

Clair Baker MSP (Lab) asked a number of questions in the Scottish Parliament (2012), some regarding welfare issues on the use of Larsen-mate type traps and included the risk of injury to birds, the impact on protected and non-target species, and the provision of food, water and shelter for captured birds.

Many of the criticisms of Larsen-mates mirror criticisms levelled at Larsen traps, such as the stress and trauma for birds in traps (decoy and trapped birds), trapping during the breeding season, traps at ground level equating to trauma from predators, and that traps are indiscriminate and catch non-targets (Animal Aid, 2011).

A summary of the main concerns raised by various bodies include the following:

1. Indiscriminate capture of non-target species
2. Risk of injury and/or entanglement to captured birds
3. Risk of Injury and/or entanglement to non-target mammals/other animals
4. Restrictions on ability to move in trap
5. The stress of captivity
6. The additional stress of captivity on parent birds during the breeding season
7. Welfare of offspring during the breeding season
8. Danger from predators visiting trap on ground (trapped and decoy bird)
9. Inadequate or no water, food and shelter for caught bird
10. Abuse of legal traps for illegal purposes (e.g. the killing of raptors)
11. General welfare of all birds in traps (trapped and decoy birds)

Some of these concerns were partially addressed with changes on the 2013 general licence. Concern 3 was partially addressed by stipulating that Larsen-mate traps had to be anchored in place to help prevent an animal which had become caught in the mechanism, dragging the trap away, assuming it might struggle to disentangle itself and then die of thirst or starvation. Larsen traps were initially included in this requirement, but were removed since Larsen traps tend to be quite large and heavy, such that any animal would not be able to drag it away. Further, by not allowing the use of meat baits in Larsen-mates/Larsen pod type traps, the risk of capturing raptors is reduced, and any associated risks may also be reduced. Nonetheless, some significant welfare concerns still exist, and the results from this research project are able to shed some light on concerns 1-5, 8 and 10.

1.3 Decoy ('call' or 'lure') birds

This report does not attempt to assess the welfare aspects of using and keeping live decoy birds because:

- limited resources were available and we would have been unable to devote sufficient time to this additional work;
- the welfare of decoy birds is probably more suited to a controlled experimental study combined with a field study, that takes into account the time a bird is held as a decoy, the use of aviaries to hold decoys when not in traps, long-term health and behavioural issues, and survival post-release after variable lengths in captivity;
- the Larsen-mate trap does not use decoy birds and both other trap types are often used with food bait instead of a decoy. Hence a decoy bird study is relevant to fewer trapping situations.

2. METHODS

2.1 Study sites

The Study area was a lowland arable farm to the west of Edinburgh. The three locations used on the farm were as follows:

Compound: A high fenced compound approximately 50x50m containing grass enclosures, adjacent to a commercial building but relatively undisturbed. A Larsen trap had been run near this compound in previous years for short periods with reasonable success.

Orchard: mixed woodland ‘shelter belt’ between two fields. This site provided reasonably thick cover to the traps during the summer. Note: the name “Orchard” is historical; it is not an actual orchard.

Moorland: Situated along the hedgerow of an arable field (the hedge running approximately north-south and the traps being on the east side of it). The field was used to grow cereal in Spring/Summer 2015. Note, as with the previous location, the name “Moorland” is a historical field name, and bears no resemblance to moorland.

The ‘Compound’ and ‘Orchard’ sites were active from the 2nd of June 2014, the ‘Moorland’ site was first used 26th November 2014.

2.2 Trap type

At each location, a Larsen, Larsen-mate and multi-catch trap were used (nine traps in total). All traps were purchased commercially from trap retailers as ‘off the shelf’ designs.

2.2.1 Larsen Trap

The Larsen traps were of a ‘standard’ square design with two capture compartments and a single larger decoy bird compartment, the capture compartments were top entry with sprung doors. The traps were surplus from another research project so the original supplier is not known. Dimensions are given in table 2.1. All were metal (apart from wooden perches) and were constructed from 75mmx 25mm galvanised weldmesh. See Figure 2.1.

Table 2.1 Dimensions of Larsen traps

Larsen Trap	Trap (overall)	Decoy bird compartment	Capture compartments
Length	76cm	76cm	38cm
Width	76cm	38cm	38cm
Height	55cm	55cm	55cm

The doors of the Larsen capture compartments were full width/length of the compartment (i.e. there was no significant ‘frame’ or border around them, just a small overlap at the closure) thus maximising the entrance size. The decoy bird compartment had a galvanised steel sheet of dimensions 38cm x31cm on the top surface at one end to provide some shade and shelter.

Figure 2.1 Larsen trap, all metal.

2.2.2 Larsen-mate/clam trap

Two slightly varying designs of Larsen-mate were used, one was a Larsen-mate sourced from Game and Country Ltd.; the second was a Solway Larsen-mate sourced from Solway Feeders.

The dimensions of the traps are listed in Table 2.2. Both traps use a steel square mesh, the G&C trap used a bright steel 50mm square mesh and the Solway a dark green powder coated 50mm square mesh. The two traps are shown in Figure 2.2.

Table 2.2 Dimensions of Larsen-mate traps.

Larsen-mate (G&C)		**Larsen-mate (Solway)**	
Length	41cm	**Length**	45cm
Width (open)	41cm	**Width (open)**	40cm
Height	46cm	**Height**	41cm

Figure 2.2 Larsen-mate traps (suppliers: Left = Game & Country, Right= Solway Feeders).

2.2.3 Multi-capture 'ladder' trap

The multi-catch "ladder" trap was a fairly standard design of multi-catch trap made with a wood frame and galvanised wire rabbit netting on the outside (20 gauge, 40x25mm mesh). The main dimensions of the trap are listed in Table 2.3. It had a hinged full height (145cm) door at one end for access. The trap incorporated, as part of the commercial design, a fine wire mesh curtain suspended from both sides of the horizontal ladder system, to help prevent bird escapes. See figures 2.3 and 2.4.

Table 2.3 Dimension of multi-catch traps.

Multi-catch trap	Dimensions
Length	180 cm
Width	160 cm
Height (outer)	180 cm
Height (ladder)	145 cm
Dimension of ladder entrances	24 cm x13 cm later reduced by a wire divider to 16 cm x13 cm

Based on published information regarding bird escapes from ladder traps, and visual confirmation, the traps were modified early in the trial by incorporation of a thick wire running under the length of the ladder. This restricted the opening by approximately one third (figure 2.4). This approach was adopted because the wire is potentially less noticeable from above, and therefore the entrance might appear less restricted to any bird wishing to enter, than if the narrowing was achieved using wood. However, the wire was clearly visible viewed from below. Nonetheless, some birds continued to escape these traps.

Figure 2.3 Multi-capture trap. Note: raised shelter box with perch, box on ground to shelter food; fine mesh curtain to deter bird escapes.

Figure 2.4 Detail of ladder with wire restriction (15cm ruler for scale) implemented by the authors. Note fine mesh curtain (hangs at 90˚ to ladder), which was part of the design of this commercially sourced trap.

2.3 Operation of traps

Traps were normally set on a Monday morning and operated until mid to late Friday afternoon. Due to logistical and manpower constraints, there were occasional days and weeks when trapping did not take place, or only took place at a reduced number of sites. For instance, Moorland field became inaccessible, even using a 4WD vehicle, during periods of extreme wet weather. Trapping was also stopped during periods of extreme bad weather, such as gales, torrential rain and snow. Between 02/06/14 and 13/09/15 traps were active for the equivalent of 1601 out of 2907 possible days (55%; table 2.4).

Because the primary focus was video observation of trapped birds, we did not want to complicate catches in the Larsen traps by having more than one bird captured at a time. Thus Larsen traps were operated with one of the two capture compartments set and the second locked open and inactive. This reduced the effectiveness of the traps in comparison with normal trap operation, and there were instances, seen on video, when a second bird entered the inactive compartment after a first bird had been caught, that support this conclusion. Furthermore, there were instances when birds would enter the inactive compartment, even when the other trapping compartment was set and unoccupied.

Table 2.4 Number of days each trap was in use.

	Compound	Orchard	Moorland
Larsen	223	199	111
Larsen-mate	223	199	112
Multicapture	224	199	111

2.3.1 Baits

Three different bait types were generally used: Bread, eggs or meat. In addition we also used decoy birds in Larsen traps and occasionally in multi-capture traps. The general pattern was to run one type of bait each week, although once crow decoy birds were available in the latter half of the study, these tended to be run in the Larsen traps regardless of the bait being used in other traps. Table 2.5 lists bait types and the number of days they were used. Table 2.6 also provides a breakdown of the different decoy bird species.

The baits consisted of white or brown loaves of bread broken into pieces, standard brown hen eggs, and meat which was normally day old chicks of the type supplied as pet food, although on a few occasions, rabbit meat was used. Eggs were arranged in a 'nest' made from dried grass generally with two eggs, often with one broken open and arranged to show the inside of the shell and the orange yolk. When available, decoy birds were normally used in the Larsen traps, but only on a few occasions in the multi-capture traps (magpie and jackdaw only). This avoided the risk of the decoy birds escaping, but also reduced complications associated with CCTV analysis of bird behaviour when multiple birds were confined in a trap.

Table 2.5 Number of days when each bait type was used (locations combined)

	Bread	Egg	Meat	Decoy bird
Larsen	102	49	121	261
Larsen-mate	210	109	215	0
Multi catch	201	101	212	20

Table 2.6 Number of days each species was used as a decoy bird

	Magpie	Crow	Jackdaw	Rook
Larsen	55	206	0	0
Larsen-mate	0	0	0	0
Multi catch	0	0	17	3

The traps were operated in a manner that complied with the conditions of the general licences although they were run under a scientific licence from SNH that enabled any bait type to be used. Given that the use of meat baits in Larsen-mate traps was a concern regarding raptor catch, and the potential misuse of these traps, it was decided to test the validity of this risk by using meat baits in Larsen-mate traps, which is not permitted under the general licence.

Although traps were checked at intervals that attempted to sample the full range of scenarios that might be encountered with legal trap use under the general licence daily, they were often checked twice daily. The general licence requires users to visit traps at intervals that do not exceed 24hrs and we adhered to this rule. Normal practice was to check the trap in the morning usually between 7:30 and 10:30 (although times were variable), and again in the afternoon usually between 14:30 and 17:00 (but again times varied). However there were occasions when the traps were only checked once daily (although still within the 24hrs).

Decoy birds were kept in aviaries when not in traps, and on days when adverse weather was forecast. During short periods of inclement weather, shelter was sometimes added temporarily to the decoy bird compartment in the form of a thick plastic sheet attached by cable ties to the top/side of the trap to give extra shelter against wind and rain. Multi-capture traps were permanently fitted with raised wooden boxes with perches to offer shelter to decoy birds or captured birds.

2.4 CCTV

A digital CCTV recorder (Swann DVR4-1500 four channel compact DVR) was used at each site. The recorders had three cameras attached, with one camera focused on each trap.

Several different camera types were used, Swann PRO-510 cameras that were supplied with the DVRs were used on some traps, Swann 'Megaflood' cameras were used on others and Swann 'Night owl' 105's on initially two, but later just one trap. All cameras had built in banks of infra-red LEDs for illumination at night, these came on automatically when light levels dropped. The choice of camera was determined by which camera produced an image of the trap of a useable size given the trap position and choice of camera mounting points; they were positioned to show the trap and an area of at least around 1m around it.

The CCTV system at the Compound site was run from mains electricity, but at the other sites the DVR and cameras were all run from 12 volt leisure batteries which required replacing every few days and in mid-winter sometimes daily. Recharging frequency increased during the winter due to low ambient temperatures which affected power capacity, and because infra-red LEDs would be operational for far longer during long nights than short nights, increasing power demands by more than twice that required during the summer. DVR's and batteries were housed in lockable waterproof equipment cases in the field.

The DVR's had a storage capacity of 500 GB which with three cameras attached allowed for over five full days of video recording on the settings used. This video was then reviewed and any relevant footage of captured birds tagged and exported for storage and later reviewing. In addition, random one hour observations of traps were made to record all bird presence and activity. Once any relevant video had been observed or copied, the DVR hard disk was wiped for reuse.

2.4.1 Video replay

Several media software packages were used for viewing the video footage:

VSPlayer 6.0.0.4 was used for quick viewing of footage (e.g. locating an event or scanning for activity).

VSPlayer V7.0.0 was used for more detailed viewing such as the one hour observations, primarily because it has the ability to play footage backwards making it easier to scroll back to an event if required.

The behavioural analysis software BORIS (Behavioural Observation Research Interactive Software) v 2.1 (Friard & Gamba, 2016) was used for recording behaviour when watching footage of crows and buzzards in traps. The software package Observer by Noldus (Zimmerman *et al.,* 2009) was used to record magpie behaviour.

2.5 Captured bird behaviour observations

For each bird caught in a trap, video footage was retained from shortly before capture until removal from the trap. Early recordings tended to have substantial periods prior to capture retained, due to the way the device saved footage. In later recordings, we aimed to start the retained footage in the minute prior to capture (due to the very large size and large number of files being held as footage), but occasionally started it sooner if something of interest was happening.

Five birds were not recorded due to equipment faults, and sixteen birds were recorded in situations of multiple capture, which did not allow each individual to be consistently identified. The quality of footage varied significantly with environmental conditions. Night footage was often as good as footage on dull or overcast days, particularly where the camera could be positioned closer to the trap (e.g. on smaller traps where the field of view was by necessity smaller) and the infra-red illumination lit the trap more clearly. However, footage in high contrast conditions e.g. bright sun in morning and late afternoon/evening combined with shadows from trees etc. could result in very poor quality recordings.

Observations of bird behaviour in the traps were a compromise between the amount of video footage available and the resources available to watch and record data from it. For each bird we observed two minute video samples taken every 15 minutes (starting 15 minutes after capture). Each species was only recorded by a single researcher to avoid observer bias effects within species samples. Data were transferred to Excel spreadsheets and were later analysed using the R statistical package, version 3.0.2 (R Core Team, 2015) by Biomathematics and Statistics Scotland (BioSS) using primarily generalised linear models.

2.6 One hour observations

For each day that trapping took place the sunrise and sunset times were noted and a random number facility in Excel was used to select a time of day between those limits to begin the one hour observation. If a trap was not running at that specific time then another random number would be chosen so that it did coincide with when the trap was set. If a bird was caught in a trap at that time then no observation was made and a time period not overlapping with a captive bird would be used.

When viewing the one hour sequence, during each individual minute the presence of crows, magpies and other animals was recorded along with the number present and their position in relation to the trap (>1m from trap, <1m from trap, on the trap or in the trap). It was not always possible to identify species of small passerine due to video quality issues, and all small birds such as robins, blue tits, great tits and dunnocks were amalgamated into a single group and referred to as ‘small passerine’.

The data were summarised in the form of the number of minutes in each hour when a category of animal was present, split into the distance categories from trap and with a note of the maximum number recorded at any one time.

Due to constraints of camera positioning, the area around the trap that was visible for each trap varied, and this influenced what could be seen in the >1m category. Hence analysis only considered animals seen within one meter of the trap, rather than any seen further away but in the vicinity.

2.7 Injury assessments

2.7.1 Scope for injury

Non-target species removed from traps were examined for any injuries or marks (fresh or old), and then released. Target bird species were removed from traps and either kept for use as decoy birds, or more often euthanized. Most birds were examined in detail, again noting any fresh or old injuries, and then frozen for later examination by a veterinary surgeon. These data were used to investigate the relationship between traps, activity in the traps and the bird’s subsequent physical condition.

2.7.2 Initial examination

During the initial examination a note was made of the following:

- Standard morphometric measurements;
- Bill abrasion above the bill: scored from 0 to 5, (where 0= none and = serious (e.g. raw and bleeding over a significant area);
- Bill abrasion below the bill: scored from 0 to 5 (where 0= none and 5= serious (e.g. raw and bleeding over a significant area);

- Bill damage: scored 0 to 5 (0= no marks and 5= serious (e.g. significant area of missing bill sheath). This was combined with the bill abrasion scores to give a 0 to 15 score;
- Condition of primary (scored 0 to 5), secondary (scored 0 to 5) and tail feathers (scored 0 to 5) where 0 is no damage and 5 is serious damage.: combined to give a 0 to 15 score. Theses scores incorporated all visible wear and damage and therefore also included any pre-existing wear and damage. Temporary factors such as feather matting and feather separation, both of which could be resolved by the bird preening itself at some future point were also incorporated in the overall score;
- Any injuries to feet, toes or claws: scored 0 to 5 (0= none, and 5= serious (e.g. missing toe).
- Any other obvious injuries.

2.7.3 Veterinary examination

Examination by the veterinary surgeon took place on 95 birds, who undertook the following measurements:

- Age group and sex.
- Condition score based on the thickness of the pectoral muscle tissue either side of the keel bone: 1 to 3, with 3 indicating a very high body condition score based on a substantial amount of pectoral muscle.
- Overall injury score, this took account of all injuries found on the bird, including abrasions, feather breakages, any cuts or marks or subcutaneous haemorrhage that was found. The injuries were scored as nil, mild, moderate or severe. A mild or moderate level of injury was one, which in the vet’s opinion, would be unlikely to compromise the bird’s survival should it escape or be released.
- Total internal fat: this was removed from around the crop and from the abdominal cavity and weighed.
- Liver weight: the liver was removed and weighed.

3. RESULTS: BIRD CATCH

Over the course of the study, reasonable numbers of three of the four main target corvid species were caught (magpie, carrion crow and jackdaw); note that hooded crows are not commonly found in the trap area. Only a single individual of another target species (rook) was however caught. In addition several non-target species, including a significant number of buzzards, were caught. The catch statistics below focus on the main target corvid species plus buzzards, which were the only non-target species to be caught in significant numbers and are of interest due to concerns about raptor trapping.

3.1 Catch by species

There were 138 captures of target species and a further 15 captures of non-targets. Table 3.1 lists all birds (and mammals) that entered and triggered a trap. However, some of these species exited the traps prior to removal by a trap operator. The actual figures for birds that were retained by the trap were slightly less, and this latter figure would be the 'apparent' catch, comparable to other studies and observations which recorded birds caught and later removed or released. This section considers birds actually caught in the trap regardless of whether they later escaped.

Table 3.1 Trap 'captures' (figures in brackets refer to the subtotal of animals present when trap visited, i.e. apparent catch), and catch rate (total number caught as % of 1601 days trapped).

Species/Group	Total Number Caught	Number escaping immediately	Number escaping in total	Catch rate
Crow	**40** (38)	0	2	2.50%
Magpie	**71** (64)	1	7	4.43%
Jackdaw	**26** (23)	0	3	1.62%
Buzzard	**9** (7)	1	2	0.56%
Rook	**1** (1)	0	0	0.06%
Blackbird	**4** (3)	1	1	0.25%
Small Passerine	**1** (0)	1	1	0.06%
Grey Squirrel	**1** (0)	1	1	0.06%
Total	**153** (136)	5	17	0.1%

In the case of one magpie and one buzzard they exited through the jaws of a Larsen-mate after the jaws initially closed (potentially as the jaws 'bounced'). Two blackbirds, a small passerine and a grey squirrel also triggered traps while inside them, but immediately exited through the mesh of the trap. Direct and video observations revealed that many small passerines entered but did not trigger traps (see 4.3). In many cases, in particular the multi-catch cage traps, small passerines were able to exit the traps either via open entrances or through the mesh.

3.2 Catch by location

The number of corvids and raptors trapped at each location are shown in figure 3.1.

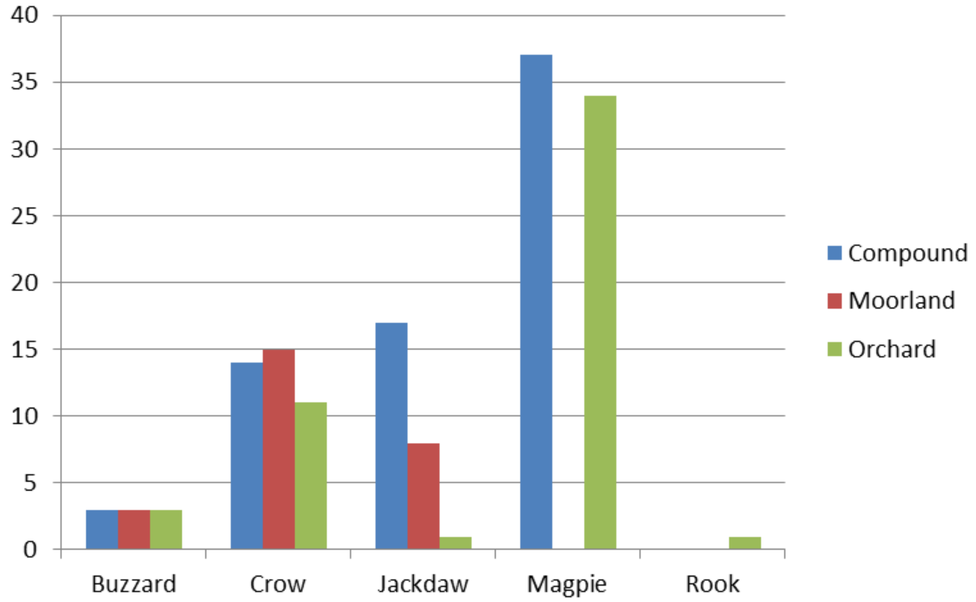


Figure 3.1 Number of birds caught at each location.

The catch pattern for most species varies between sites, even if allowing for the shorter trapping period at Moorland. The most notable pattern is the lack of magpies caught at 'Moorland' and the very low number of jackdaws at 'Orchard'. For buzzards and crows similar numbers were trapped at each site. The lack of rooks is surprising given that they appeared at least as numerous as jackdaws on the farm where the study took place and were often seen feeding with jackdaws in the fields.

3.3 Catch by trap type

The numbers of corvids and raptors caught by each trap type are shown in Figure 3.2.

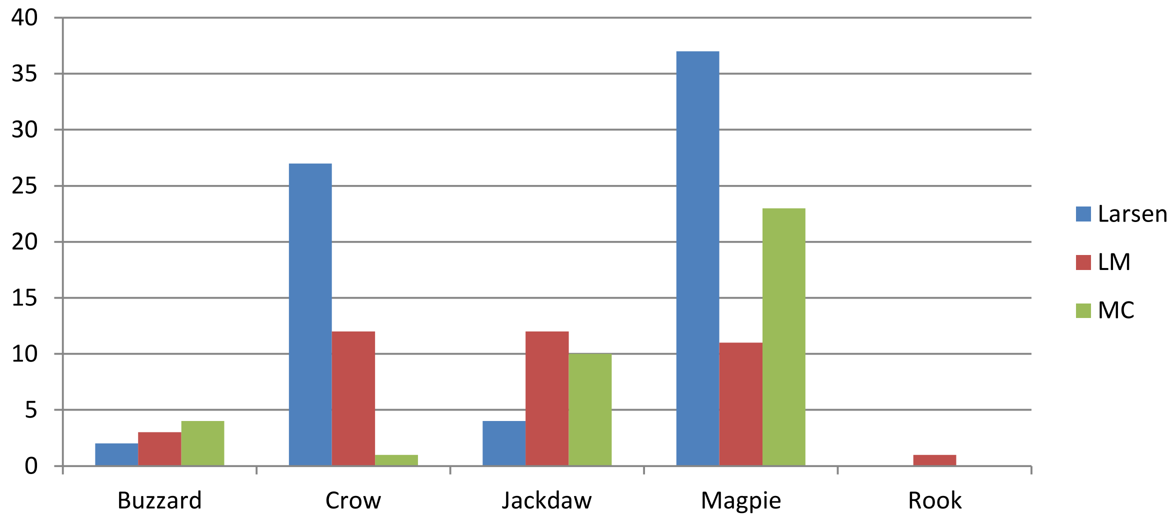


Figure 3.2 Number of birds caught by trap type.

The most notable pattern is the lack of crows caught in the multi-catch trap.

3.4 Catch by date

The numbers of each species being caught varied throughout the year. Figure 3.3 shows the monthly catch of the three main corvid species and buzzards from June 2014 to September 2015.

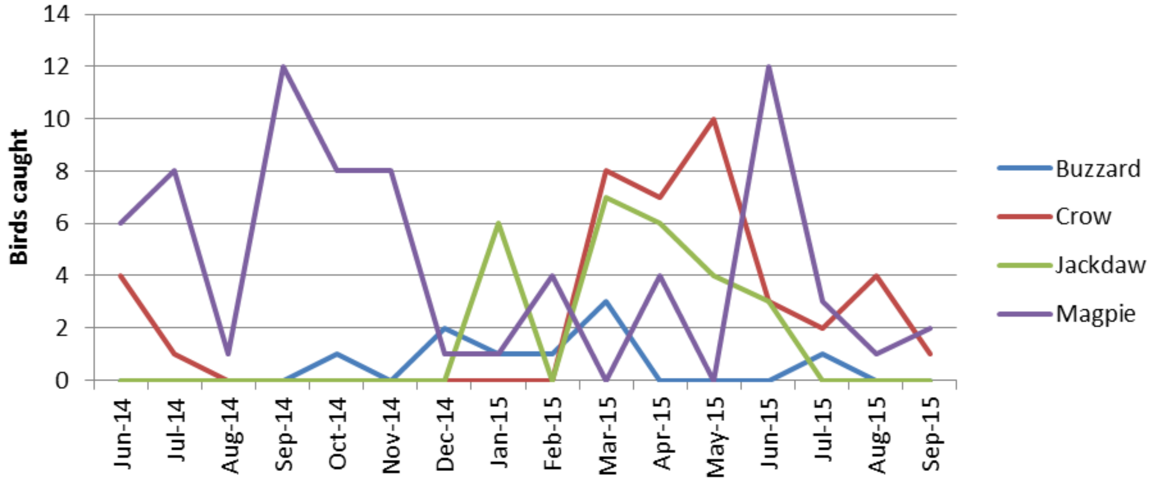


Figure 3.3 Birds caught by month (in all trap types)

Figure 3.3 illustrates the pattern of catches in terms of individuals through the study. However, the number of trap days in each month did vary considerably, so a difference between months in the numbers caught could be influenced by a difference in the number of trapping days. To correct for this we calculated a catch rate for each species using the numbers trapped and the number of trap days. These catch rates have been plotted by species for each of the three trap locations in figures 3.4 (1-4).

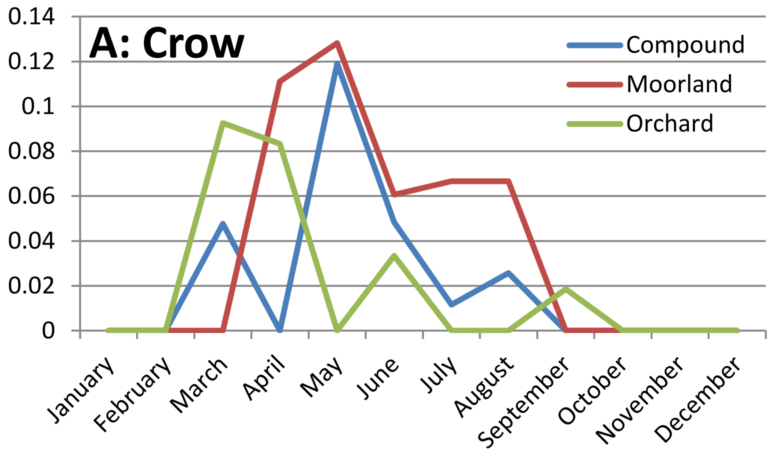


Figure 3.4.1 Catch rate of Crows by month and location

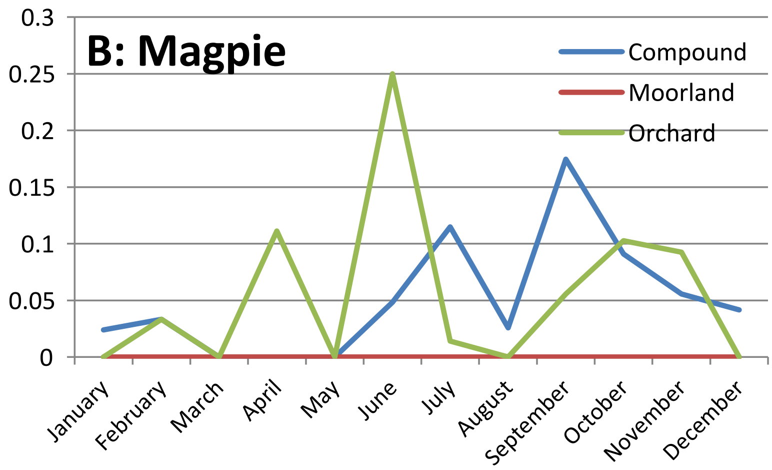


Figure 3.4.2 Catch rate of Magpies by month and location

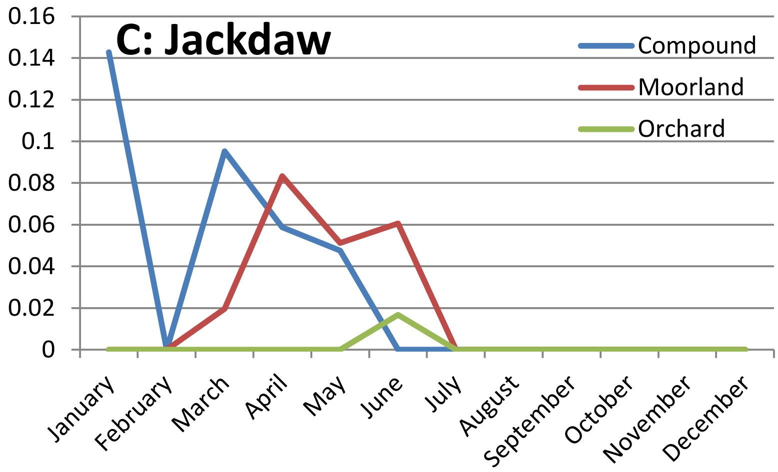


Figure 3.4.3 Catch rate of Jackdaws by month and location

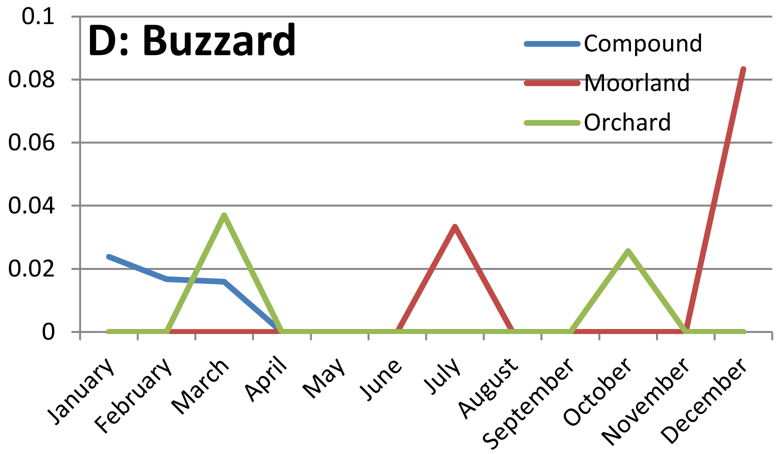


Figure 3.4.4 Catch rate of buzzards by month and location

The catch rates varied considerably month to month for each species. The catch rate of crows increased in March and eventually fell away by Sept/Oct with no birds being caught in the period October to Febuary. This pattern was broadly similar for all three sites.

The magpie catch rate peaked mid-summer at 'Orchard' and around mid-autumn at 'Compound' however it varied considerably from month to month. Catch rate in winter was low. This variation may be indicative of the fact that magpies often appeared in groups during summer and autumn, and many members of that group would become trapped over a period of days, thus explaining bursts of catches. No magpies were caught at 'Moorland' (large arable field, bounded by a hedge that contained the occasional mature tree), although a pair of magpies was seen in the vicinity of the traps on at least one occasion when the trap was visited. Jackdaws were only caught between January and June, and apart from a high January catch at 'Compound' the catch rate was similar across two of the locations, however the 'Orchard' location only caught one bird.

The total number of buzzards caught was low, thus any interpretation of monthly catch rates should be cautious. The catch was spread out across the year but does appear highest in winter and early spring.

3.5 Modelling catch rates

For magpies and jackdaws there were some instances of more than one bird being caught in the same trap on the same day. This was firstly because it was possible to catch a bird early in the day, remove it and then catch another, and secondly with the multi-catch traps more than one bird could be caught at the same time (this would also be true for Larsen traps if more than one capture compartment had been set). Catches of more than one bird per day per trap were relatively few, and for the purpose of the analysis, the probability of catching at least one bird per trap per day has been considered. Actual catch rates would be somewhat higher than these values.

The effect of several factors on the probability of catching birds were modelled using binomial Generalised Linear Models (GLMs) with a logit link. We investigated the significance of factors by looking at their associated p-values when dropping them from the full models. We also considered a sequential backward elimination procedure, in which non-significant variables (i.e. with p . > 0.05) were dropped, starting with the variable with the highest p-value, after which the model re-fitted with the remaining variables. This did not affect results.

3.5.1 Crows

As there was only a single crow caught in a multi-catch trap, this was removed from the model, which examined crow trapping in Larsen and Larsen-mate traps only (table 3.2).

Table 3.2 Results of a binomial Generalized Linear Model for crow catch rate. The p-values are from the full model

Variable	P-value
Month	<0.001
Location	0.26
Trap type	0.015
Bait	0.61

The month showed the strongest effect in terms of catch rate, primarily because crows were not caught between early July 2014 and March 2015 (a period of over seven months).

Possible reasons for this are discussed elsewhere (6.1.1) but may not all be directly linked to the date. Trap type was also significant, but there were no clear effects of bait type or location.

By fitting a binomial GLM using all variables without interactions and averaging out other factors, the marginal catch probability on a given non-autumn/winter day can be estimated (i.e. outside of August to February – during which times no crows were caught) for trap type, bait type, and for trap type at each location. The probabilities are presented as percentages in tables 3.5 & 3.6, effectively describing the percentage chance of catching a crow on an average day.

Table 3.5 Estimated daily chance of catching a crow by bait and trap type

Trap type	Egg	Bread	Meat	Decoy crow	Average
Larsen	5.37%	5.33%	7.65%	9.45%	6.95%
Larsen-mate	3.29%	3.27%	4.76%	NA	3.77%

Table 3.6 Estimated daily chance of catching a crow by location and trap type

Trap type	Compound	Orchard	Moorland
Larsen	6.07%	5.31%	9.46%
Larsen-mate	3.26%	2.84%	5.22%
Average	4.66%	4.08%	7.34%

3.5.2 Magpies

Magpies were not caught at the Moorland site, and this site was therefore excluded from the model. Results for the remaining two sites are shown in table 3.7.

Table 3.7 Results of a binomial Generalized Linear Model for magpie catch rate. The p-values are from the full model

Variable	P-value
Months	<0.001
Location	0.778
Trap type	0.011
Bait	<0.001

The variables bait and month showed the strongest effect in terms of magpie catch rate. Trap type was also significantly associated with catch rate.

As with crows, a binomial GLM was used incorporating location, trap type and bait, which gave marginal catch probabilities for trap type with bait type, and for trap type at each location; these are presented in tables 3.8 and 3.9.

Table 3.8 Estimated daily chance of catching a magpie by bait and trap type

Trap-type	Egg	Bread	Meat	Decoy magpie	Other bird	Average
Multi-catch	3.95%	5.42%	2.34%	NA	1.01%	3.18%
Larsen	7.18%	9.62%	4.36%	30.38%	1.94%	10.70%
Larsen-mate	2.33%	3.24%	1.36%	NA	NA	2.31%

Table 3.9 Estimated daily chance of catching a magpie by location and trap type

Trap type	Compound	Orchard
Multi-catch	3.30%	3.06%
Larsen	10.99%	10.41%
Larsen-mate	2.39%	2.22%

3.5.3 Jackdaws

All of the variables in the binomial GLM were significantly associated with the probability of catching jackdaws (table 3.10). Bait, month and location all showed strong effects. The strong association with bait can be explained by the fact that jackdaws were only caught using bread or decoy birds. Similarly, the association with month can be explained by the fact that jackdaws were only caught between January and June 2015.

Table 3.10 Results of a binomial Generalized Linear Model for jackdaw catch rate. The p-values are from the full model

Variable	P-value
Months	<0.001
Location	0.001
Trap type	0.039
Bait	<0.001

The strong effect of Location can be explained by the fact that only a single bird was caught at the 'Orchard' (mixed woodland) site, whereas many more jackdaws were caught at the other two locations. Finally, the significant effect of Trap type was much weaker than the other factors, and while multi-catch traps had a slightly higher catch rate, the difference between the trap types was quite small.

As with crows and magpies we modelled the marginal catch probabilities, which are presented in tables 3.11 and 3.12 as the percentage chance of catching a jackdaw on an average day.

Table 3.11 Estimated daily chance of catching a jackdaw by bait and trap type

Trap type	Bread	Decoy magpie	Decoy jackdaw	Average
Multi-catch	3.46%	NA	18.61%	11.04%
Larsen	5.51%	18.48%	NA	12.00%
Larsen-mate	13.03%	NA	NA	13.03%

Table 3.12 Estimated daily chance of catching a jackdaw by location and trap type

Trap type	Orchard	Compound	Moorland
Multi-catch	1.52%	16.17%	15.42%
Larsen	1.62%	17.59%	16.77%
Larsen-mate	1.65%	19.19%	18.24%

The results suggest that when a decoy bird (jackdaw or magpie) was used in either a Larsen or a multi-catch trap, it was more effective than bread (eggs and meat were not effective at all) at catching jackdaws. The location data shows that the 'Orchard' (woodland) site was far less successful than the other two sites which had broadly similar catch rates.

3.6 Discussion

3.6.1 Bait

Modelling suggests that there were significant differences according to time of year and different trap types when catching crows, but we did not identify a significant difference between bait types, although this may be due to small sample sizes. Nonetheless, there is a suggestion that crows are more easily caught using a decoy crow than using food bait alone. GWCT experiments found decoy crows to be 15 times more efficient at catching crows than bait (Reynolds, 1990). However, efficacy data from the current study was much closer to that collected by British trap users (Tapper *et al*., 1991), and reflected that of Tsachalidis *et al*. (2007), who also found that a decoy bird was most effective for catching crows, but also that meat was a better bait than bread or eggs.

Time of year and in particular, bait type were also important factors affecting magpie catch rate, although trap type less so. In all trap types, meat was the least effective bait for magpies, egg was more effective than meat, and bread was more effective than egg. However in Larsen traps, the use of a magpie decoy bird was considerably more effective than bread, which probably accounts for why the Larsen trap appears to be more effective for catching magpies than the other traps. A decoy magpie was between three and seven times more effective than food bait (depending on the bait). These results are similar to the results reported by Reynolds (1990) and Tapper *et al*. (1991), which suggested that magpie decoys were 10 times more effective in strictly controlled experiments and five times more effective when examining trap user data. Our magpie results contrast with the findings of others working in Greece and Korea (Tsachalidis *et al*., 2007; Song *et al*., 2015) who found that meat was as good as or better than using a decoy bird to attract magpies. However, one study had poor success with Larsen traps, and both studies used large multi-catch cages.

Jackdaw catch was also strongly linked to time of year but also to bait type, with location and trap type having some influence. Decoy birds appear to be the most successful bait to attract jackdaws, although Reynolds (1990) speculated that decoy birds (in Larsen traps) would be much less effective for rook and jackdaw. However, results from the current study for jackdaw suggest that a decoy bird could be between three to five times more effective at attracting jackdaws than food baits alone. For magpies conspecific decoy birds were best, although for jackdaws both jackdaw and magpie decoy birds were equally successful (albeit in different trap types). Jackdaws were not used as decoy birds in the Larsen trap, as this is currently not permitted under the general licences, and it is unlikely that trappers use this method, although jackdaws were used as decoy birds in the multi-catch traps. Conversely, magpies or crows were not used as decoys in multi-catch traps in the current study, primarily to ensure key decoy species did not escape.

Buzzards were only ever caught with meat baits, which given their main dietary components, is not surprising. However some fears had been voiced that they might occasionally be attracted to eggs based on results of studies conducted by the Department of Agriculture and Fisheries, Scotland (DAFS) in the early 1970's, that trialled the use of eggs laced with alpha-chloralose to control hooded crows in Argyll. A report on these trials (Cuthbert, 1973) states that six buzzards were recovered, but that only one had eaten an egg and died, the remaining ones had scavenged poisoned crow carcases (four survived being narcotised and one died). The trials in Argyll indicated that the attractiveness of eggs to buzzards is likely to be very low, a conclusion strongly supported by the results from this study.

3.6.2 Month

The month of the year was a strongly significant explanatory variable of catch rate for all species; and it is widely acknowledged that trapping can be dependent on season. Factors influencing this may include the level of territoriality (or not) in the spring; the degree to which species flock or disperse at different times of year, or seasonal availability of foods. Figures 3.3 and 3.4 (1-4) show the distribution of catches.

Other additional factors that may be more unusual were two incidents detailed in section 5.3, in which crows were caught but then escaped from traps. Evidence suggested that these crows then became very wary of the traps and that this wariness also influenced their partner's behaviour toward the traps. We believe it likely that their territorial defence kept other crows away from the trapping site. This resulted in a failure to trap crows between August 2014 and February 2015, until a crow decoy was acquired. Magpies were caught in most months but there was period from mid-winter to mid-spring when catch rate was low. However during this period few magpie decoy birds were used and the use of crow decoy birds from spring 2015 onwards may even have had a deterrent effect on some magpies. Jackdaws appear to have a period of catch success from January through to June. None were caught in late summer through to winter although arguably there was no apparent reason related to bait or bird behaviour (as for magpies and crows) to explain it.

In this study we used both baited traps, and traps with decoy birds. While it is generally accepted that the use of decoys is more effective against territorial individuals (in the case of crows and magpies) than bait alone, it is highly likely that non-territorial birds will also be drawn to decoys due to curiosity or desire to associate. The degree of territorial defence behaviour may vary through the year (certainly the size of territories can vary significantly (Charles, 1972; Birkhead *et al*., 1986) and this in turn may influence both the trapability of a breeding bird (using a decoy) and the likelihood of non-territorial birds being present (and thus trappable). A further influence will be the effect of the capture, removal and speed of replacement of territorial birds. In this study the cumulative effect of all of the above factors may have influenced seasonal catch rates thus it is not possible to accurately determine the root cause of any seasonal variation. During this study we did not specifically target any single species (with the exception of decoy choice) or territorial or non-territorial individuals and the traps were operated at the same sites throughout the duration of the study. This may be representative of the way that some people operate their traps, but others may move their traps around different sites and may only target territorial birds, or non-breeding flocks depending on the nature of their problem. The length of time we were trapping at sites may have influenced our catch rate at certain times of year compared to trappers operating different strategies, such as moving traps or only trapping for limited periods.

3.6.3 Trap type

The relative success of trap types with the different target species suggests that using a multi-catch with just bait is ineffective for crows. However, a crow decoy bird was not used in multi-catch traps (Section 2.3.1) and it is possible that influenced crow catch in these traps. In addition, the exclusion wire we fitted to the multi-catch traps (Section 2.2.3) to reduce the chance of escapes may have had a slight deterrent effect of crows, although the single crow that was caught was in a trap fitted with the wire, and we caught three buzzards in a multi-catch restricted with wire and buzzards are larger than crows (although perhaps not as cautious). The type of trap seems much less important for magpies and jackdaws. Bearing in mind caveats about the small sample size, trap type appeared to have no influence on buzzard capture rate.

3.6.4 Location

While crows showed no significant increases in catch rate between locations (and buzzards showed no difference at all), catch rates of both magpies and jackdaws appeared to be influenced by site. The failure to catch magpies at 'Moorland' might be reflective of the fact that the 'Moorland' location was around 100m+ from any significant wooded areas in which one might expect magpies to be based whereas 'orchard' was actually in a wooded shelter belt, and 'compound' was around 10-20m from a thick wood of young trees and bushes. However given that territorial magpies generally have a home range size in the order of 5ha in summer and 7ha in winter (Vines, 1981; Birkhead *et al*., 1986) it is surprising that none were caught and few were seen (116 hours of video viewed of traps at the moorland site and only 1 magpie seen). The 'Orchard' site had an extremely low jackdaw catch, but this site had quite a high degree of cover from trees and bushes and it may indicate that this sort of site (effectively 'woodland') is not ideal for targeting jackdaws. We know that mixed flocks of rooks and jackdaws were seen on a number of occasions feeding in adjacent fields so were potentially available to catch. However in contrast to jackdaws, the only rook caught was trapped at the 'Orchard' site, which given the close association between rooks and jackdaws is surprising.

3.6.5 Summary

Crows: Caught at all sites, Larsen most effective, multi-catch not at all (but did not use decoy bird). Bread and eggs less effective than meat or decoy bird, but not significant. Large period of year when none caught, but this can probably be explained by experience based trap avoidance.

Magpies: Not caught on the open arable site, multi-catch most effective followed by Larsen (once multiple catches are taken into account). Bread is more effective in all traps than egg or meat, but decoy bird much more effective than all baits in Larsen (did not use in multi-catch).

Jackdaws: More successfully trapped in open habitats than woodland. Bread is the most effective food bait (not eggs or meat). Decoy birds (jackdaw or magpie) are more effective than bread, but this limits the trap types which can be deployed.

Buzzards: All three trap types captured buzzards with equal success, although if the current study had not used meat baits, it is possible that buzzards would not have been caught at all, although more medium sized passerines may have been.

4. RESULTS: BIRD ACTIVITY AND NON-TARGET CAPTURE

4.1 Overview

While traps were operating the CCTV was recording constantly, and any activity in the immediate vicinity of the traps was recorded. To gather data on which animals (birds or mammals) visited traps we observed random sections of footage stratified through the daylight hours. Daylight hours were targeted because the primary interest was to identify which birds had the potential to be caught by the traps. For details of the method of random one-hour observations of traps and the one metre area bounding traps used in the analysis, see section 2.6.

4.2 General results

In total, 741 hours of video recordings were observed (245 Larsen traps, 243 Larsen-mate traps and 253 multi-catch traps).

Of these, 420 hours (56%) showed least one visit by an animal (target or non-target) to the vicinity around the trap, but some were outside the one metre area immediately around the trap.

In addition, 372 hours (50%) had at least one visit by an animal to within 1m, including on or in the trap, but which were not caught by the trap, e.g. in deactivated capture compartment of Larsen.

Table 4.1 Number of one hour samples where at least one animal is seen <1m from a trap, % of total hours observed and number of animals caught as % of total days traps set.

Animal	Number hours observed <1m from trap (including on or in trap)	Hours observed as % of total	Catch rate (number caught as % days traps set)
Small Passerine	169	22.7 %	0.06 %
Carrion crow	106	14.2 %	2.50 %
Magpie	98	13.2 %	4.43 %
Blackbird	58	7.8 %	0.25 %
Jackdaw	16	2.2 %	1.62 %
Grey squirrel	14	1.9 %	0.06 %
Buzzard	8	1.1 %	0.56 %
Pheasant	5	<1 %	0.00 %
Rabbit	5	<1 %	0.00 %
Woodpigeon	3	<1 %	0.00 %
Rook	1	<1 %	0.06 %
Stoat	1	<1 %	0.00 %

4.3 Crow and Magpie activity

Both of these target species were seen relatively frequently close to, or on traps. More than 14% of sampled recordings had crows within 1m of the trap, and a similar figure (>13%) was obtained for magpies. Crows and magpies also had the highest catch rates in the study (table 4.1). These comparative differences in observation rates and trap rates is the result of magpies catches, in which multiple magpies would often be caught in quick succession at a given site. This suggests that magpies move around in small groups more than crows, and crows were often observed in pairs or singularly.

4.4 Small passerine activity

Table 4.1 shows that as a group, small passerines were the most commonly recorded animals in the immediate vicinity of traps, and were also the ones that were most frequently seen inside traps; as such, they might be considered the highest potential non-target capture risk. However, evidence suggests that they rarely set traps off, since only one triggered the trap (table 4.1) and this passerine immediately escaped. In general, small passerines are not heavy enough to trigger the Larsen or Larsen-mate traps, and if they do, they are able to squeeze through the mesh to escape. Small passerines were commonly observed entering and exiting multi-catch traps via the mesh. Compared with the corvids, small passerines were seen in the one hour samples approximately one and a half times more frequently than crows or magpies, and yet were 40 times less likely to be caught than crows and 70 times less likely to be caught than magpies.

Table 4.2 provides a breakdown of the 1hr video samples when a small passerine entered a trap, and shows that small passerines are much more frequent visitors at the woodland (Orchard) site (between 16% and 23% of video samples featured them entering traps). This probably reflects the higher density of small passerines present in a woodland location compared to the more open nature of the other two sites. They appear less regularly at the 'Moorland site', where the traps were s*et al*ongside a hedgerow, which may have provided an environment accommodating to small passerines. The smaller sample number at this site may account for the higher variability per trap. The compound site had no shrubs or trees adjacent to the traps, and the nearest vegetative cover of this nature was around 15 metres away on the other side of a high fence. This almost certainly accounted for the infrequency with which small passerines were observed at this site.

There is clear evidence to suggest that small passerines are more likely to be seen entering a trap if it is baited with bread rather than meat or eggs. However, they may have occasionally entered the traps to search for invertebrates, which would have been attracted to the broken egg and meat.

Table 4.2 Number of one hour video samples when small passerines entered traps (by location, trap type and bait type), total number of samples viewed and percentage of total samples viewed at location/trap type with small passerines.

Location	Trap type	Bread	Egg	Meat	Decoy	Total n	% of trap/site
Compound	Larsen	0	1	1	0	102	1.96%
	Larsen-mate	2	0	0	0	100	2.00%
	Multicatch	0	0	3	0	107	2.80%
Orchard	Larsen	10	2	1	4	105	16.19%
	Larsen-mate	17	3	4	0	105	22.86%
	Multicatch	11	3	6	0	106	18.87%
Moorland	Larsen	0	0	2	0	38	5.26%
	Larsen-mate	4	1	1	0	38	15.79%
	Multicatch	0	0	0	1	40	2.50%
	Total	**44**	**10**	**18**	**5**	**741**	**10.39%**

4.5 Other species activity

4.5.1 Blackbirds

Blackbirds are seen near traps (mostly in 'Orchard') reasonably frequently, but only four birds were caught (table 4.1), one of which subsequently escaped through the mesh. Although blackbirds were seen approximately half as often in random one hour samples as crows and magpies they were ten times less likely to be caught than crows and almost 18 times less likely to caught than magpies. Data (not presented) suggests that blackbirds may also be more likely to enter a trap baited with bread.

4.5.2 Jackdaws

Jackdaws were seen relatively infrequently, and were only recorded in 2.2% of one hour video samples, although their catch rate was 1.62%. In contrast to blackbirds and small passerines, their catch rate was actually quite close to their sighting rate. However their catch rate is inflated as jackdaws tended to arrive at traps in small flocks, and were often caught in multiples. Nevertheless they are much more likely to be caught than the smaller birds.

4.5.3 Grey squirrel

Grey squirrels were only seen visiting traps at the woodland ('Orchard') site, although they were seen very occasionally at the 'Compound' site (not during these trials). On several occasions they were seen to climb over the multi-catch trap and on one occasion one triggered a Larsen-mate (but escaped via the mesh; table 3.1). Despite being seen almost as frequently as Jackdaws the one Larsen-mate incident was the only capture event (table 4.1).

4.5.4 Buzzards

Buzzards were also seen relatively infrequently in the one hour video samples (1.1%), but were caught quite frequently. Their catch rate as a percentage of total days trapped was 0.56% which is reasonably close to their sighting rate. Buzzards were seen frequently in the vicinity (i.e. within 100m) of all trap sites when traps were being operated, and may have been searching for prebait (bait left around the trap to help entice birds into the trap).

4.6 Discussion

4.6.1 Selectivity

The above data indicate that with the exception of buzzards, the traps are reasonably selective for target species compared with non-target species. Blackbirds, and small passerines in particular, were seen very frequently at traps but were caught far less frequently than the corvids (table 4.1). Total non-targets comprised 9.8% of capture events, and excluding buzzards, these non-target captures fell to <4%, of which almost half escaped immediately.

However, to compare with other studies, it is first necessary to consider only those birds that were retained in the trap by the time the operator arrived, i.e. the 'apparent' catch. This 'apparent' catch rate gives a target catch of 136 birds vs a non-target catch of 10, thus non-targets comprise 7.4% of 'successful' catches (table 3.1). Other studies such as Tapper *et al*. (1991), Tsachalidis *et al*. (2007) and Diaz-Ruiz (2010), have reported non-targets comprising 0.5-2.1% of total catch. Thus 7.4% seems quite high, with buzzards alone accounting for 5.1%. However, at least one individual (tagged, ringed) buzzard was caught on three separate occasions, and one other buzzard was suspected of being caught twice. This may also happen in other studies, but it is uncertain if trappers will be aware of such recatches, or if they are, regard them as single raptor catch. Two of the studies took place outside the UK, and raptor data may not be justifiably compared, while the Tapper *et al*. (1991) study took place in the UK. The high buzzard catch in this study might be explained by habitat, since the lowland arable farmland on which the traps were located contains several widespread pockets of woodland, and may be considered ideal buzzard habitat. Another more likely explanation could be the size of the buzzard population, which in Scotland has grown by an estimated 48% between 1994 and 2014 (SNH, 2015), and when Tapper *et al*. (1991) undertook their study in 1990, buzzard populations were far lower than they are currently, especially in England (figure 4.1).

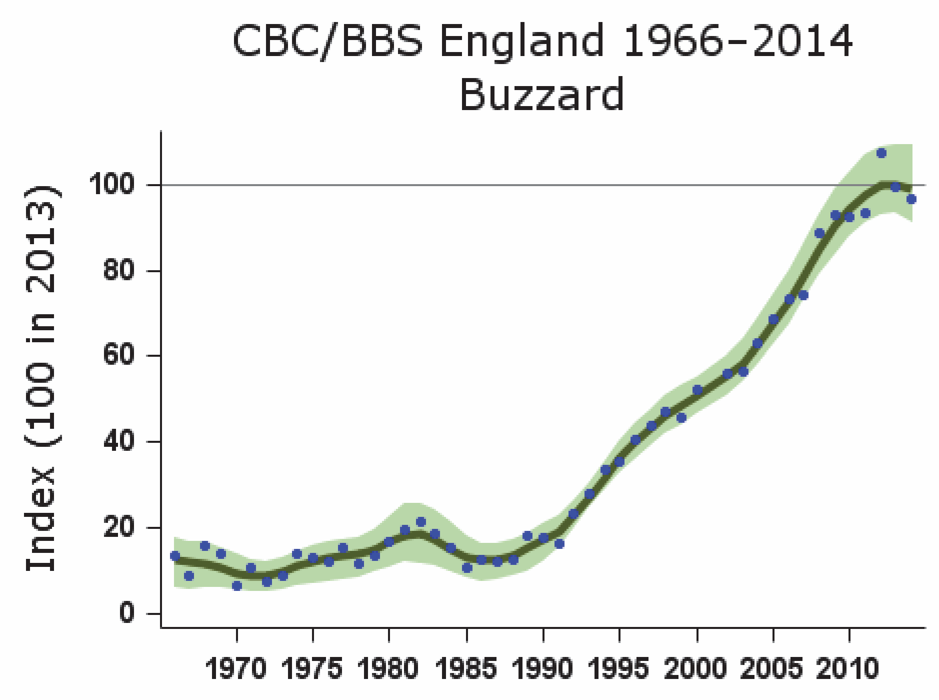


Figure 4.1 Relative change abundance indices for the common buzzard, England 1970-2010, based on data from the Common Birds Census and the Breeding Bird Survey, 1966-2014. Figure reproduced with permission the British Trust for Ornithology, from http://blx1.bto.org/birdtrends/species.jsp?&s=buzza (accessed 9 March 2016).

5. RESULTS: ESCAPES FROM TRAPS

5.1 Escapes

Whenever a Larsen or Larsen-mate trap was sprung, but without a catch, the video footage was examined to identify the cause. In many instances the trap appeared to spontaneously trigger, possibly due to a combination of too sensitive a set and the weather, such as a gust of wind, but occasionally it turned out to have been an escaped bird.

Similarly, if meat or egg baits were taken from a multi-catch trap during the day without a catch, video footage was again observed. It was quickly recognised that small passerines took bread baits from these traps. In addition, random one hour observations of multi-catch traps also helped to identify escapes. However, figures for escapes from multi-catch traps must be considered a minimum, since resource constraints meant that every minute of video footage could not be examined, and bird escapes might be overlooked if the bird were present in the trap for just a few seconds (one magpie entered a multi-catch and exited again within 15 seconds).

Birds managed to escape from both Larsen-mate and multi-catch traps, although only one small passerine was observed escaping a Larsen trap, making it the most effective trap in terms of minimising escapes. The proportion of target birds that escaped from traps (Larsen mates and multi-catch traps only) was 8.7%.

Table 5.1 shows the numbers of each target species, plus buzzards and blackbirds, that escaped the different types of trap. In addition a single grey squirrel escaped from a Larsen-mate and a small passerine escaped from a Larsen after triggering.

Table 5.1 Number of escapee birds (and as percentage of total caught in trap type).

	Larsen	Larsen Mate	Multi-catch
Crows	0	2 (17%)	0
Magpies	0	1 (9%)	6 (26%)
Jackdaws	0	0	3 (30%)
Buzzards	0	1 (33%)	1 (25%)
Blackbirds	0	1 (100%)	0

The worst trap for escapes was the multi-catch; escapes occurred despite narrowing the size of the openings on the ladder. At least 26% of magpies and 30% of jackdaws escaped. The one buzzard (25%) that managed to escape was accidentally assisted because the ladder section had been temporarily removed from the entrance slot of the trap on that particular day. This was a one-off event, and it seems likely that the escape would not have happened had the ladder section been in place.

5.2 Method of escape

Observations of escapes fell into 4 distinct categories.

5.2.1 Larsen-mate trap escapes

There were several target and non-target escapes from Larsen-mates. These escapes were of 3 categories:

- Category 1: Small species simply exited via the 50mm mesh (blackbirds, squirrel, small passerines).

- Category 2: On two occasions birds (buzzard, crow) managed to fly out of the trap while taking off from the split perch, as it gave way. Although the trap closed quickly, there may have been a slight 'bounce' when the spring tension relaxed that enabled the bird to continue its upward momentum and push through the doors in the second after the initial contact of the two trap halves.

- Category 3: On two occasions crows managed to force their way out by pushing the spring-loaded halves of the trap apart. However on one occasion, the crow was uncomfortably entangled, half in and half out of the trap for 14 minutes, until it managed to extricate itself.

Of the two types of Larsen-mate used, both the Category 2 and Category 3 escapes only occurred with one of the designs. This may have been chance or might indicate a difference in spring strength or tension.

5.2.2 Multi-catch trap escapes

Multi-catch escapes took two forms:

- Category 1: Small passerines were able to pass through the wire mesh ‘chicken wire or rabbit netting’ of the traps.

- Category 4: Larger birds escaped either by deliberately or accidentally flying out through the ladder. Deliberate attempts were normally preceded by a number of directed attempts until they appeared to learn to find enough momentum to fold their wings at the right moment to fly out through the gap. Some birds appeared to fly around randomly in the trap before eventually escaping by what appeared to be ‘lucky’ accident. Most of the escapes occurred *after* the entrance was narrowed using a wire.

5.2.3 Larsen trap escapes

Only one bird (a small passerine) escaped after triggering the trap by flying through the trap mesh, i.e. a category 1 escape.

5.3 Discussion

Anecdotally it is well known among many regular trappers that birds are able to escape from multi-catch traps, and has been documented by other corvid trap researchers (e.g. Tsachalidis *et al.,* 2006; Shannon *et al*., 2014). The style of multi-catch trap used for this trial, the ladder trap, is an adaptation of the more basic ‘letterbox’ trap with extra cross-members intended to reduce the chance of escapes. However, further narrowing of such entrances is often undertaken by trappers in response to escape events. Tsachalidis *et al*. (2006) monitored escapes from a similar ladder trap design and progressively reduced the size of the opening, reducing hooded crow escapes from 80% down to 0% and magpie escapes from 100% to 19% at a final entrance size of 17.5 x 15cm. As noted in the methods (2.2.3) the traps in this trial were commercial, off-the-shelf designs, and initially, the ladder trap was used without modification. However reports in the literature, and witnessing a bird escape, prompted the authors to reduce the entrance gap using an offset wire fairly early in the trial, taking the aperture down to 16 x 13 cm.

5.3.1 Larsen-mate escapes

Two crows managed to escape from Larsen-mates after being trapped (category 3 escapes), which illustrates several potential problems with the trap design.

In the first incident the bird was caught cleanly in the Larsen-mate, but after a few minutes managed to climb up into the narrow section near the 'jaw' opening of the trap. In the process of moving, it pushed its back against one side of the trap and its feet on the other, which created a gap by forcing the trap halves apart. Eventually the bird managed to push itself through the gap to escape.

The second incident took place after the crow had been in the trap for three hours, when it managed to push its head through the mesh close to the 'jaws' of the trap. Most birds caught in Larsen-mates push their heads out through the mesh repeatedly due to the large size of the mesh. However, in this case, while its head was protruding out of the mesh, it managed to push the two halves of the trap apart enough to flip its body out. The trap then closed, leaving the bird with its body outside the trap, its neck in the trap 'jaws' and its head sticking through the mesh. If its head had simply been inside the trap, then it would have probably pulled it out through the jaws, but because the head was stuck back through the mesh, it made it much harder for the bird to escape the trap. The trap ended up on its side, with the bird entangled half in and out for 14 minutes, before it finally got free and flew away.

5.3.2 Escapes and mesh size

In contrast to other categories of escape, which can apply to target birds, category 1 escapes are desirable, since they allow small, non-target species to leave unharmed, they are a direct consequence of the mesh size. The standard wire netting (40 x 25 mm) of the multi-catch and the weldmesh (75 x 25 mm) of the Larsen both allowed small birds to pass through when they moved slowly, but when birds were moving quickly, it occasionally became a barrier. For example, on one occasion a small passerine was in a multi-catch trap when a magpie entered. The magpie chased the small passerine for a brief period while the smaller bird appeared to be trapped, although eventually it escaped through the mesh. The 50 x 50 mm mesh of the Larsen-mates allowed small passerines through at speed, and even blackbirds and squirrels could pass through it barely obstructed.

Increasing the size of the mesh on all traps to something approaching the mesh size found on the Larsen-mates could be a means to prevent non-target captures of most birds and mammals smaller than corvids.

5.3.3 Other forms of escape

The process of removing both trapped and decoy birds from traps, changing the feed and water of decoy birds, and transfer of decoy birds between traps and holding facilities (if these are used), all provide opportunities for birds to escape. Taking account of non-targets that were released, and trapped birds which escaped of their own accord, 30 birds were lost accidentally on these occasions, in particular during the process of maintaining the birds in the aviaries. The main issue relating to this type of accidental loss is the condition of the bird at the point of escape, and whether or not the process of trapping has impacted upon the survival capability of that bird; this will be covered in section 8.

6. RESULTS: INITIAL CAPTURE BEHAVIOUR

The initial capture sequence (i.e. the point at which the bird enters the trap and is caught) was considered separately from the rest of its time in the trap. The primary interest was to see if the spring closure mechanisms of the Larsen and Larsen-mate traps were likely to injure or entangle the birds in any way. The behaviour of the birds immediately upon entering and becoming trapped was also of interest, as was the level of cautiousness expressed by the birds prior to getting trapped.

6.1 Cautiousness

The degree of caution exhibited by birds prior to entering traps varied widely. In an attempt to measure hesitance, an index of caution based on a scale of 0 to 5 (0= no sign of any caution to 5= showed extreme caution) was created. The assessment was entirely subjective, and results are listed for each trap type in tables 6.1.1 to 6.1.3. The average score is the sum of the scores for that species, divided by the total number of that species caught in the trap (n); the smaller the figure, the less caution observed. A dash ('-') denotes that the sample size was too small to justify calculating an average.

Table 6.1.1 Degree of cautiousness shown at Larsen-mate traps.

Larsen-mate traps	0	1	2	3	4	5	Average score
Crow (n = 11)	3	4	1	2	0	1	0.55
Magpie (n = 10)	1	4	3	1	1	0	1.7
Jackdaw (n = 11)	4	3	3	1	0	0	1.1
Buzzard (n = 3)	0	2	1	0	0	0	-
Rook (n = 1)	1	0	0	0	0	0	-
Percent of total	25%	36%	22%	11%	3%	3%	

Table 6.1.2 Degree of cautiousness shown at Larsen traps.

Larsen traps	0	1	2	3	4	5	Average score
Crow (n = 24)	0	7	14	2	0	1	1.91
Magpie (n = 38)	2	16	10	6	3	1	1.87
Jackdaw (n = 3)	2	1	0	0	0	0	-
Buzzard (n = 1)	0	0	1	0	0	0	-
Percent of total	6%	36%	38%	12%	5%	3%	

Table 6.1.3 Degree of cautiousness shown at multi-catch traps.

Multi-catch traps	0	1	2	3	4	5	Average score
Crow (n = 1)	0	0	1	0	0	0	-
Magpie (n = 14)	1	7	5	1	0	0	1.43
Jackdaw (n = 1)	0	0	1	0	0	0	-
Buzzard (n = 4)	0	0	2	1	1	0	-
Percent of total	5%	35%	45%	10%	5%	0%	

No statistical analysis has been conducted on these figures and sample sizes for jackdaw, buzzard and rook are small (and for crows in multi-catch traps). The percentage figures at the bottom of each table indicate that most birds show a low or modest amount of caution towards entering the traps. The data also suggest that birds are least concerned about Larsen-mate traps than the other two trap types. While crows are marginally more cautious than magpies at Larsen traps, they are less cautious than both magpies and jackdaws at Larsen-mate traps. The above data does not include incidents where birds were overly cautious to the extent that they did not get trapped, and therefore it may be biased towards lower scoring individuals. Incidents of this are discussed below in 6.1.1.

6.1.1 Trap avoidance

On the 12th of June 2014, a crow was caught in a Larsen-mate trap at the Orchard site, which then escaped by its own efforts; another crow was not caught at that location until 9th of March 2015, approximately nine months later. Similarly, a crow was caught and then escaped (see 5.3) from a Larsen-mate on the 3rd of July 2014 at the Compound site; no further crows were caught at this location until the 3rd of March 2015, eight months later. During this period the traps were baited and set, and regularly caught other species such as magpies, jackdaws and buzzards. Crows were frequently present at the sites, and would often cautiously venture close to the traps to take pre-bait, and where possible, bait within the traps. Typically, the crow would walk to within 0.5-1m of a Larsen or Larsen-mate, dart in quickly to take bait and jump back as if frightened of the trap. One of the sites is overlooked by the authors' office, and from here, the crows were normally seen near the traps in pairs. While one would try and take bait, the other would act as a lookout standing on a high point nearby. If the 'lookout' caught sight of movement, it would alert its partner who would immediately abandon the attempt to take bait, and they would both fly away, indicating some level of cooperation and communication between them. The crows were also seen standing on Larsen traps, and would attempt to reach the bait without actually entering the trapping compartment. One crow was finally caught when attempting this manoeuvre and slipped in by accident. In both cases, it was assumed that the experience of being caught and then escaping a trap had made both crows extremely wary, and that they had then influenced their partner's attitude towards the traps. The result was a territorial pair that wouldn't enter a trap, but which also defended their territory, and prevented other crows from interacting with the traps.

Once one of these birds was finally caught, it was used as a decoy bird at the other location, where a further crow was quickly caught, suggesting that the desire to defend against an intruder (decoy bird) was much stronger than the desire to avoid entering the trap. Once these pairs were removed, crows were regularly caught at both trap sites. We consider it likely that we would have continued to catch some crows through autumn and winter but that the behaviour described above precluded it.

The concept of an animal becoming or being trap-shy is accepted by most trappers. However, there is anecdotal evidence that some raptors released from multi-catch traps unharmed will return to take more food. This suggests that for some birds the experience was not overwhelmingly unpleasant, or that the chance of a free meal was enough to override the negative aspects. In this study, a buzzard caught in a Larsen trap, which was ringed and tagged, was subsequently caught twice in ladder traps. Some of the trappers involved in Part 2 of this study also reported repeat catches of tagged/ringed buzzards, sometimes very frequently (S Jamieson pers. comm.).

6.2 Behaviour towards decoy bird

The behaviour of a trapped bird towards the decoy bird, for approximately two minutes prior to capture was also analysed. In total, 40 sections of video footage were retained that were sufficiently long to permit analysis. The behaviour was categorised as follows: none, shows interest, mild aggression, strong aggression (table 6.2).

Table 6.2 Level of interest shown in decoy bird by bird immediately before capture.

	None	Interest	Mild aggression	Strong aggression
Crow (n = 19)	3	8	4	4
Magpie (n = 21)	8	11	1	1

Bearing in mind the small sample size, most magpies showed some interest or none at all in the decoy bird, and only a small number exhibited any aggression towards it. Crows appeared more likely to show aggression than magpies. For both species, curiosity was the most likely behaviour shown towards the decoy bird.

6.3 Risk of injury during capture

Two aspects of the initial capture of birds in Larsen and Larsen-mates were examined: whether the bird was struck by the mechanism and how hard, and whether the bird became entangled in the mechanism and for how long.

6.3.1 Larsen traps

There were 67 video clips of a Larsen capture event, involving four species.

Striking of the bird by the door as it closed was categorised as "not struck", "'brushed' by door", "light contact with door", or "hard contact with door" (see tables 6.3 and 6.5). While the term 'hard contact' implies a level of seriousness or injury, 'hard' was judged relative to the other categories, and in actual fact none of the birds was struck violently. The intention was also to record if birds were 'stunned' by contact with the door, but none of the birds seemed to be affected in any way by impact from the trap closure mechanism, so all were recorded as '0' and this category has not been included in the tables below.

Table 6.3 Bird contact with door of Larsen traps at closure.

	Contact with door of Larsen at closure			
	No contact	**'Brushed'**	**Light contact**	**Hard contact**
Crow (n = 24)	1	12	10	1
Magpie (n = 38)	16	16	5	1
Jackdaw (n = 3)	2	1	0	0
Buzzard (n = 2)	0	0	2	0
Percent of total	28%	43%	25%	3%

As expected, the results indicate that the larger birds (crows and buzzards) were more likely to be contacted by the door mechanism as it closed simply due to their size relative to the opening. Nonetheless, the majority of birds were simply 'brushed by the door', with very few being struck 'hard'.

Entanglement was defined as any part of a bird being caught in the trap mechanism, or its progress into the trap being impeded or delayed noticeably by the mechanism, even for one second (tables 6.4 and 6.6).

Table 6.4 Birds entangled in Larsen traps.

Entanglement in Larsen door	No	Yes
Crow (n = 24)	17	7
Magpie (n = 38)	37	1
Jackdaw (n = 3)	3	0
Buzzard (n = 1)	0	1
Total	57	9

The vast majority of birds (86%) did not get entangled in any way. Of the remaining 16%, all were caught with one wing in the closing door. The length of time the bird was caught or delayed in the mechanism was also recorded. Seven out of nine birds were caught/delayed for between one and three seconds (one magpie, and six crows). One buzzard was caught for five seconds and one crow was caught for 10 seconds. In the case of the buzzard it entered the trap with its wings up and then had to pull them in past the closing door of the trap. The crow was only caught for 10 seconds because it chose to grasp hold of the door as it closed and was left hanging mostly in the trap and with its wing outside until it let go, at no time did it appear to be physically trapped or held by the door.

As with strikes, the larger birds (crow and buzzard) appeared to become entangled proportionally more often, although in both cases the sample of buzzards is very small and any interpretation should be treated with caution. All in cases, the buzzards were not obviously injured at the inspection prior to release, and all flew away in a manner that indicated there was no injury.

6.3.2 Larsen-mate traps

There were 36 instances of video footage of a Larsen mate capture event, involving five species. Instances when birds made contact with the trap at closure were assessed (table 6.5), and indicate that birds were less likely to make contact with the trap at closure than with Larsen traps, although these data are based on fewer capture events. Again, no birds were deemed to have been 'stunned' by any contact with the trap.

Table 6.5 Birds struck by closing Larsen-mates.

	Contact with Larsen-mate at closure			
	No contact	**'Brushed'**	**Light contact**	**Hard contact**
Crow (n = 11)	9	1	1	0
Magpie (n = 10)	9	0	1	0
Jackdaw (n = 11)	10	0	0	1
Buzzard (n = 3)	1	0	2	0
Rook (n = 1)	1	0	0	0
Percent of total	83%	3%	11%	3%

The data for crows and magpies are quite similar but there is a small indication that buzzards might be more likely to be struck by the closing trap, but the very small sample size should be treated with caution.

Records of entanglement in the Larsen-mates were recorded in the same way as for Larsen traps (table 6.6).

Table 6.6 Birds entangled in Larsen-mates.

Entanglement in Larsen- mate	N	Y
Crow (n = 11)	11	0
Magpie (n = 10)	10	0
Jackdaw (n = 11)	10	1
Buzzard (n = 3)	2	1
Rook (n = 1)	1	0
Total	34	2

It is clear that most birds (94%) did not become caught in the mechanism. Of the two birds that became caught, one was a buzzard that jumped into the trap with wings up and the trap closed on them, whereupon it pulled its wings in; total time 'caught' was around one second.

The other entanglement involved a jackdaw that entered the trap, picked up the bait, then attempted to fly away. As the bird took off from the split perch it triggered the trap and it closed just as the bird was about to exit. The trap closed with the birds head outside and the body inside the trap. The bird was caught initially near the top of the trap but then slid down about halfway, stuck between the two halves of the trap. It seemed unable or unwilling to pull its head back through and sat for several minutes with occasional attempts to free itself. After four minutes it had moved back to the top of the trap and it managed to pull its head back inside. The bird did not seem particularly traumatised by this and immediately went back to pick up the bait again and attempt to leave. This was the only incident out of all *captures* in all traps that a bird became seriously entangled, all other incidents were merely delays to the bird being fully inside the trap. However, these data do not include the crow that managed to escape a Larsen-mate, but also spent some time with its head entangled in the trap (see 5.3).

The risk of injury at the point of capture seems to be low in Larsen-mate traps, but higher than in Larsen traps. Multi-catch traps pose very little risk of injury at the point of capture because they have no moving parts.

6.4 Aftermath of capture

Bird behaviour during the first two minutes of captivity was also assessed, in particular, the level of attention given to any bait (where applicable), and if the bird undertook two classes of behaviour ('jumping, flying and climbing behaviours, and peck and bill pushing behaviours) which were believed to indicate that the bird was trying to escape the trap either by exiting back through the door or top of the trap or by pushing through the mesh.

6.4.1 Bait interest

The level of interest that the bird showed in any bait in the trap in the first two minutes was described as "no interest", "minor", "significant" and "complete" (table 6.7).

Table 6.7 Level of interest in bait after capture

Interest in bait	No	Minor	Significant	Complete
Crow (n = 28)	14 (50%)	5 (18%)	6 (21%)	3 (11%)
Magpie (n = 54)	22 (41%)	11 (20%)	17 (31%)	4 (7%)
Jackdaw (n =17)	3 (18%)	4 (24%)	10 (59%)	0
Buzzard (n = 8)	3 (38%)	1 (13%)	2 (25%)	2 (25%)
Rook (n = 1)	1 (100%)	0	0	0
Percent of total	40%	19%	32%	8%

Approximately 50% of crows and 40% of magpies ignored the bait in the initial two minutes post-capture. Most of the other crows and magpies showed moderate (minor and significant) levels of interest, and only a small proportion showed complete interest in the bait. Jackdaws tended to show greater level of interest in the bait immediately post-capture.

6.4.2 Post capture escape behaviours

Escape attempts, based on a subjective assessment of all bird behaviours in the first two minutes of capture, were also assessed (table 6.8).

Table 6.8 Level of escape attempts in first two minutes of capture

Escape attempts	No	Moderate	Significant
Crow (n = 36)	9 (25%)	13 (36%)	14 (39%)
Magpie (n = 61)	4 (6%)	20 (33%)	37 (61%)
Jackdaw (n =17)	0	3 (18%)	14 (82%)
Buzzard (n = 8)	3 (37%)	2 (25%)	3 (37%)
Rook (n = 1)	0	0	1 (100%)
Percent of total	13%	31%	56%

These data suggest that jackdaws are most likely to make early and significant escape attempts, followed by magpies, then crows and buzzards. A quarter of all trapped crows made no immediate attempt to escape (and 37% of buzzards, although small sample size should be taken into account).

It might be assumed that these data would be closely linked to the interest shown in bait, as birds that are not trying to escape may be preoccupied with the bait in the trap. While this held true for the single rook caught, this overall relationship is less certain for the other species.

In general, the behaviour in the immediate aftermath of capture suggests that the overwhelming majority of birds quickly began testing the trap or attempted escape. However, the attention given to bait, when available, does suggest that the birds are not necessarily blindly panicking, since around one third of them have significant time to interact with the bait (picking up or eating) rather than climbing or probing the trap mesh. Those birds that are interacting with the bait appeared less intent on escaping in that initial capture period. In almost all trap situations involving bait, the bait was eaten by the time the bird was taken from the trap.

6.4.2.1 Behaviour towards decoy bird

Any interest shown in the decoy bird in Larsen traps prior to capture, nearly always disappeared on capture. This occurred with both crows and magpies, and tended to occur even when the trapped bird had formerly been acting aggressively towards the decoy bird.

In multi-catch traps, there were some instances of aggression when multiple catches of magpies and jackdaws occurred. None of the magpie incidents involved a decoy bird, but some of the jackdaw incidents did (see section 7.4).

6.5 Discussion

6.5.1 Injury

From examining the traps and observing the birds entering the traps, it can be reasonably assumed that the majority of birds caught are unlikely to be injured by the actual closing of the trap. The models of traps used in these trials did not appear to have springs powerful enough to impart a significant blow to the birds, and the closing door of the Larsen or sides of the Larsen-mate traps, tended to just push the bird out of the way. Due to the way in which the birds trigger the traps and their position in the trap when it closes, there are very few situations where serious injury is likely to occur. In terms of a strike injury the biggest concern is probably the use of poor quality traps with faults such as sharp edges and protruding wires, or traps that have springs that are too powerful. This latter problem could either be due to an over-engineered trap, or might simply be due to the adjustment of existing springs on what would otherwise have been a trap that would be highly unlikely to injure a bird on closure. In this respect, a potential problem is that of large volume Larsen-mate traps. There are now a number of 'large' Larsen-mates available; one company advertises both a standard Larsen-mate and a second one, "twice the size". In a significantly larger trap, the moving parts are larger and heavier, and may require stronger springs to enable the same speed of closure. The greater momentum which this would generate might injure a small bird struck by the moving part, although the larger volume will probably reduce the risk of entanglement. The reason for the large volume may, ironically, be to increase welfare, since one of the criticisms of these traps is their small volume which restricts the movement of the birds.

6.5.2 Entanglement

The incident of the 'entangled' jackdaw suggests they are able to extricate themselves from such a position in this particular model of trap. However, it is possible that they may only be able to do this at the top of the trap where due to leverage, the force required to separate the halves of the trap is small. The lower the bird is positioned between the two trap halves of the trap, the more leverage is required to open it, and there may be a point where it becomes too difficult for the bird. The trap in question was the Larsen mate which had plastic 'stops' at the top to prevent the trap fully closing (figure 2.2). If these had not been fitted, then it may have required more effort to open the trap and the bird's neck may have been more compressed while it was trapped.

The bird extricated itself fairly easily by moving up the side of the trap. It does however raise the question of what would happen if it had become caught at the bottom of the trap, and something had prevented it moving to the top, e.g. it had become trapped below a side mounted spring, or if it had been caught in a Larsen-mate with a stronger spring. This has relevance to the issue of spring strength and of spring positioning. Most Larsen mate designs allow the springs to be moved to different positions that could significantly change the forces applied by the trap. In this study, the springs came off of one of the traps while it was being handled, and refitting to the exact same positioning required that the trap be compared to others purchased at the same time. If manufacturers were to clearly mark on their traps where the springs should be attached, this would ensure any reattachment would create the appropriate tension and force to enable fast closure but minimise injury risks. Obviously home-made designs may vary widely in the type and fitting of springs and this raises the potential risk of badly positioned springs that may increase the chance of entanglement or injury.

Overall the risk of injury at the point of capture appears low. It is virtually negligible for multi-capture traps as there are no moving parts. It is very low in Larsen traps and low in Larsen-mates.

7. RESULTS: BEHAVIOUR IN TRAPS

This section discusses the video observations made of birds while captive in the trap. It gives an overview of what the birds did in the traps, and how frequently. The data collected are then discussed in terms of welfare in the following section. For details of methods, please see sections 2.4 and 2.5.

7.1 Recording behaviour

Two types of data were collected from the two minute video samples. The first concerned the behavioural 'state' of the birds during each two minute period and the second was a count of individual actions (point behaviours). These give a basic assessment of whether the bird was active, and if so, what it was doing.

Initially it had been hoped to record a number of 'states' (active-moving, active-still, inactive-awake and asleep), but in practice it was not possible to clearly determine when inactive birds were actually asleep, and active birds were often only still for very short periods, resulting in the sample being dominated by motion. In the end, activity states were merged into 'active' or 'inactive', and each two minute sample was assigned a single behavioural state that dominated that sample.

Counts of individual actions involved selecting behaviours that were believed to be representative of escape behaviours, and included those most likely to be associated with the potential for physical injury. The main activities recorded are listed in table 7.1.

Table 7.1 Ethogram: List of behavioural ('point') activities counted and recorded.

Activity (point behaviour)	Description
Jump	Bird jumps up. May open or flap wings, but upwards movement assumed to be generated from the jump rather than from flight.
Flap	Bird extends (partially or fully) wings and flaps them once or more.
Hang	Bird holds on to side or roof of trap with both feet.
Grasp	Bird grasps side mesh with a single foot; may be a step to a further action or an end in itself.
Push bill	Bird places bill through mesh, partially or fully, or even pushes head through, if mesh size permits.
Peck	Bird pecks at something (could be the trap or an object in the trap including bait).
Fall	Bird lands on floor of trap but not on feet (often after hanging or a jump). Typically involves wingtips or tail hitting trap floor.
Fly	Normally associated with multi-catch traps due to volume of trap interior. Briefly possible in Larsen traps for smaller species.
Other minor activities	**Description**
Lift, drop, shake, throw, eat, preen, attack	These other activities took place infrequently, and some were initially described as "other behaviours," that were later ascribed names.

Due to visibility issues 'peck' and 'eat' were often difficult to distinguish. Several of the minor behaviours occurred very infrequently. Those behaviours interpreted as 'escape' behaviours (Jump, Flap, Hang, Grasp and Push bill, with the addition of Fly for multi-catch traps) were the focus of the analysis. While all of these behaviours could be interpreted as 'escape' behaviours, there may also be other interpretations depending upon circumstance.

Birds were often classed as ‘active’ but perform little or none of the ascribed activities/point behaviours (table 7.1), which normally indicated that the bird was walking back and forth or around the trap. This stop and start walking was typical of most of the birds trapped. The method of recording behaviour did not however, distinguish between different extremes of walking, e.g. slow stop-start walking or continuous back and forth repetitive movements. Nonetheless, the more energetic the walk, the more likely it was to incorporate instances of other activities (such as jump or flap or grasp), so overall, these point behaviours were likely to give a measure of the level of general activity, and perhaps an insight into the degree to which the bird was stressed. The number of two-minute samples viewed are shown in table 7.2.

Table 7.2 Number of two minute observations by species and trap type (number of birds sampled).

Species	Larsen	Larsen-mate	Multi-catch	Total
Crow	673 (20)	371 (8)	0	1044 (28)
Magpie	1055 (36)	238 (9)	212 (11)	1505 (57)
Buzzard	13 (2)	17 (2)	79 (4)	109 (8)

7.2 Activity in traps

There are three distinct periods over which birds may have been captive; the first daylight period, followed by night and then the second daylight period. All birds caught were diurnal species and therefore caught during the day; most were removed the same day, at an afternoon check. However, any birds in the trap when night fell spent the whole night in the trap (the time varied according to season), and then spent a few more hours in the trap when daylight returned before being removed the following morning. Night-time behaviour was compared to daytime behaviour, using the sunrise and sunset times for each day as a proxy for day and night. These precise times do not correspond exactly with the start and end of daylight and darkness due to dawn light and twilight periods, which also vary with cloud cover and associated weather. It was not possible to determine the transition from day to night on the video footage because as light levels vary, the video cameras adjust exposure accordingly.

7.2.1 Day/night activity levels

The proportion of time that crows and magpies were active during each period of captivity are shown in figure 7.1 (a & b). In all cases the difference in the proportion of time spent active was significantly different between the daylight hours and night, and between the two daylight periods. Birds were much less active at night, but were also slightly less active in the second daylight period than they were in the first. Only a small sample size existed for buzzards, and all but one was removed during the first daylight period, so statistical comparisons were not conducted.

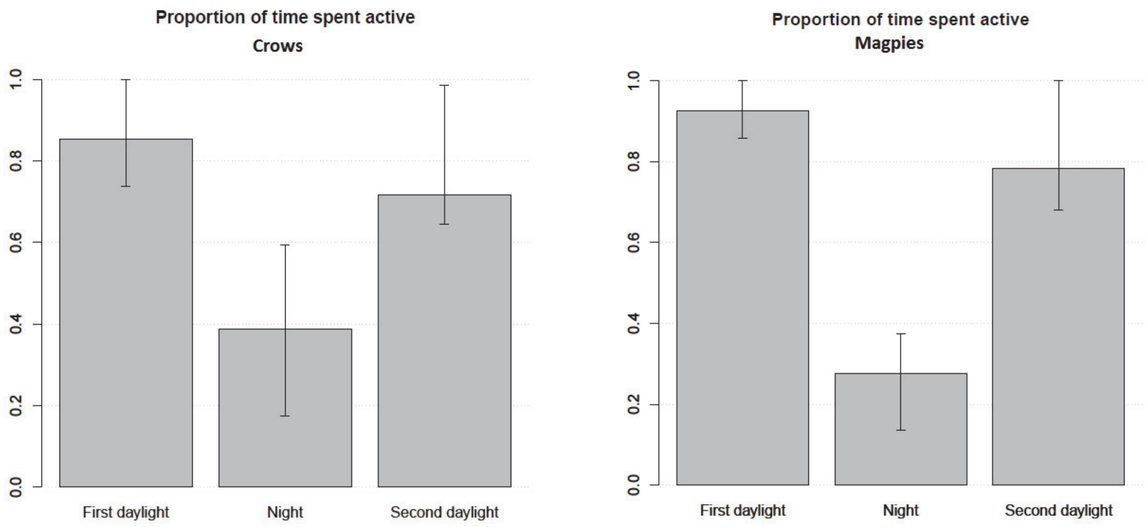


Figure 7.1 Proportion of time spent active in different periods by crows (left) and magpies (right) in traps. Error bars show quartiles for the value amongst the different birds (50% of sample lies within error bar range).

The above figures are based on the average activity state of all birds; there is however significant variability between the active/inactive state of individual birds. Figures 7.2 and 7.3 show the patterns of activity throughout the captivity period of individual birds and also illustrate at what point in the day they were caught and the position of sunrise and sunset times on the timeline. In addition the graphs are split by trap type.

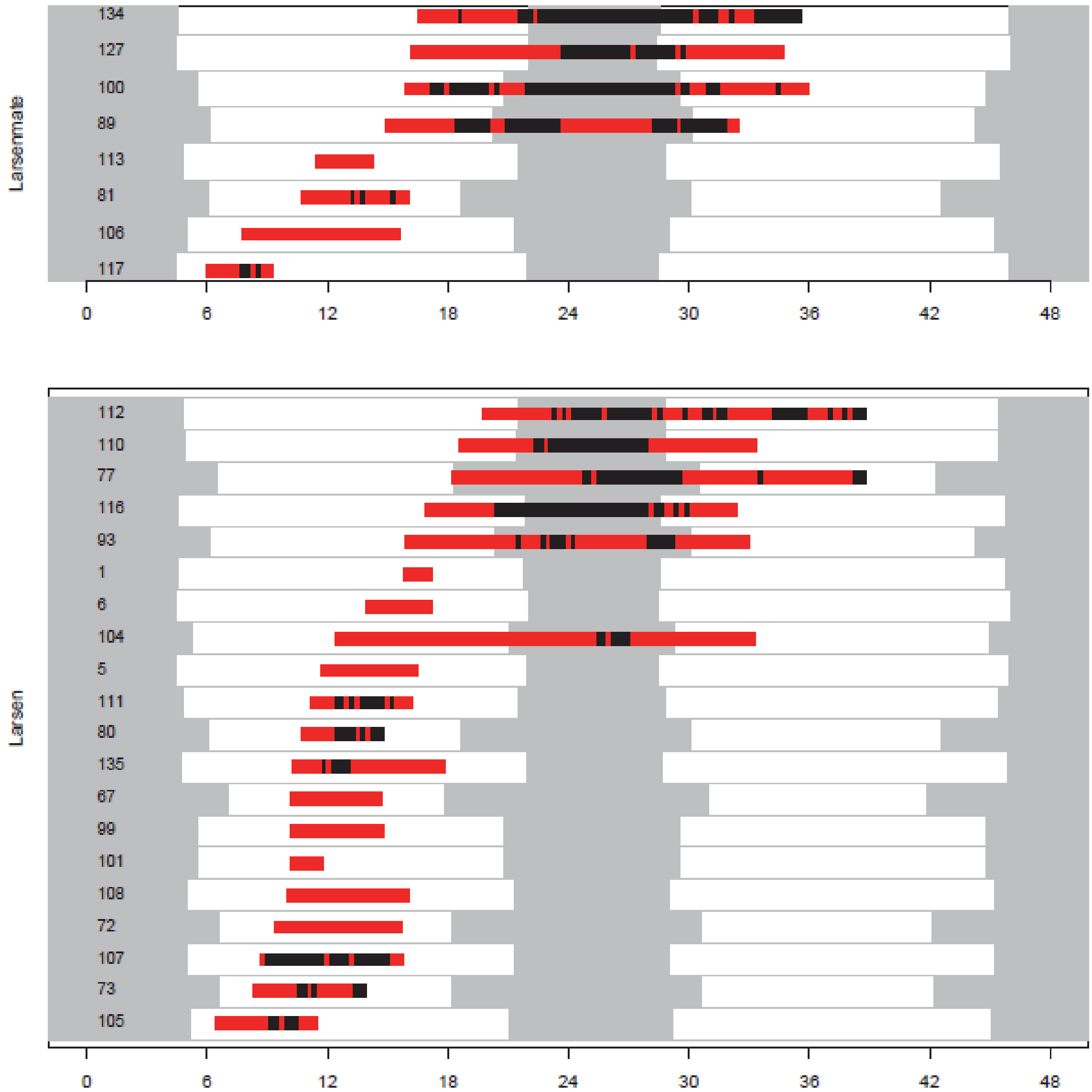


Figure 7.2 Plot of time each crow spent in a trap showing active (red) and inactive (black) periods, and also showing day (white) and night (grey) and split by trap type. X axis is the time of day (over a 48+hr period) Y axis shows ID number of bird. Ordered top to bottom by time of day caught.

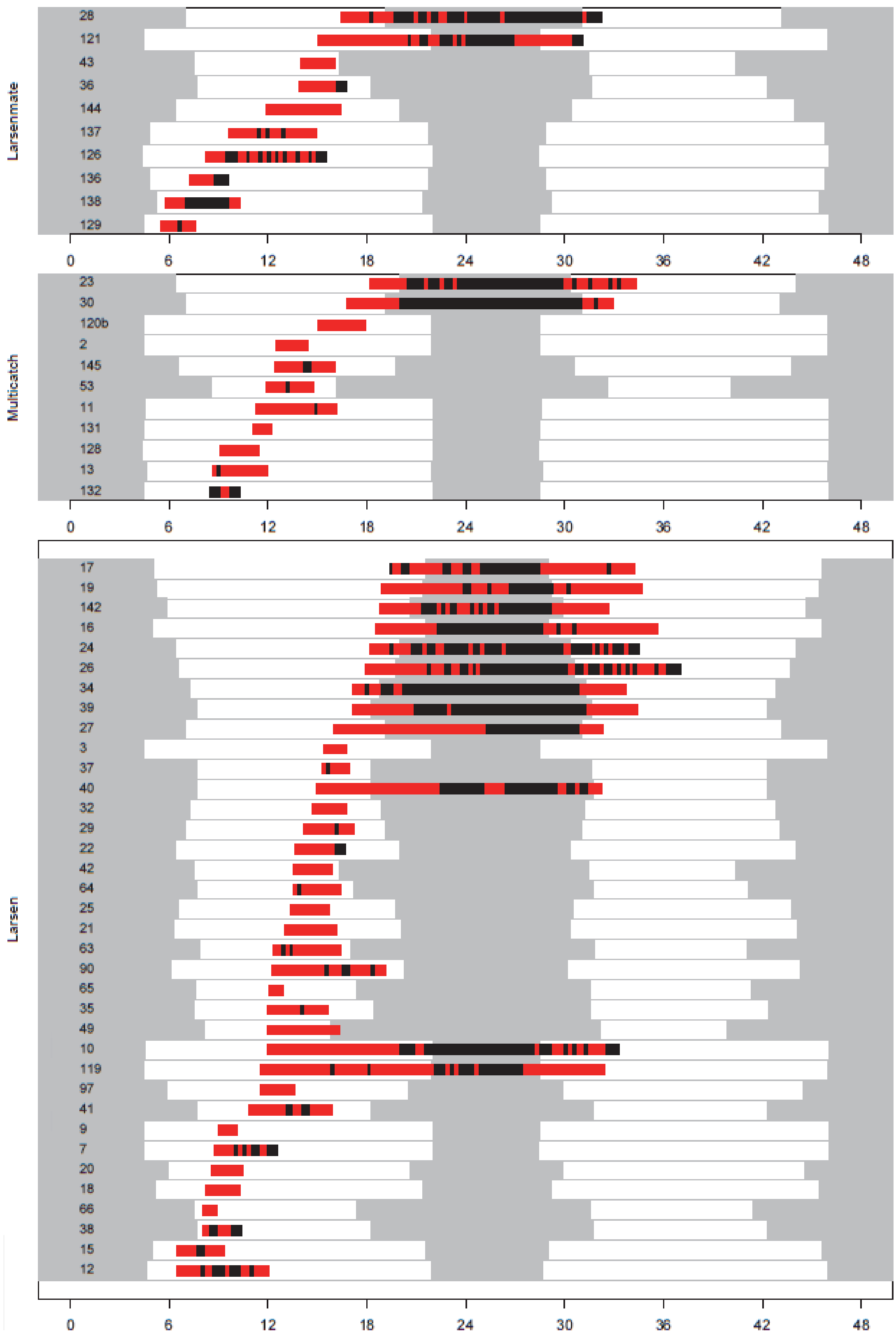
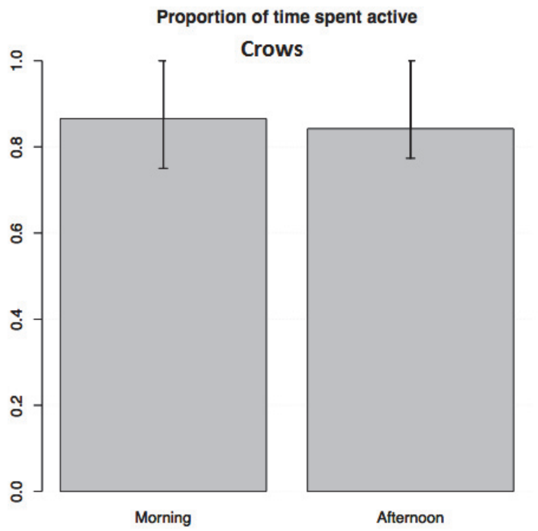


Figure 7.3 Plot of time each magpie spent in a trap showing active (red) and inactive (black) periods, and also showing day (white) and night (grey) and split by trap type. X axis is the time of day (over a 48+hr period) Y axis shows ID number of bird. Ordered top to bottom by time of day caught.

The bars in figure 7.2 and 7.3 indicate that roughly one third of crows and one quarter of magpies spent a night (and some of the following day) in a trap. The general pattern for overnighting birds was to exhibit long periods of inactivity occasionally punctuated by short periods of activity. However a few birds showed a high proportion of activity during the night (e.g. crows 104 and 77, and magpie 40).

Activity during the first daylight period tended to be fairly constant, punctuated by brief periods of inactivity (if at all). There were a very small number of individual birds that stand out as having fewer active than inactive periods during the day, but broadly the pattern is the same for both species.

It was possible that time of day caught could affect activity, so activity levels of birds caught before noon (GMT) were compared with levels recorded in birds caught after noon (GMT) (figure 7.4 a & b); no significant differences were found.



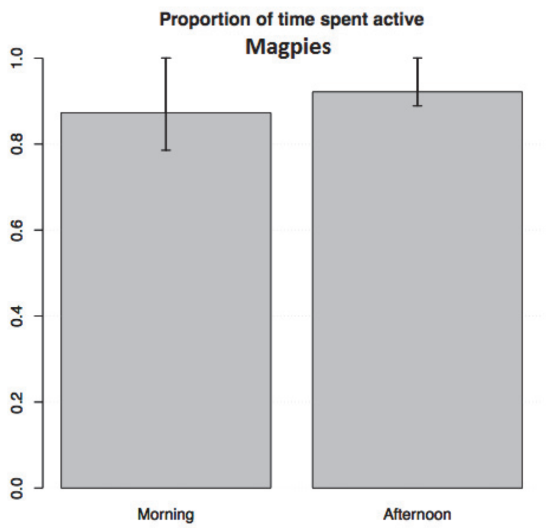


Figure 7.4 Proportion of time spent active by crows (left) and magpies (right) in traps in the morning and the afternoon of the first daylight period. Error bars show quartiles (50% of sample lies within error bar range).

7.2.2 Intensity of Activities

The above plots and bar charts only indicate whether birds were active or not; they do not indicate the nature or intensity of that activity, e.g. a bird that was jumping or flapping at a rate of five times per minute is clearly less active than one doing so at forty times per minute. Differences in activity rate may affect the likelihood of injury or of reaching exhaustion. A much higher activity rate may also have indicated greater stress and desperation to escape.

Some minor behavioural activities were rarely observed, and so the following analyses have focused on a number of common point behaviours (Jump, Flap, Hang, Grasp, Push bill, and Fly for multi-catch traps; see table 7.1).

Figures 7.5 and 7.6 are similar to previous plots of 'behavioural state', but show how the rate or intensity of activities/point behaviours varies with each two minute sample. The total count of activities per two minute sample, were split into four groupings: blue for no activity, pale green for low activity, orange for medium activity and red for high activity. No activity indicates that none of the activities/point behaviours occurred in that two minute sample period. The remaining 3 groupings were created by proportionally dividing into thirds the range of frequency with which the behaviours were recorded. Figures 7.5 and 7.6 show the activity intensity for all of the main behavioural activities combined. Plots of individual behaviours are presented in appendix 1.

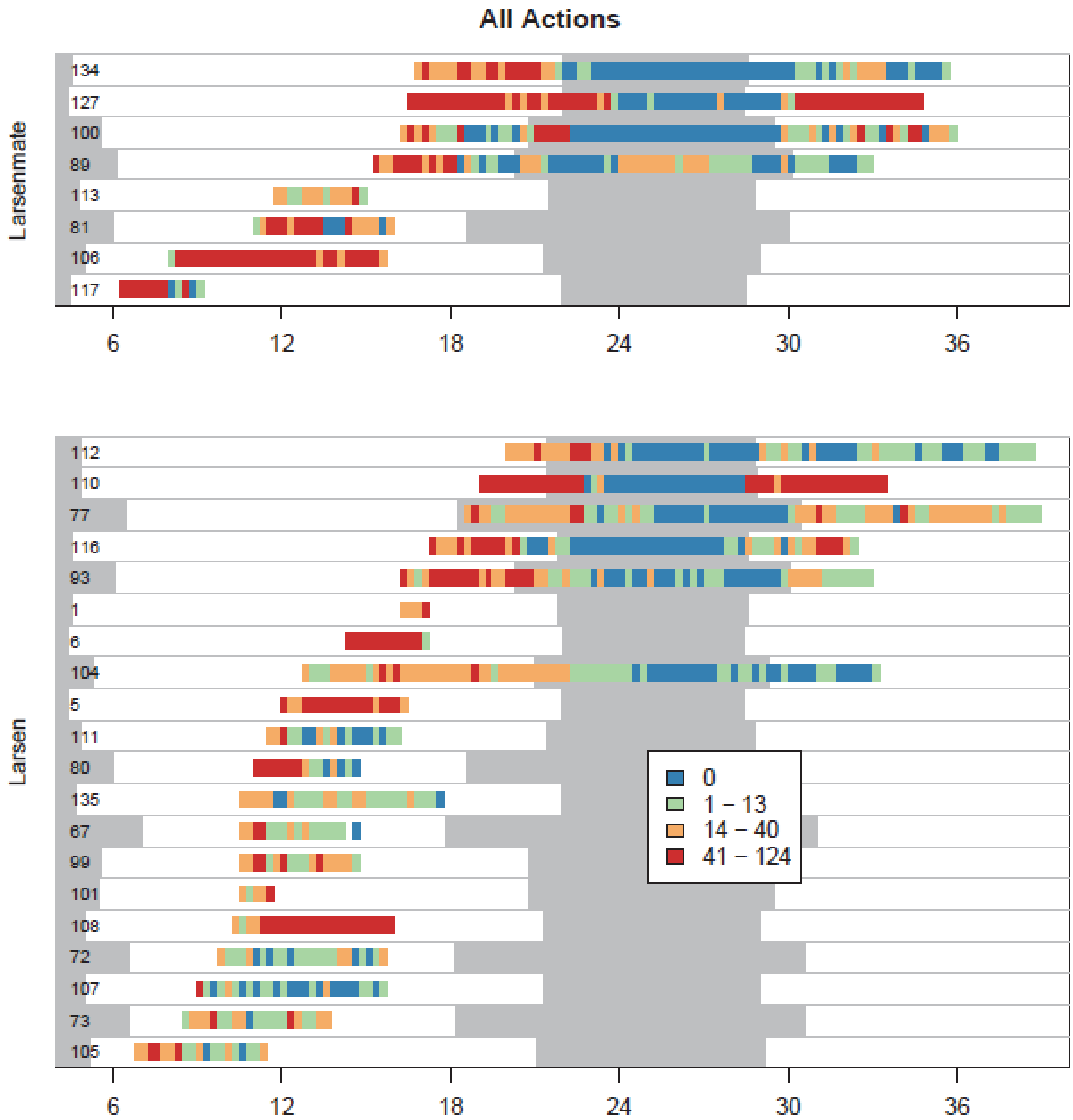


Figure 7.5 Intensity of recorded behaviours in captured crows. Blue = no activity; pale green = low activity; orange = medium activity; red= high activity, based on the total number of behaviours recorded per 2 minute sample, per 15 minute section of video recording of trapped birds. Day = white; night =grey. Charts are split by trap type.

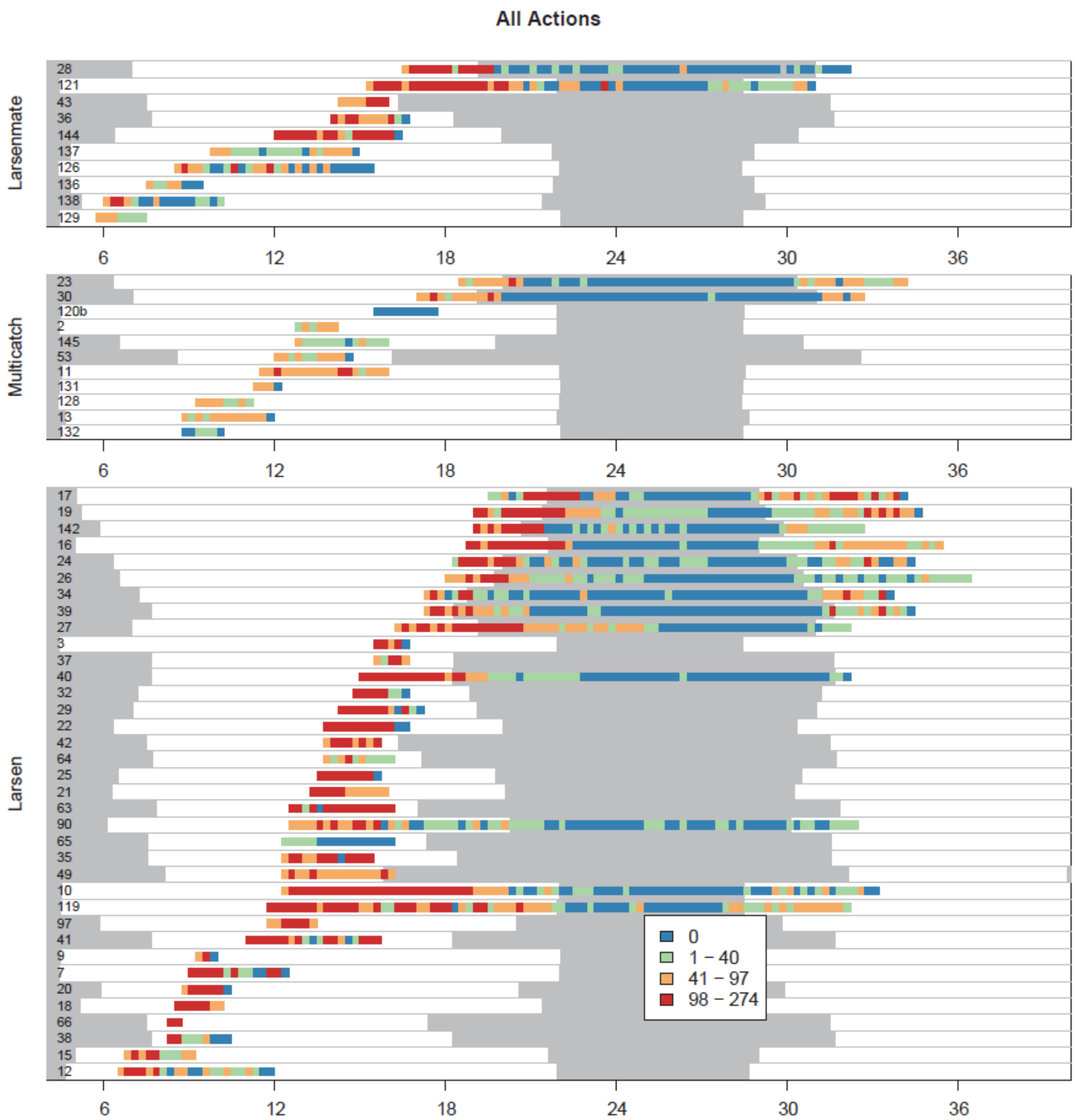


Figure 7.6 Intensity of recorded behaviours in captured magpies. Blue = no activity; pale green = low activity; orange = medium activity; red= high activity, based on the total number of behaviours recorded per 2 minute sample, per 15 minute section of video recording of trapped birds. Day = white; night =grey. Charts are split by trap type. (Note that bird 120b is blank for activities due to a software recording error and has been excluded from this related analysis).

The above plots illustrate quite clearly that the highest intensity of activities (red) is concentrated in the first daylight period, and that for all birds, activity rates decline during much or all of the night (blue and pale green).

A Poisson GLM, adjusted for over-dispersion in the data, was used to compare activity rates between periods, allowing for different baseline rates amongst different birds (thus also accounting for differences between trap types). The model found that the rates for all main activities during daylight are significantly different from those at night, in both crows and magpies ($p<0.001$). Crows were active in 85% of daytime samples, but only 39% of night samples. For Magpies the equivalent figures were 93% and 28%. Comparison of the first daylight period with the second found that for both species, there was a significant difference ($p<0.05$) between the rates of all main activities, with the exception of 'jump' for crows.

The average activity rate of each main behaviour in each trap type for the three time periods is shown in figure 7.7 for crows, and figures 7.8 and 7.9 for magpies. From these plots we can see that the highest activity rate were in the first daylight period, with the exception of 'fly', which only occurred in multi-catch traps (magpies only), and was higher in the second daylight period. In the majority of cases, birds appeared less active at night than in the second daylight period. However there were a few exceptions, most notably the 'push bill' activity by magpies in Larsen-mates was higher at night than during the second daylight period; 'flap' and 'grasp' also deviated slightly from the general pattern as did 'fly'.

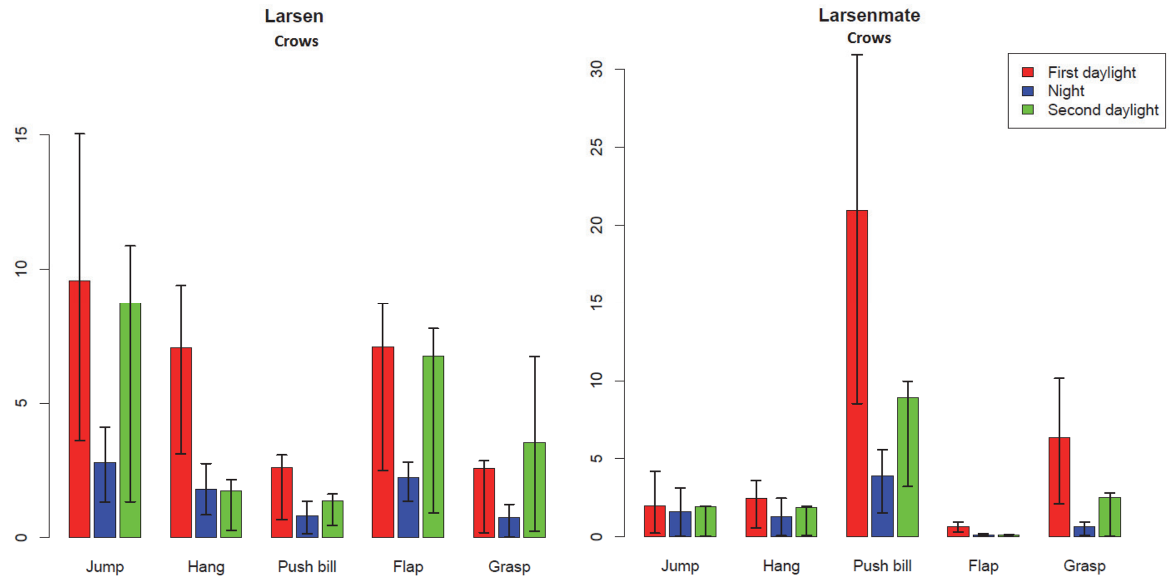


Figure 7.7 Average crow activity rates (actions per two minute sample every 15 minutes in trap) for day/night periods for Larsen traps (left) and Larsen-mate traps (right). Error bars show quartiles (50% of sample lies within error bar range).

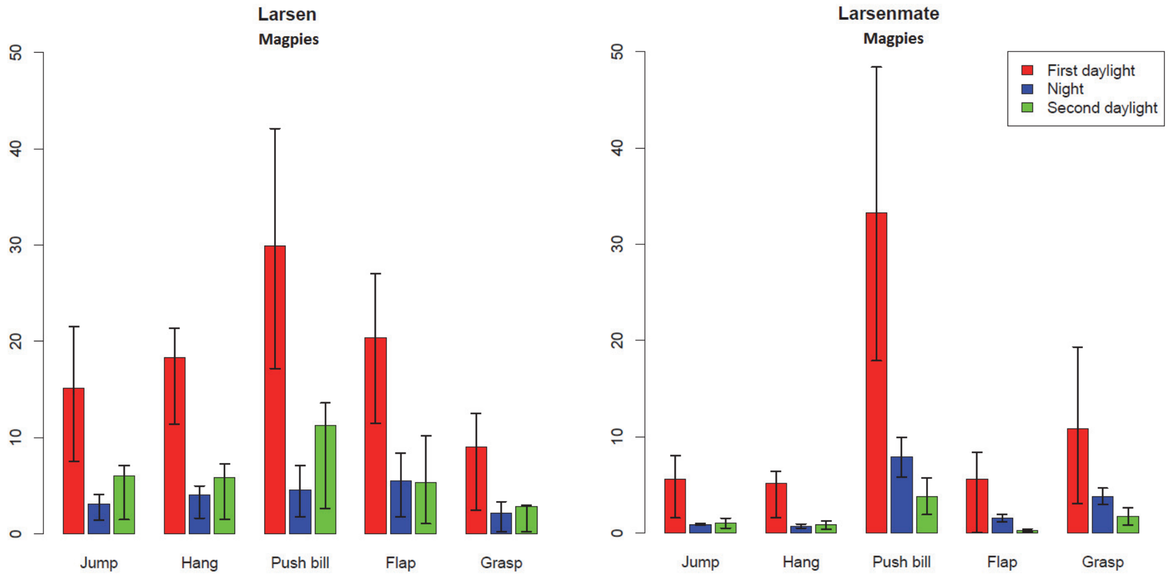


Figure 7.8 Average magpie activity rates (actions per two minute sample every 15 minutes in trap) for day/night periods for Larsen traps (left) and Larsen-mate traps (right). Error bars show quartiles (50% of sample lies within error bar range).

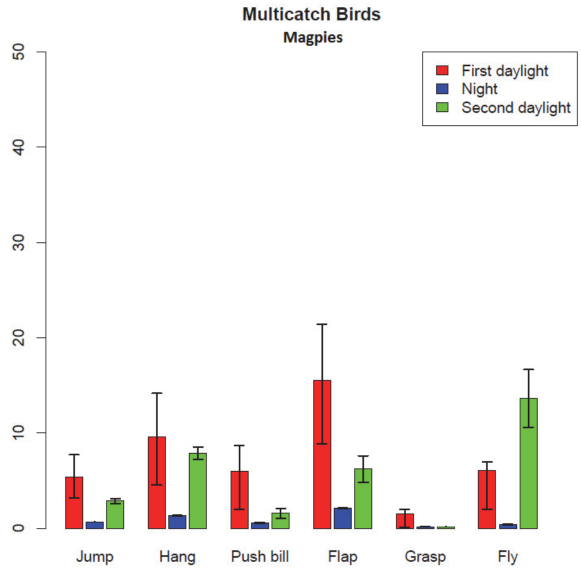


Figure 7.9 Average magpie activity rates (actions per two minute sample every 15 minutes in trap) for day/night periods for multi-catch traps. Error bars show quartiles (50% of sample lies within error bar range).

7.2.3 Behaviour and trap type

Analysis of the different point behaviours above reveals clear differences between the traps. Anova analysis comparing average activity rates of crows in different traps, using daytime data only (given that activity declines considerably at night) found significant differences between Larsen and Larsen-mate traps in two of the five main activities; Push bill ($P<0.001$) and Flap ($P=0.028$). Similarly, there were significant differences observed in activity rates for all behaviours in magpies held in different trap types ($p<0.004$ for all behaviours except Grasp, which was $p=0.013$).

These differences can be explained by the relative sizes of the different traps. The relatively small volume of Larsen-mate traps restricts the ability of the bird to Jump, Flap and Hang, but this appears to be compensated for by Push Bill movements through the trap mesh. The larger volume of the Larsen traps in comparison with the Larsen-mates, allows the birds to exhibit these greater movement behaviours far more frequently. In multi-catch traps, there appears to be a delay between magpies entering and then trying to escape; this might be explained by the birds taking longer to realise that they are trapped. The doors of the Larsen and Larsen-mate closing probably alerts the bird to its predicament, whereas in the multi-catch trap, the bird will only notice when it decides to leave.

Birds had much more space in the multi-catch traps than in the other types, and were able to fly, with most of the birds flying back and forth from ground to perches, which were frequently used. Magpies in multi-catch traps overnight made use of perches in 60%+ of observations made and spent much of the night on them. Generally the magpies showed a lower frequency of the main 'escape behaviours' in the multi-catch traps, and notably, were recorded preening in multi-catch traps far more often than in Larsen or Larsen-mate traps. Crows were rarely recorded preening in Larsen and Larsen-mate traps, and only one crow was caught in a multi-catch trap.

7.3 Activity and time in trap

The first daylight period is probably the most important in terms of potential injury given that it is the period that involves the most intensive activity, and it is also more relevant to most practical trapping situations because trappers who check their traps twice or more daily, may have very few birds that are in traps overnight and the following morning.

A Poisson GLM, with adjustment for over-dispersion of data, was used to model changes in activity rates from the first daylight period against time spent in trap, allowing for different baseline levels from different birds. This showed that for crows, the two behaviours of Hang ($p<0.003$) and Push Bill ($p<0.001$) significantly declined in frequency with time spent in the trap, but for the remaining three behaviours (Grasp, Flap and Jump), there was no significant decline. However the variation between individual birds was large.

For magpies, all of the five main behaviours exhibited significant declines in frequency with time in trap; Jump ($P=0.014$), (all others $p<0.001$). The additional behaviour of 'fly' does not decline in frequency with time. Flying is an energetically costly process compared with walking (Whittow, 2000). It could be argued that despite restricted access to food since the trapping event, and despite having already exerted considerable amounts of energy at escape attempts, magpies nonetheless still had enough energy reserves to continue to fly around the trap on the second day.

Although there appears to be an overall decline in activity over time during the first daylight period, it was noted that many magpies appeared to show an upward spike in activity around twilight, which then decreases slowly after dark.

7.4 Fighting and aggression

Aggression in relation to Larsen decoy birds was briefly mentioned in the previous section (6.4.2.1). However, aggression was also observed in multi-catch traps between captured birds and decoy birds, or between captured birds. There were six instances when magpies were caught together with another bird in a multi-catch trap, and in three cases, no aggressive behaviour was observed between the birds, possibly because they may have been related to each other. In another instance there was a magpie and a jackdaw in a trap, these two birds were fairly tolerant of each other, and although they squabbled briefly if they inadvertently came together, there was no apparent victimisation of one by the other and most interactions appeared accidental rather than deliberate. A further instance involved two magpies, where there were 38 'bouts' of aggressive behaviour in a 41 minute period with an average duration of around 4.5 seconds. One bird persistently approached the other forcing it to move away, although there was no prolonged chasing or physical attack, the behaviour appeared intimidatory.

In another instance between two magpies, there were 42 'bouts' of aggressive behaviour over a 36 minute period. Most involved chasing or intimidatory approaches with no physical contact but there were also an additional 18 instances of physical attack where the aggressor got hold of the victim or on some occasions pinned it to the ground for several seconds.

Due to limited resources, the Jackdaw footage was not examined via systematic sampling as it was for crows and magpies but it has been viewed on a random *ad hoc* basis. Several instances of aggression were seen, all of them in traps that held a decoy bird and at least two trapped birds, involving intermittent attacks by one bird upon another, often with the third bird looking on and only occasionally taking part. In one instance there was a sustained sequence of attacks that lasted several minutes. The sample size was small and the time in traps relatively short, but the apparent severity of the attacks does raise some concern for the welfare of the bird being attacked. Due to the difficulty of identifying the individual birds and keeping track of them in the trap, it is not possible to be certain if the decoy bird was the victim or even if it was the same bird each time. Several of the birds escaped the traps so it was not possible to examine them, but of those that were removed from the trap, there were no obvious signs of fighting injuries.

7.5 Other interactions

A number of interactions were observed between trapped birds with conspecifics outside of the trap. There were several instances of birds (crows and magpies) outside of traps holding the feathers of trapped birds. A similar instance was observed with a jackdaw in a Larsen-mate, where a crow visited the trap several times and tried to attack the jackdaw, managing to briefly grasp its leg at one point.

Another behaviour that was seen on several occasions was juvenile magpies, possibly trying to solicit food from an adult bird in the trap (presumably the parent). Magpies occur in family groups from early summer onwards and groups of birds often appeared at traps leading to several captures in a short period of time. The begging behaviour of the juveniles might elicit feeding urges in the adult, and the inability to fulfil that urge could place additional stress on the adult. The impact this has on the fledged young will depend on their ability to feed themselves, possibly combined with the environmental conditions. The same is not true however, of unfledged youngsters assuming both parents were trapped.

7.6 Individual behaviour patterns

Detailed analysis of crow and magpie behaviour has been covered above. This sub-section covers those species caught relatively often, but for which there is less quantitative analysis.

7.6.1 Jackdaws

We did not undertake systematic behavioural observations of jackdaws, so records were anecdotal and based on random video and trap observations. In Larsen mate traps, like the other corvids, they pushed their bills and heads through the mesh very frequently but they also appeared to do a lot of jumping and hanging (they can possibly do this more easily than crows or magpies because their body length is shorter).

In Larsen traps the birds appeared to do a lot of pacing and a moderate amount of pushing bills into the mesh; there was also some jumping and hanging, but possibly less than magpies. In the multi-catch traps, jackdaws seemed to spend a significant proportion of time walking around and possibly foraging; they also made good use of perches. They would occasionally fly to the top of the trap and hang there.

7.6.2 Buzzards

There was a relatively small sample of buzzards, and most were only in a trap for a short period, and only one was in overnight. One noticeable characteristic of buzzard activity in the traps was that the birds seemed much calmer than the corvids. They were still active, but their movements were comparatively slow and the frequency of activities was fairly modest, making them appear more relaxed than the corvids.

In the small traps they did a modest amount of climbing and hanging, but appeared less frantic than the corvids. In the multi-catch traps, the buzzards walked around and spent a fair amount of time on the ground, even though there were perches available. They did however spend a lot of time on perches too and regularly flew back and forth between perch and ground. The birds did very little pushing of their bill through mesh.

7.7 Discussion

The above data only describes some of what the birds were doing in the traps while they were captive. The main findings can be summarised as follows:

- Most birds were very active when first caught in traps; they were just as active if caught in morning or afternoon. We had initially speculated whether being caught at a specific period of the day might influence behaviour perhaps in relation to whether the bird has fed sufficiently or not.
- For birds that spent a night in a trap, overall activity fell significantly at night, and the rate of the recorded behaviours was low. However, most birds continued with low levels of intermittent activity. This is was not surprising but it does suggest that the birds are on average ‘calmer’ during the hours of darkness, and this might indicate lower levels of stress when it is dark.
- Much of the observed activity was walking or pacing in the trap, but there were other specific behaviours recorded, and the intensity of these tended to decline during daylight with time spent in the trap.
- The first daylight period was the most active period for all behaviours, but not always significantly so. The only exception was magpies making flying attempts in multi-catch traps, which occurred significantly more during the second daylight period.
- The intensity rates of individual behaviours fell at night, but tended to pick up again with daylight the following morning, but usually not to the level of the previous day.
- There appeared to be a short spike in activity for magpies at twilight (and possibly for crows). This spike in activity as the light was fading may be the bird feeling the urge to roost, and making an increased effort to escape the trap. Or it could simply reflect normal pre-roosting behaviour that some magpies exhibit in late afternoon (Birkhead, 1986). If the bird was feeling a strong urge to be doing something else, but the trap was preventing it from expressing that behaviour, then it may become more stressed during this period.
- There were differences in the behaviour of birds in different traps. It seems likely that the different size and structure of the traps constrains the ability of birds to undertake some behaviours and potentially encourages other.

- Crows pushed their bills (and heads) through the mesh of Larsen-mate traps considerably more than those in Larsen traps. Crows in Larsen traps flapped their wings often, those in Larsen-mates hardly at all. Other behaviours differed but not significantly.
- For magpies all of the main recorded behaviours differed in frequency of occurrence between traps. They pushed their bills/heads into the mesh much more frequently in Larsen and Larsen-mates than in multi-catch traps. They jumped and hung from the mesh more in Larsen traps than in the other two types of trap. They only flew in multi-catch traps, but flapped more in both Larsen and multi-catch traps.
- Behaviour varied greatly between individual birds of both magpies and crows.
- Some aggression was seen between multiple birds caught in multi-catch traps. Unfortunately it was not possible to determine how this related to captured and decoy birds, we assume that the most likely aggression would be from a territorial bird attacking a decoy placed in its territory, but cannot confirm if any instances observed conformed to this.
- Birds in multi-catch traps made frequent use of perches, particularly at night and they may have a lower rate of activity as a result.
- Buzzards had a lower activity rate than corvid.

8. RESULTS: INJURIES AND WELFARE

The previous sections describe attempts to assess the risk of injury during the capture process for mechanical traps, and during the period of captivity based on behaviour in the trap. This section focuses on direct assessment of birds for a range of physical injuries once they were removed from the traps.

8.1 Injuries

The potential for sustaining injury at the point of capture was discussed in Section 6; it was determined that overall risk of this was low in Larsen-mates, very low in Larsen traps, and negligible in multi-catch traps. Section 7 described the various behaviours and rate of performing those behaviours by birds while in the trap. This section compares recorded behaviours with recorded injuries, and considers the risk of the injury to the bird due to its activities in the trap. In addition, body condition was assessed, and compared with various other factors.

8.1.1 Overall injury

The injury scores given to birds examined by the veterinary surgeon as described in 2.7 are shown in table 8.1

Table 8.1 Overall injury scores for birds from veterinary post mortem examination.

	n	Nil	Minor	Moderate	Severe
Crow	34	6	25	3	0
Magpie	45	6	34	4	1
Jackdaw	16	8	5	2 (2)	0 (1)
Percent of total	95	21%	67%	11%	1%

Two of the 95 individual birds examined were rated as severe. However, one of these was a jackdaw caught in a multi-catch trap, and which had a fractured radius (wing). Examination of the video footage shows all birds in the trap flying around minutes before removal. As such, the authors are certain this injury was not sustained in the trap, but either during euthanasia or immediately afterwards during transport, and should not be counted as an 'in-trap injury'. The second 'severe' injury involved a magpie that was injured by a fox while captive in a trap (section 8.4.9). Thus the severe injury rate from this sample of examined birds was around 1% (1/95). However, a total of 147 birds were caught, amounting to a 'severe' in-trap injury rate of 0.6% of captures. There were no actual fatalities, but the severely injured magpie would have died if returned to the wild. One of the magpies that was scored as moderate had some subcutaneous haemorrhage on both wings (antebrachium) which might have compromised survival, but on balance the veterinary surgeon felt that a score of 'moderate' was most accurate. The other birds only had relatively minor injuries related to being in the trap (e.g. minor abrasions, claw damage), and the only significant sign of trauma was due to a severe blow to the head to induce concussion/death, followed by cervical dislocation to ensure death.

The majority of birds exhibited abrasion of the skin abound the bill, although for many it was just a slight reddening of a narrow ridge of skin approximately 10-25 mm long. Fourteen birds had some damage to the bill, a few birds had damaged claws, there were a small number of minor cuts, some broken feathers and a few had minor bruising.

The overall injury score for crows and for magpies was tested using a binomial GLM against the bird's overall activity rate, the trap type and total daylight time in trap. No significant associations were found between these factors and the injury score. This was probably due to the relatively broad categorisation of injury score, which did not allow sufficient detail to determine relative differences.

8.1.2 Bill Abrasion and damage

Bill abrasion above and/or below the bill was the most commonly recorded injury; 81 of 116 birds examined (70%) had some form of noticeable abrasion mark. It is important to emphasise that none of the bill abrasions found were particularly serious and if a mild/moderate/severe scoring system had been used, the majority would have been scored 'mild'. However, a much finer scoring system was used to try and distinguish between birds where there was a just a small amount of friction rash from gentle rubbing, birds with light bruising and those birds where the skin had been abraded, resulting in some bleeding/scabbing.

In addition to bill abrasion, 'bill damage' (any cut or breakage to the keratin layer of the bill - the rhamphotheca) was recorded. Bill damage was also likely to be the result of the same abrasive actions that caused the contusions described above. It was uncommon, but was typified by a small patch of missing bill sheath, and might consist of a few square millimetres in area. Photographs of typical bill abrasions and damage are included in appendix 2.

Bill abrasion above and below the bill, and bill damage were combined into an Abrasion damage score (from 0 up to a maximum of 15) for analysis. Table 8.2 gives the average scores for bill abrasion/damage by species and trap type.

Table 8.2 Average combined bill abrasion and damage scores (maximum possible score = 15) for each species and trap ('.' Indicates fewer than five samples available)

	n	**All traps**	**Larsen**	**Larsen-mate**	**Multi-catch**
Crow	37	3	3.3	1.8	.
Magpie	51	3.3	4.2	0.4	3.25
Jackdaw	21	0.9	.	0.4	1.8
Buzzard	7	1.71	.	.	.

These average scores indicate that abrasion scores were relatively low. Out of 116 birds, only 3 (2.6%) scored as high as 10, from a possible maximum score of 15, while 34 birds (29%) scored 0 (i.e. no abrasions or bill damage).

Comparing abrasion-damage scores by species and trap using Welch's unequal variances t-test, a significant difference between Larsen and Larsen-mate traps for both crows ($p=0.027$), and for magpies ($p<0.001$) was found. The average abrasion score in the Larsen traps was greater, especially for magpies (table 8.2). For magpies, a significantly higher abrasion score for multi-catch traps than Larsen-mates ($p<0.003$) was also found, but the difference between Larsen and multi-catch traps was not significant. Jackdaw abrasion scores were generally very low and showed no relationship with trap type or time in trap. Buzzards were only caught in small numbers so analysis of abrasion for individual traps was not conducted. Overall buzzards appeared to have a slightly lower level of bill abrasion damage than crows and magpies, but not as low as jackdaws.

8.1.3 Abrasion and behaviour

A simple linear model was used to examine the relationship between the number of times a bird performed a specific behavioural activity during its entire captivity, against the abrasion damage score. The bill abrasion score in crows had a significant (<0.05) but weak positive relationship with the 'flap', behaviour in Larsen-mates (not 'push bill' as might be expected). In Larsen traps there was a significant positive relationship with 'jump' (p=0.017) and with total activity (i.e. all behaviours) (p=0.041), but again not with 'push bill'. This could indicate that birds that are more active/energetic are incurring greater abrasion damage or that they hurt their bills early after capture as a result of "push bill" activity, which caused them to stop repeating this behaviour. There was no significant relationship between abrasion score and specific activities for the main behaviours performed by magpies in Larsen-mates or multi-catch traps; there was however a significant relationship with 'push bill' in Larsen traps (p=0.007). There was also a weakly significant positive relationship with the total activity (p<0.05).

8.1.4 Abrasion and other factors

There were no significant relationships found between the amount of daylight time crows or magpies spent in any trap and the level of abrasion damage sustained.

8.1.5 Foot and claw damage

Very few injuries to the birds' feet or claws were identified, and of those found, the majority of them were from Larsen traps (table 8.3); the small size precluded further analyses. In addition to injuries sustained in the traps, a further three birds (1 crow, 1 magpie, 1 jackdaw) had old foot injuries that had clearly happened, and had healed, prior to being trapped. No injuries were observed to the feet or talons of buzzards.

Table 8.3 Average score (number) of birds sustaining foot/claw damage score (0 to maximum score of 5) for each species and trap.

	n	Number birds with no foot/claw injury	Larsen	Larsen-mate	Multi-catch
Crow	37	32	0.46 (4)	0.2 (1)	.
Magpie	52	51	0.13 (1)	.	.
Jackdaw	21	20	0.5 (1)	.	.

One jackdaw scored 2 from a foot injury sustained in a Larsen trap, although in this sample, only 4 jackdaws were caught in Larsen traps in total, so this average score should be treated with caution (based on a sample of 1 in 4).

8.1.6 Feather condition

During the initial examination each bird was allocated an overall score for the condition of its feathers (see 2.7.2). Due to the unknown levels of previous wear and the reversibility of some of the 'damage', the implications of these scores should be interpreted cautiously. Nevertheless the overall score out of 15 (table 8.4) gives a snapshot of the bird's feather condition at the point it was removed from the trap.

Table 8.4 Average feather damage score (0 to maximum score of 15) for each species and trap ('.' Indicates fewer than five samples available).

	n	All traps	Larsen	Larsen-mate	Multi-catch
Crow	36	7.4	7	8.7	.
Magpie	46	6	6.3	6.9	5.1
Jackdaw	18	5.8	.	6.8	4.7
Buzzard	7	5.7	.	.	.

Feather damage scores were compared within species, across different trap types using Welch's t-test. There was a significant difference between crows in Larsen and Larsen-mate traps (p=0.008), with birds in Larsen-mates having feathers in significantly worse condition (table 8.4). Differences between the three trap types for magpies were not significant.

There were no significant relationships for crows or magpies between feather damage and total activity (the number of times a bird performed a specific behavioural activity during its entire captivity) for any of the main behaviours recorded. Nor was there a significant relationship between feather damage and the length of daylight time spent in traps (regardless of trap type).

8.1.7 Condition score

The veterinary surgeon provided a condition score based on the relative amount of pectoral muscle on the keel bone (see 2.7.3). Table 8.5 provides condition scores by species from a sample of 94 birds.

Table 8.5 Condition score, based on depth of pectoral muscle mass, of each species.

Condition score	n	3	2	1
Crow	34	0	26 (79%)	7 (21%)
Magpie	45	0	27 (60%)	18 (40%)
Jackdaw	16	3 (19%)	8 (50%)	5 (31%)

The majority of birds were considered to be in the middle of the condition range and most of the remainder were in the lower range. The veterinary surgeon stated that the majority of birds were in a reasonable condition not detrimental to their survival, and that the condition score was more likely to reflect their underlying health, rather than their experience in the trap, since it is unlikely that birds would lose a significant amount of muscle mass after spending less than 24 hours in a trap. While it would have been interesting to test for the possibility that birds in consistently poorer body condition might be entering traps to take advantage of the food available, this was not possible because background data on the body condition of *un-trapped* birds from the same location were not available, and many traps, even ones with decoys, had some bait within them.

During the post mortem examinations, six birds were noted with potential signs of disease. Three had discolouration/lesions on their liver, one had airsacculitis, one had peritonitis and one had lesions on the palate which may have indicated Trichomoniasis. Three of these birds had a condition score of 1, and three a condition score of 2, so despite the likelihood of illness, the birds' condition reflected the general pattern seen in healthy corvids.

Comparisons between condition score and daylight time in trap, overall activity rate, trap type, and time of year found no significant relationships for either crows or magpies.

8.1.8 Other injuries

One bird, severely injured in a trap, was the victim of a fox attack while it was caught overnight in a Larsen trap. This bird was visited by a fox and after initially being agitated and active it became quite calm. As a result, the fox managed to grasp a hold of the wing tip feathers and the magpie did not struggle as the fox pulled at it. The fox then managed to pull the wing through the mesh and remove it, returning later to repeat the process with the other wing. Both times when the fox managed to grasp the tail or a wing the magpie appeared to freeze and not struggle. When released the second time, the magpie fell over and remained completely still, appearing to be dead, but after several minutes it got up, and then moved to sit elsewhere in the trap.

8.2 Body weight and time in trap

Another concern was that birds might lose excessive amounts of body weight if they are abnormally active in traps for a prolonged period, and have access to little or no bait. Behavioural observations reveal that some birds were very active during daylight periods, and a few were quite active for at least a proportion of the night, although most were relatively inactive at this time. Without control data on un-trapped birds, it is not possible to know if these activity levels are 'normal'. Nonetheless, it was possible that birds in traps might be more active than free-living birds, and that this might result in excessive weight loss.

Body weight of birds removed from traps can be compared with time spent in the trap, which can be divided into those that were captive only during the day, and those that were in a trap overnight. These two groups have no overlap in length of time in trap; birds removed during the day were in a trap for less than 7:40 hours, and birds that were trapped overnight were present for more than 13:15 hours. The average weights of these groups by species are shown in table 8.6, along with the percentage change in body weight relative to the daylight group.

Figure 8.6 Average body weight of birds (g) based on time spent in trap and % difference relative to body weight of 'daylight' birds.

Species	n	Average body weight (g) 'daylight' birds (<7:40hrs in trap)	Average body weight (g) 'overnight' birds (<7:40hrs >13:15hrs in trap)	Difference
Crow	34	467	479	+2.5%
Magpie	41	208	192	-7.69%
Jackdaw	16	244	219	-10.25%

Crows in the 'overnight' trap group appeared to be slightly (2.5%) heavier on average than those that were in traps only during the day. The opposite effect took place in magpies and jackdaws, where the 'overnight' group were on average 7.7% and 10.3% lighter than the 'daylight' group respectively. A two-tailed t-test, assuming equal variances, was used to compare the groups. The difference between the crow groups was not significant ($p=0.063$), while evidence of a difference between the magpies and jackdaws groups was weak at best ($p=0.054$ and 0.058 respectively).

8.3 Discussion

8.3.1 Psychological welfare

Attempting to assess the psychological welfare of trapped animals is extremely difficult, particularly without any relevant baseline studies on the species in their normal habitat and day-to-day circumstances. Interpretation of the observed behaviour and its drivers is very subjective and observers may have a tendency to impose their own preconceived biases on their interpretations of what they see.

Specific behaviours can be performed for all sorts of reasons and context is likely to be very important. Using changes in time budgets for interpreting animal welfare in a trap is problematical, since animals introduced to new captive environments often change their behavioural routines and undertake activities that may be interpreted as ‘escape’ behaviours (such as pacing) as they adapt to the new situation (Talling & Inglis, 2009). During this period of adaptation, the welfare of the animal is generally not considered to be seriously compromised (although it may be if the behaviour persists after several days) (Talling & Inglis, 2009). Unless there is good background information on ‘normal’ time budgets and activities in the wild, it is difficult to assess what is happening in a trap in the context of normal behaviour. Similarly, attempting to measure levels of fear and anxiety is also complex and responses vary widely between individuals of the same species.

8.3.2 Repetition

In this study, birds were active in the traps for most of the first daylight period, when they spent most of their time conducting a core behaviour of walking around, or back and forth in the trap. Point behaviours such as grasping or jumping and hanging were often incorporated into a repetitive pattern with some birds being more repetitive than others. The nature of this repetitive behaviour was probably a function of the limited space and options available in the traps, leading the birds to repeat a small group of available behaviours as they attempted escape. While there is a broad overlap in the behaviour of individuals, it was noticeable that some individuals chose to repeat very different behavioural routines than others, so there is no one pattern that emerges. While these repetitive actions may be similar to stereotypies observed in captive animals sometimes seen in zoos, the latter are usually defined as repetitive, rigid and having no apparent function. In contrast the behaviours exhibited in the trapped corvids could all arguably have a function in terms of trying to find a way out of the trap, although it is likely that prolonged captivity might lead some of these behaviours to develop into stereotypies (and might therefore be observed in decoy birds). However extreme repetition (leading to a high frequency of a behaviour rate) might be indicative of a bird that is under high levels of stress, and may be identified by observing those birds that repeat behaviours far more than other birds.

8.3.3 Escape behaviours

There is clearly a level of stress acting on the birds which influences their behaviour in the trap, but this does not mean that the bird is suffering a high degree of distress. The level of escape behaviour shown by an animal could act as an indicator of welfare, but there is huge variation in the pattern and extent of such behaviours (Talling & Inglis, 2009). In the case of this study, it would be preferable to conduct experimentally controlled observations on a number of individuals first, for comparison with their behaviour in the traps, although this would have required manpower resources above and beyond the scope of this study. All of the main behaviours recorded and discussed in section 7 could potentially be described as escape related, and large differences were observed between individual birds in the extent of these behaviours. Birds exhibiting extreme rates of these behaviours could indicate they are suffering high levels of stress, but it could also be natural, individual variation in response to a stress stimulus.

Birds tended to become more agitated when the trap was approached by a person or another animal; this was observed with humans, and very occasionally with dogs and foxes. This increased activity is almost certainly a sign of elevated stress, but quickly subsided once the source of the stimulus was gone. It was also noted that there was a spike in activity around dusk that declined once dark, and this also might indicate elevated stress, perhaps driven by the desire to find a roost site. High rates of repetitive behaviour might indicate compromised welfare for that proportion of birds.

8.3.4 Using physical injury to assess welfare

Talling and Inglis (2009) discuss the assessment of welfare standards for restraining traps and note that psychological distress was one of several factors that could not be readily measured in a trapped wild animal (along with physiological distress and pain). They concluded that physical injury was probably the best indicator of welfare of animals caught in this type of trap and noted further justifications:

a) that fear, distress and pain may to a large degree be caused by injury;
b) that injuries can have a prolonged or permanent effect on the animal; and
c) that injuries are tangible events that can be measured and described by persons trained in pathology.

The New Zealand Animal Welfare Advisory Committee guidelines for testing trap humaneness (NAWAC, 2011) take the same physical trauma approach to measuring welfare in restraining traps, and do so on the basis that “insufficient information exists on what physiological parameters to measure and, for any one parameter, what levels could be considered as the minimum.”

8.3.5 Injuries and feather damage

With the exception of the one magpie that was attacked by a fox, all injuries or damage sustained by the other birds in traps were not believed to be detrimental to the birds’ survival had they escaped (see section 5.5).

Abrasion injuries ranged from a slight reddening of the skin to a bleeding or scabbed cut. The abrasion and bill damage recorded was very likely to be the result of birds pushing their bills into the trap mesh (the behaviour recorded as ‘push bill’; see section 7), and therefore influenced by the type of mesh used in construction of the trap. All three traps used different types of mesh (see section 2.2). Birds tended to sustain less serious abrasions when in Larsen–mate traps, which had a larger mesh size which allowed the birds to push their head through the mesh, rather than just the tip of their bill. Although bill abrasions are probably caused by birds rubbing their bills across the mesh as typified by the ‘push bill’ behaviour, the actual severity of abrasion was not strongly linked to this behaviour (frequency or time spent doing it). Birds spent a lot of time pushing their bills (and heads) through the large (50 mm) mesh in Larsen-mates (Section 7), but this resulted in very low levels of bill abrasion/damage. In contrast, the Larsen and multi-catch traps had much narrower and potentially rougher, galvanised mesh that probably explains the higher abrasion scores recorded for these traps, despite the behaviour being less frequent.

Damage to feet ranged from a very minor cut on the foot, through a missing keratin sheath to a broken claw. The data indicate that birds were more likely to sustain a foot or claw injury when caught in a Larsen trap. These injuries seem most likely to be associated with birds hanging from the mesh or briefly jumping and grabbing it, particularly in Larsen traps this was probably because these traps were large enough to allow birds to ‘jump’ and ‘hang’ from roof and sides of the trap, a behaviour shown more frequently in Larsen traps than any other trap type in both crows and magpies (see section 7.2.3), Although the multi-catch traps are larger, they may be big enough to allow other activities as an alternative to jumping and hanging. Given the larger size and greater power of crows, it might have been expected that crows would be more prone to foot/claw injury if suspended from the trap, and crows accounted for four of the six birds that had foot injuries. Furthermore, three other birds caught had long healed claw/toe injuries including loss of a claw, suggesting that this type of injury can occur naturally.

Feather damage scores for crows appear higher than the other two corvid species (table 8.4). This is possibly because crows, being significantly larger than magpies or jackdaws (average wing span of crows was 312 mm, magpies 186 mm and jackdaws 222 mm), are more likely to have their feathers rub against the trap walls or pushed into the mesh as they walk around in the trap. This is supported by the fact that the multi-catch feather damage scores are lower than those of the two smaller traps (although not significantly so for crows and magpies). The overall space and perches available in the multi-catch traps may also have provided a more favourable environment in which birds could preen themselves, and magpies were recorded preening more often in multi-catch traps than in other trap types (see 7.2.3). Furthermore, the substantial shelter in multi-catch traps would have provided better protection from rain. Regarding feather condition, of most concern would be the birds that will be released from a trap; in this case the non-target buzzards are of interest. As table 8.4 shows, buzzards actually had the lowest overall feather damage score of all the main species trapped. There were more buzzards caught in multi-catch traps than in the other trap types, which may have led to a slightly lower average score. The buzzard sample was too small to reasonably calculate averages for individual trap types, but it is worth noting that the highest buzzard scores (score=8) occurred in Larsen and Larsen-mate traps, and that most buzzards were in traps for less than three hours. Overall however, there are too few buzzard samples to draw conclusions. It seems reasonable to assume that buzzards might sustain more temporary damage to feathers than the smaller target species in the Larsen and Larsen-mate traps, but this is unlikely to pose a significant threat to their survival and welfare.

As previously documented, the feather condition score will be partly influenced by existing wear and damage. However, severely compromised feathers, particularly those that get matted and are dirty might cause problems for some birds in adverse weather conditions. There is always a risk that birds that are released or escape from a trap with compromised feathers might have less effective waterproofing and may be less able to fluff up their feathers to keep warm making them more vulnerable if the weather quickly deteriorates. While it is good practice to not trap during very bad weather, it is not always possible to accurately predict the severity of weather events.

If feathers are severely separated and matted or broken then manoeuvrability in flight may be affected, perhaps making them more vulnerable to predators. Most of these issues may be temporary risks until the birds can clean and preen but they should be seen as issues that could affect the bird's welfare. The majority of birds examined had low to moderate feather damage scores, lower still if the probability of there being some pre-existing damage/wear with some birds is factored in. Only a very small number of birds had broken feathers, and those usually involved one or two tail feathers or perhaps a primary. None of the birds were considered to have seriously compromised feathers

The freezing behaviour that led to serious injury from a fox described in 8.1.8 may be an example of tonic immobility caused by stress and fear (Gallup, 1977), and can be taken as a sign of distress. By the next morning when the trap was checked, the bird was moving around in the trap relatively normally, but was immediately euthanized. This issue is the most serious incident encountered during the study and is discussed further in section 9 on trap interference.

8.3.6 Weight loss

Evidence from studies of various bird species (although the corvids have not been tested) has suggested that they operate a trade-off system between starvation and maintaining an optimally low body weight that will improve their flight performance in the face of predation; a high body mass will increase wing loading, which in turn will impair flight performance (Metcalfe and Ure, 1995; Zimmer *et al*., 2011). Fat reserves (rather than pectoral muscle mass, which is critical for flight) normally modulates changes to body weight, but as a result of this optimisation process, birds may naturally lose between 1% and 10% of their body weight during the night, although this figure varies according to various environmental and demographic factors (Cresswell 1998; Kullberg, 1998). Unfortunately, the relatively small sample sizes in this study restricted further analyses. Nonetheless, the overnight weight losses observed were within those recorded for other bird species, and are not likely to be outwith the capability of the corvids' metabolism.

Related to the issue of weight is the condition score of the bird. We have no data on the weights and condition scores of birds in the wider un-trapped population so are unable to compare these with the captured birds. There is evidence in the literature that in some species individuals with poorer condition are more likely to be caught using certain trapping methods. A bias towards levant sparrowhawks (*Accipiter brevipes*) with lower body mass (equated with condition) being caught in food baited traps, compared to mist nets was recorded by Gorney *et al*. (1999), although the same authors did not find any significant difference for common sparrowhawk (*Accipiter nisus*). Such bias has also been reported towards individual red-winged Blackbirds with lower body masses being caught in decoy traps (Weatherhead & Greenwood, 1981). A similar bias in male citril finches was found by Borras and Senar (1986). The assumption is that hungry birds may be in poorer condition and thus have lower weight, and that they are attracted to the bait in the trap more strongly than a well fed bird, or that some gregarious species are attracted to the presence of a decoy on the assumption that there might be food nearby, and their hunger helps to overcome any trap shyness. This trap bias effect has been recorded in corvids; a study in the North East of Scotland found that rooks trapped during winter and spring were significantly lighter than rooks shot at the same location and time, suggesting that traps were selective for those in poorer condition. However, in summer (when the foods favoured by rooks tend to be in short supply) there was no difference (Patterson *et al*., 1988). The latter study suggests that at times when all individuals are hungry then there is an equal likelihood of being trapped and therefore there could be a seasonal component to the condition bias in trapping for some species However while it is important to be mindful of the potential for such selection bias when considering the condition of trapped birds, the relationship may be more complex as differences in foraging behaviour between sexes, ages and breeding and non-breeding birds may also influence the level of bias. (Dufor and Weatherhead, 1991). Selection bias may have implications for corvid trapping if birds were shown to have significant weight loss during their time in the trap, as they may already be at a low starting point, although if a trap is sufficiently baited this might be negated.

9. RESULTS: TRAP INTERFERENCE

Interference with traps is likely to come from two sources, humans and vertebrate predators.

9.1 Human interference

No direct interference from humans was experienced, although dog walkers regularly passed two of the sites and dogs off the lead ran up to traps on a number of occasions. Dogs neither damaged the traps nor tried to attack the decoy birds; in all cases they were briefly curious, although one dog tried to lift bait from a Larsen-mate on at least one occasion.

9.2 Predator interference

The harassment of trapped birds and/or decoy birds by predators is a concern that has been raised, particularly in relation to Larsen and Larsen-mates (e.g. Onekind, 2012). Both foxes and stoats were observed visiting traps, but unless they interfered with the trap in a way that raised suspicions the following day, the video footage may not have been checked, and such events may not have been identified except during other observations of video footage that took place.

9.2.1 Foxes

No foxes were seen in any of the 741 random one hour samples of video that were watched, although this is unsurprising as these all came from daylight periods (the primary aim being to record bird activity). Furthermore, the activity of dog walkers in the area during the day would probably have confined fox activity to the night.

While viewing 1044 two minute video samples (taken every 15 minutes) of trapped crows, foxes were observed visiting the traps on two occasions; a rate of less than 0.2%. In one case the fox was present for less than 1 minute in total, where it attempted to grab hold of the Larsen-mate trap containing the crow. The crow became agitated approximately 30 seconds before the fox was first seen on camera. The crow jumped around the trap before attempting to peck at the fox, whereupon the fox left. On the second occasion, the fox approached a Larsen trap containing a decoy bird and a captured bird. The fox was very cautious, but approached the trap numerous times over the course of several minutes, but never actually touched the trap. The crows were agitated for about 1 minute before the fox appeared in the video footage, and while it was there.

In 110 two minute video samples of buzzards in traps, a fox was seen only once (0.9%). In this case the fox was very nervous and as it approached the multi-catch trap, the buzzard spread its wings out and lunged at the fox on several occasions causing the fox to jump back or run away. The fox returned several times in a 9 minute period with the buzzard adopting a similar posture on each occasion.

In 1505 two minute samples looking at captured magpies, no foxes were observed. However there was one significant incident with a magpie that was not randomly sampled (due to the condition of the bird, the video was examined closely to see what had happened). In this single case, the magpie was attacked on two occasions during the night by a fox that managed to grab the bird's wings when the magpie stopped moving and froze (Section 8.4.9); the bird was still alive the following morning when it was euthanased. This incident underlines the danger that captured birds or decoy birds in a Larsen traps or Larsen-mate traps may face from a predator. It is worth noting that if this magpie had remained active in the trap (as all other birds were seen to behave when approached by a fox), then it is unlikely it would have been injured, since the fox was only able to obtain adequate purchase of the bird's wing once it had stopped moving. It is not possible to say how common this freezing response (tonic immobility caused by fear; Gallup, 1977) is likely to be.

Four other recordings of foxes visiting baited traps, without birds, were obtained, although two of the recordings are from the same location a few minutes apart, but concern different traps so are considered a single fox visit to each trap. On all occasions the fox attempted to steal the meat bait from the traps. On two occasions the fox triggers the Larsen trap while trying to steal bait, and on a further two occasions, it reaches into a Larsen-mate and lifts out the bait without triggering the trap.

Although out of approximately 30,000 hours of video footage only seven instances of fox visits to traps were identified, it is likely however that more fox visits occurred than those recorded. Nonetheless, bait was often still present in traps the following day despite the ease with which a fox had removed bait from the traps on previous occasions, indicating that foxes were not visiting the traps every night.

No routine fox control was undertaken on the farm where corvid trapping took place, and much of the surrounding area was also unlikely to have significant fox control. However, in a substantial proportion of rural situations where corvid trapping occurs, it is likely that fox control also takes place, often for the same reasons that corvid trapping occurs. This may suggest that instances of trap interference by foxes could be lower for many trap users than in the current study. The exception to this might be urban areas, where a considerable amount of corvid trapping takes place (Reynolds, 2016), but where fox control is not common place, although foxes are patchily distributed in urban areas, and not often found in cities outside of the central belt of Scotland (SASA, unpublished data).

9.2.2 Stoats

Stoats were not seen in any of the 2659 two minute samples of trapped birds, and they were recorded only once in 741 random 1 hour samples (Table 4.1). Aside from these occasions, they were occasionally seen at the Compound site, where they were observed three times on video and several times from a window.

On one occasion, a magpie was walking around outside a Larsen trap when a stoat ran at it out of the grass; it chased the bird off camera, although the bird was seen flying low in the background, as the stoat continued the chase.

On a second occasion, a small rabbit was seen on video, hopping past a Larsen-mate. The rabbit ran off as a stoat appeared; the stoat explored around the trap, and then ran away.

On the final occasion, in broad daylight, there was a magpie decoy bird and a trapped magpie in a Larsen, both of which became agitated as a stoat appeared nearby. The stoat was occasionally visible as it ran about, and stopped to look at the trap. However, it did not venture across the short grass to the trap on any occasion, and if it started to run towards the trap, it always stopped at the edge of the cover of the tall grass. It did not attempt to enter the trap or attack the birds. This event was observed directly from a window, but also captured on video.

Stoats were seen by the authors on a number of occasions at the Compound site where trapping was taking place, including around the traps. In one instance a stoat was seen to climb up the multi-catch trap, run along the top, enter the trap, and then climb back out (there were no birds present at the time). They had been seen occasionally in the area in the past, although very infrequently in the year prior to these trials. It is assumed they were regular visitors during the trials, although there was no evidence at any time of a bird being attacked by a stoat. Stoats are often attracted to noises and movement, so they may be curious about any birds in a cage. The video footage of the stoat chasing the magpie (outside of the trap) gave the impression that a stoat might attack a magpie, and the magpies were clearly disturbed by the presence of a potential predator, but the lack of incidents with trapped birds implied that the risk was low.

As with foxes, in many corvid trapping situations, it is possible that there will be some level of stoat/weasel trapping also taking place, particularly in rural areas where game management is taking place.

9.3 Discussion

Predation is a natural phenomenon, and ‘fear’ of predators is an everyday reality for most species. However, traps restrict normal escape behaviours and this inability to escape a threat might create extra stresses on birds causing a state of distress. In the instances recorded in this study, active escape behaviours appeared to be sufficient for most birds to prevent any predator gaining purchase for attack and most encounters were over in a few minutes, but a possible extreme fear reaction (‘tonic immobility’) in one instance actually aided a predation event.

Trap interference by man, domestic animals or potential wild predators could pose a welfare problem for captive birds and decoys. Any animal perceived as a threat or danger by a bird in a trap is likely to elicit additional stress in that bird if it approaches the trap and therefore attempts should be made to minimise such occurrences or mitigate their effect where possible. Such activity near a trap is also likely to disturb wild birds (i.e. potential targets) and may affect trap effectiveness, giving trap operators a further incentive to keep disturbance to a minimum. During this study there were regular dog walkers near the traps but they passed quickly and any dog that approached a trap was called away extremely quickly by the owner. It is reasonable to assume that most if not all trappers would make efforts to ensure their traps are well away from regular walking routes so as to avoid such disturbance. Reducing visits by wild predators might be more difficult, but could involve legal predator control, careful trap positioning, and/or modifications to the trap and pattern of use.

Anecdotal information arising from Part 2 of this study suggested that the trap interference and vandalism by people was a common problem, although there was a suggestion that ignorance regarding legal pest control techniques could cause some problems (Jamieson pers. comm.). Again, it is likely that such concerns will lead most trap users to carefully position their traps so as to avoid attracting the attention of the public where possible.

10. OPTIONS FOR DISCUSSION

This report provides some data with which to consider potential changes and improvements to trapping under the general licence. The findings have led us to highlight a number of areas where potential improvements could be made to the use of traps under the General Licence. These are presented as options for discussion and can be found in Part 4 of this series of reports (Campbell *et al.,* 2016). Some of these options are related to ways in which trapping might be improved from the point of view of animal welfare, and some offer ways in which trapping might be improved from the point of view of trap efficacy. The options presented draw on the results of this study and the results of those reported in parts 1 (Reynolds, 2016) and 2 (Hartley *et al.,* 2016) of this series of reports.

Overall this report has shown that although there are a number of welfare related issues associated with trapping under the general licence, these are for the most part, not major concerns and many could be addressed by some of the options detailed in Part 4.

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ANNEX 1: BIRD ACTIVITY PLOTS

This annex contains timeline plots of the activity rates of individual birds for certain recorded behaviours. The format is explained in the main report (section 7.2.2)

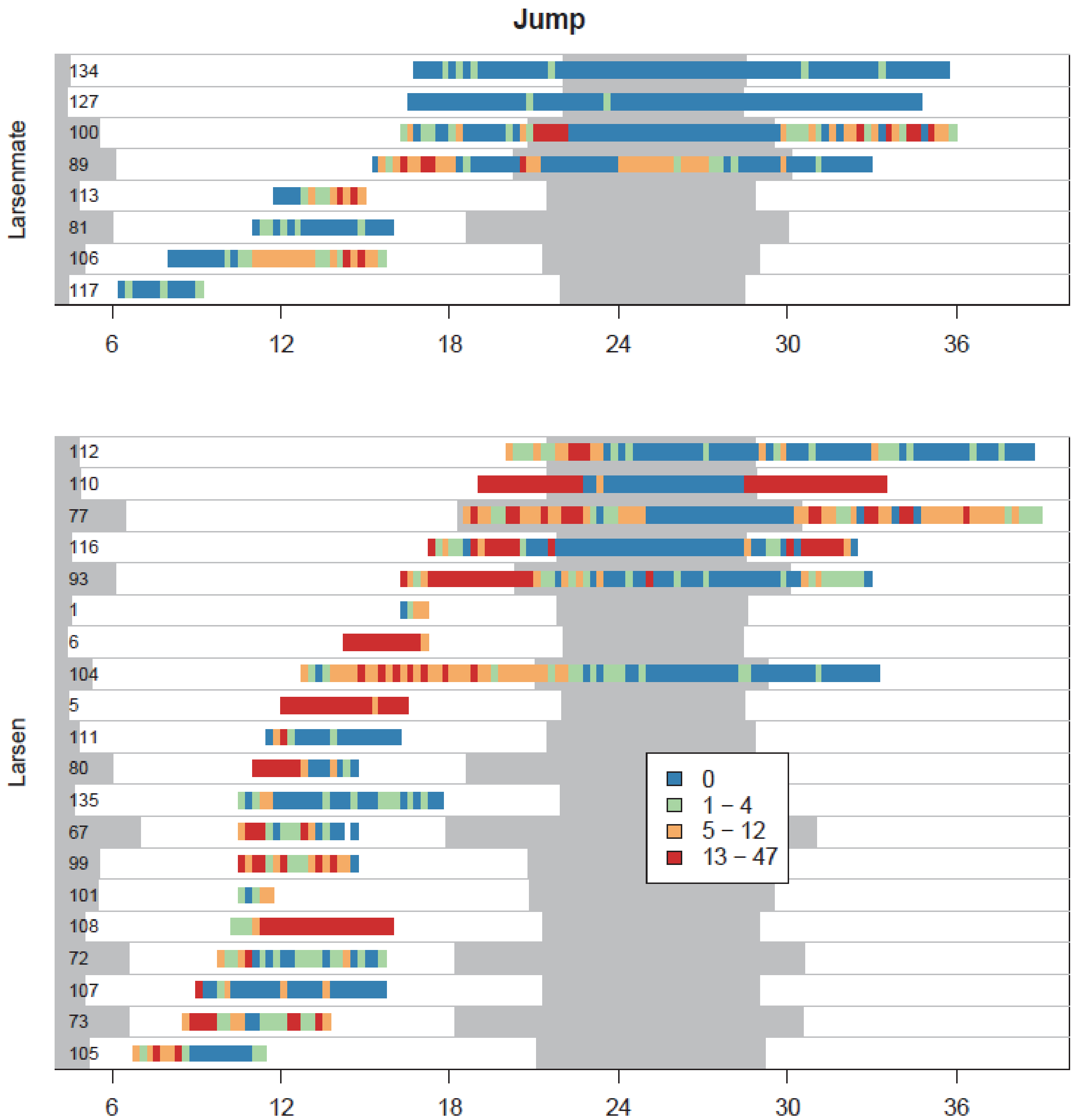

Figure 1 Intensity of jumping behaviour in captured crows, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

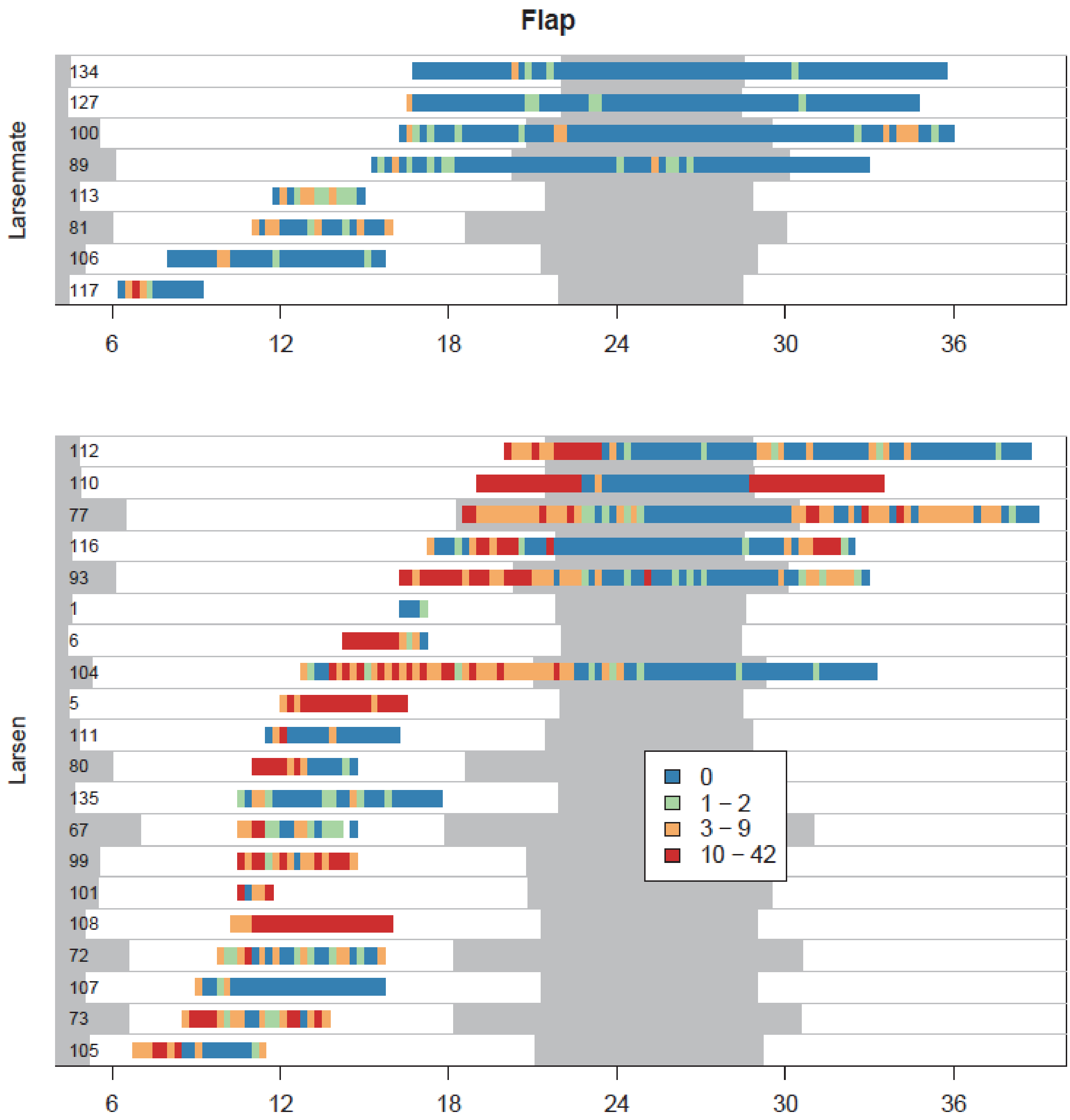

Figure 2 Intensity of flapping behaviour in captured crows, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

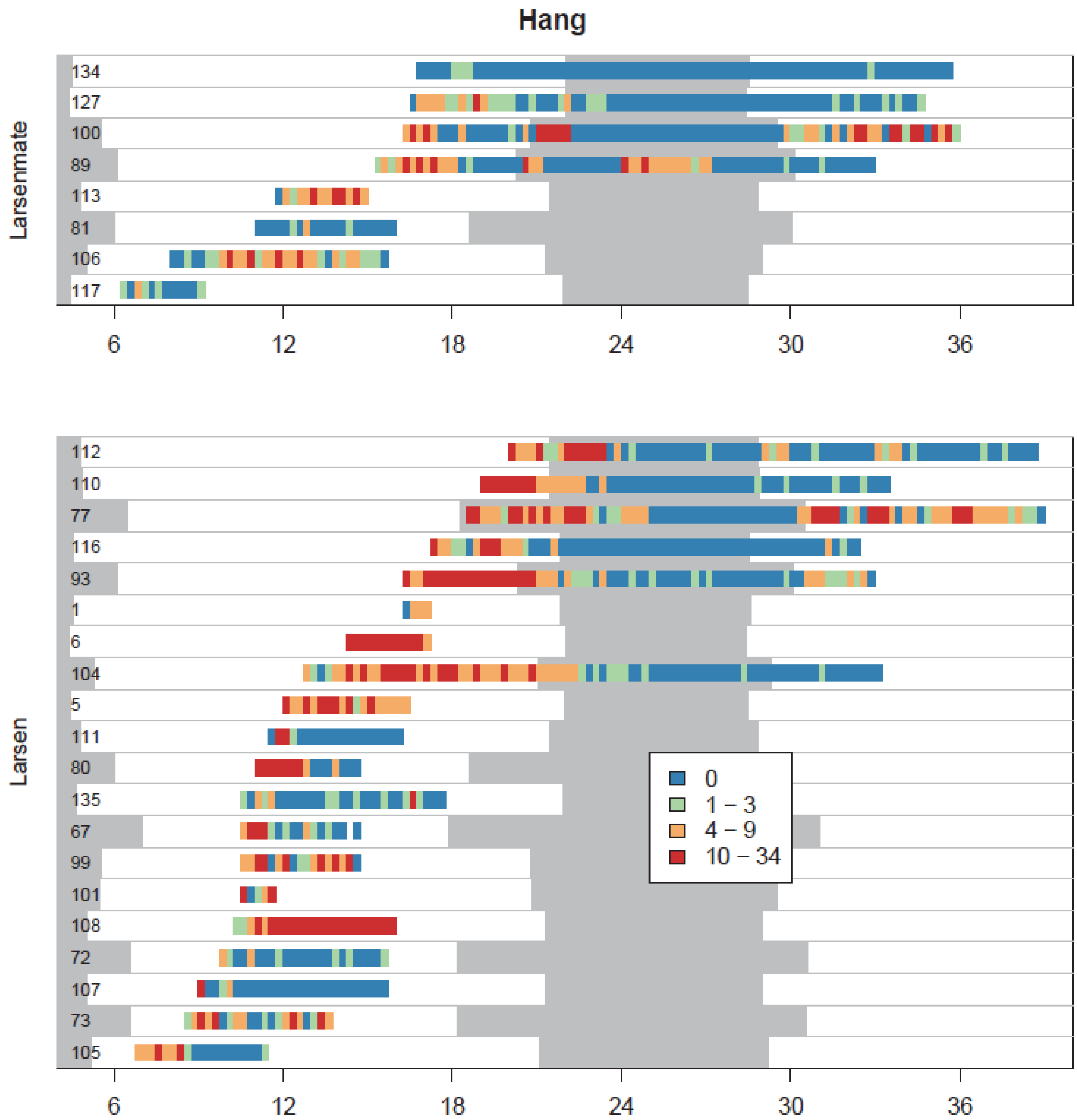

Figure 3 Intensity of hanging behaviour in captured crows, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

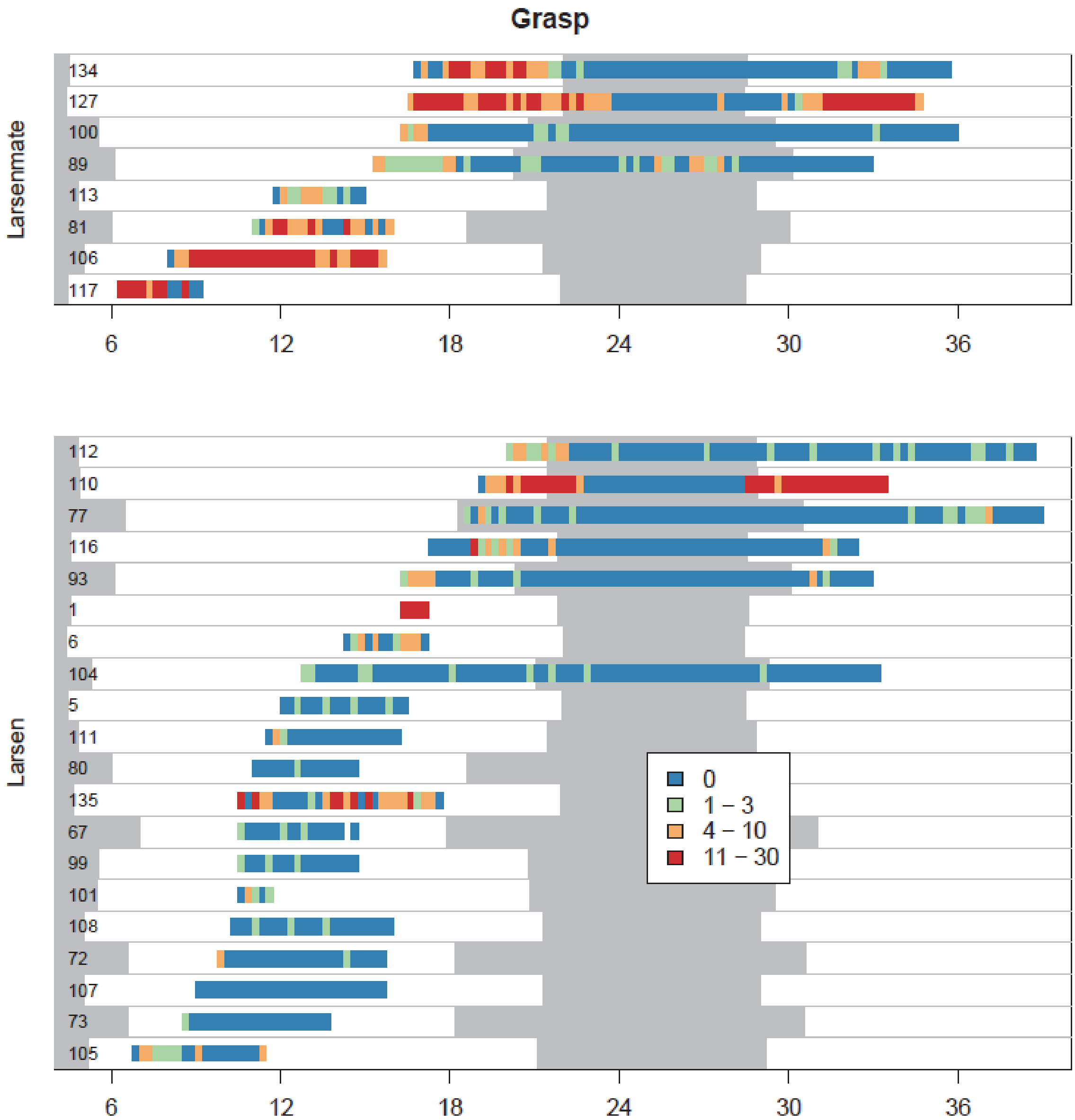

Figure 4 Intensity of grasping behaviour in captured crows, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

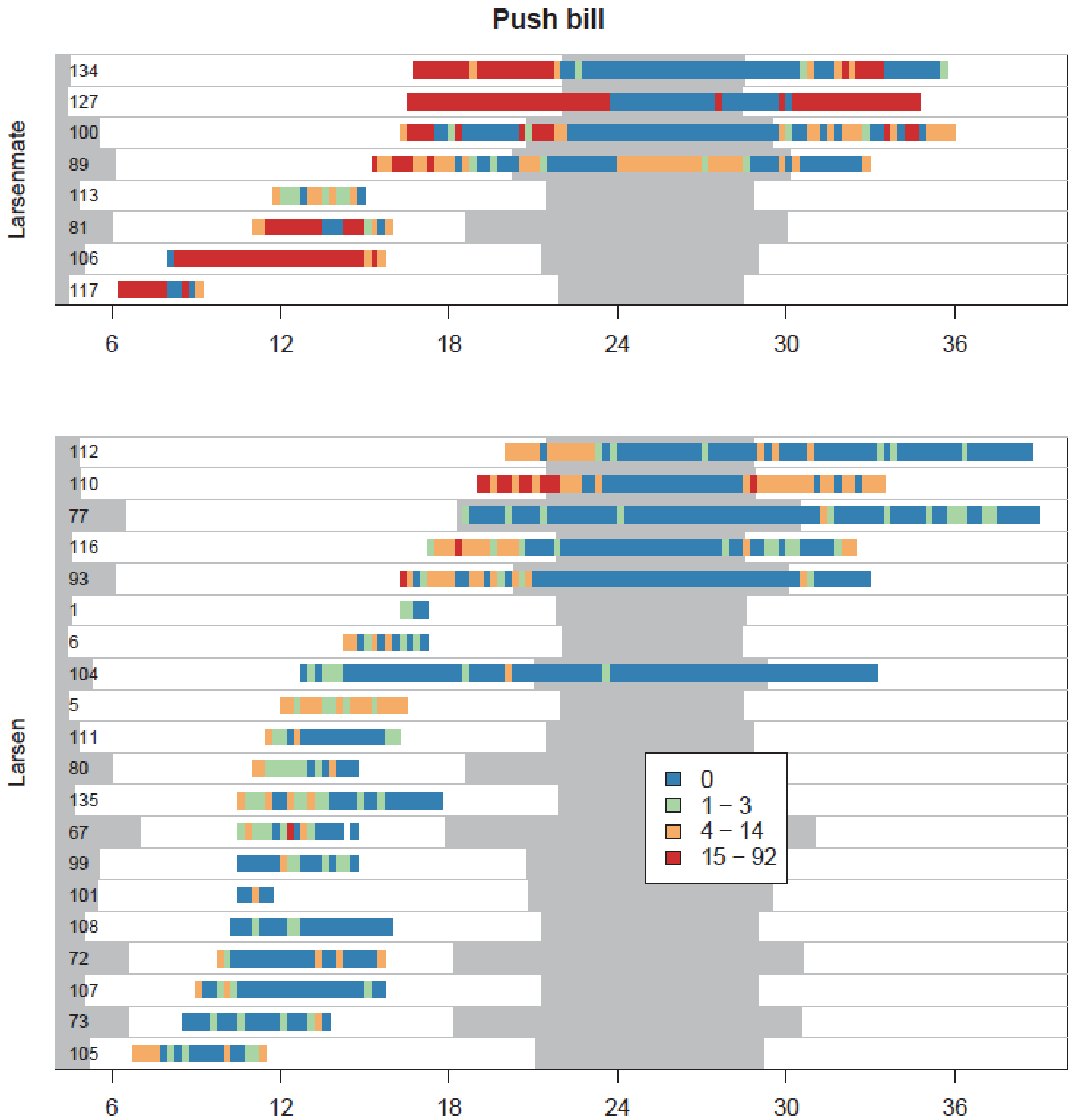

Figure 5 Intensity of bill pushing behaviour in captured crows, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

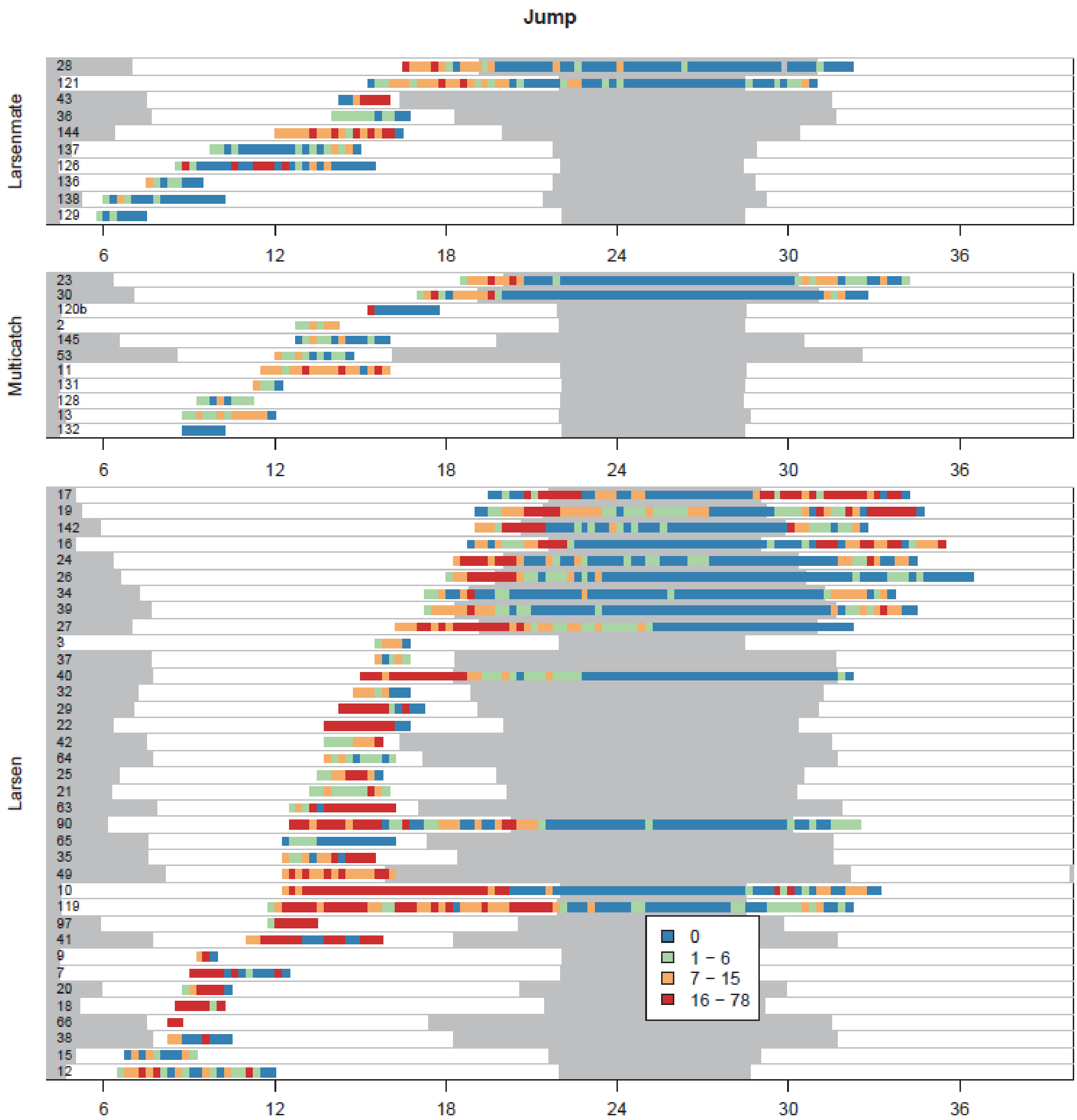

Figure 6 Intensity of jumping behaviour in captured magpies, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

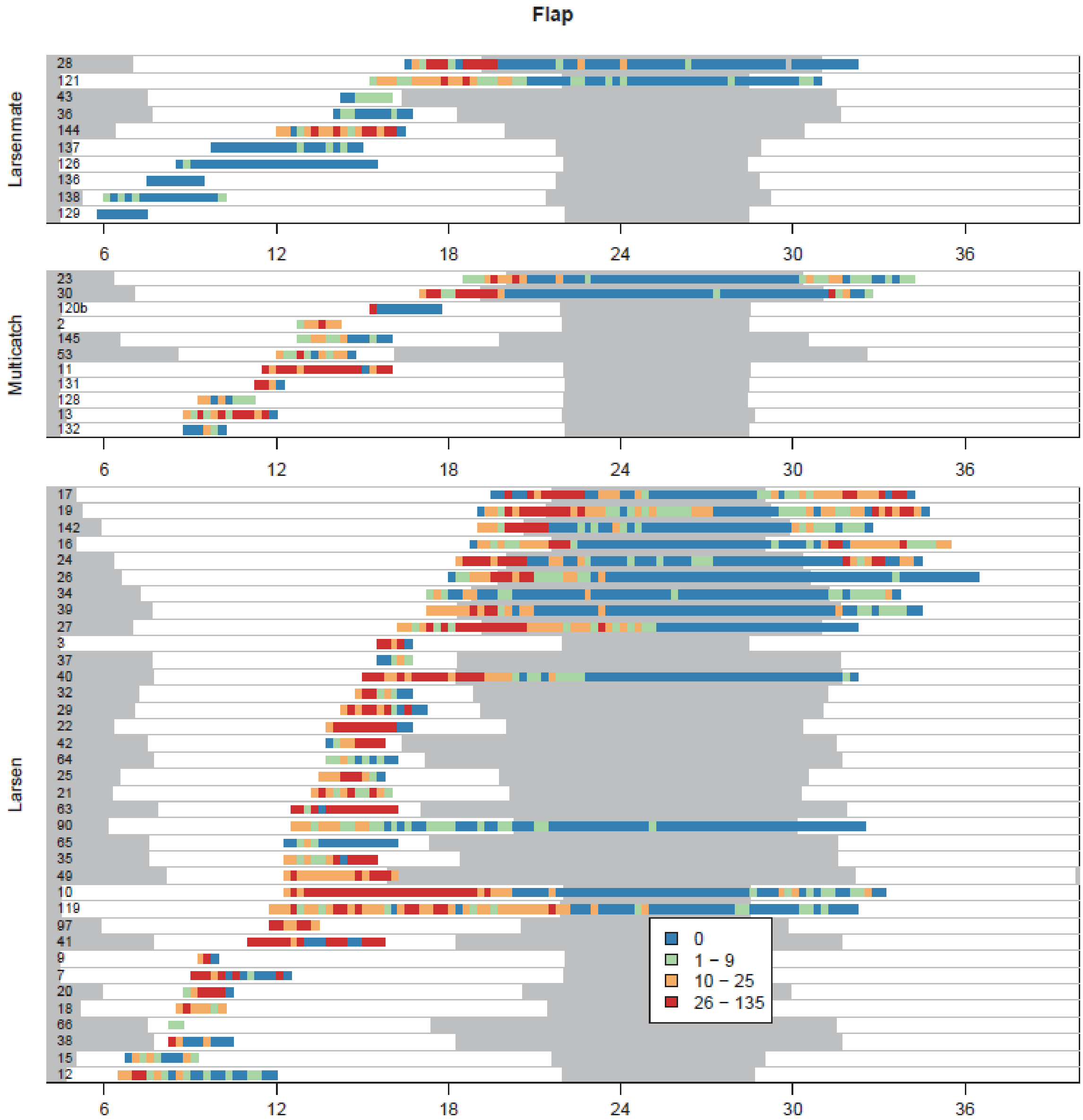

Figure 7 Intensity of flapping behaviour in captured magpies, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

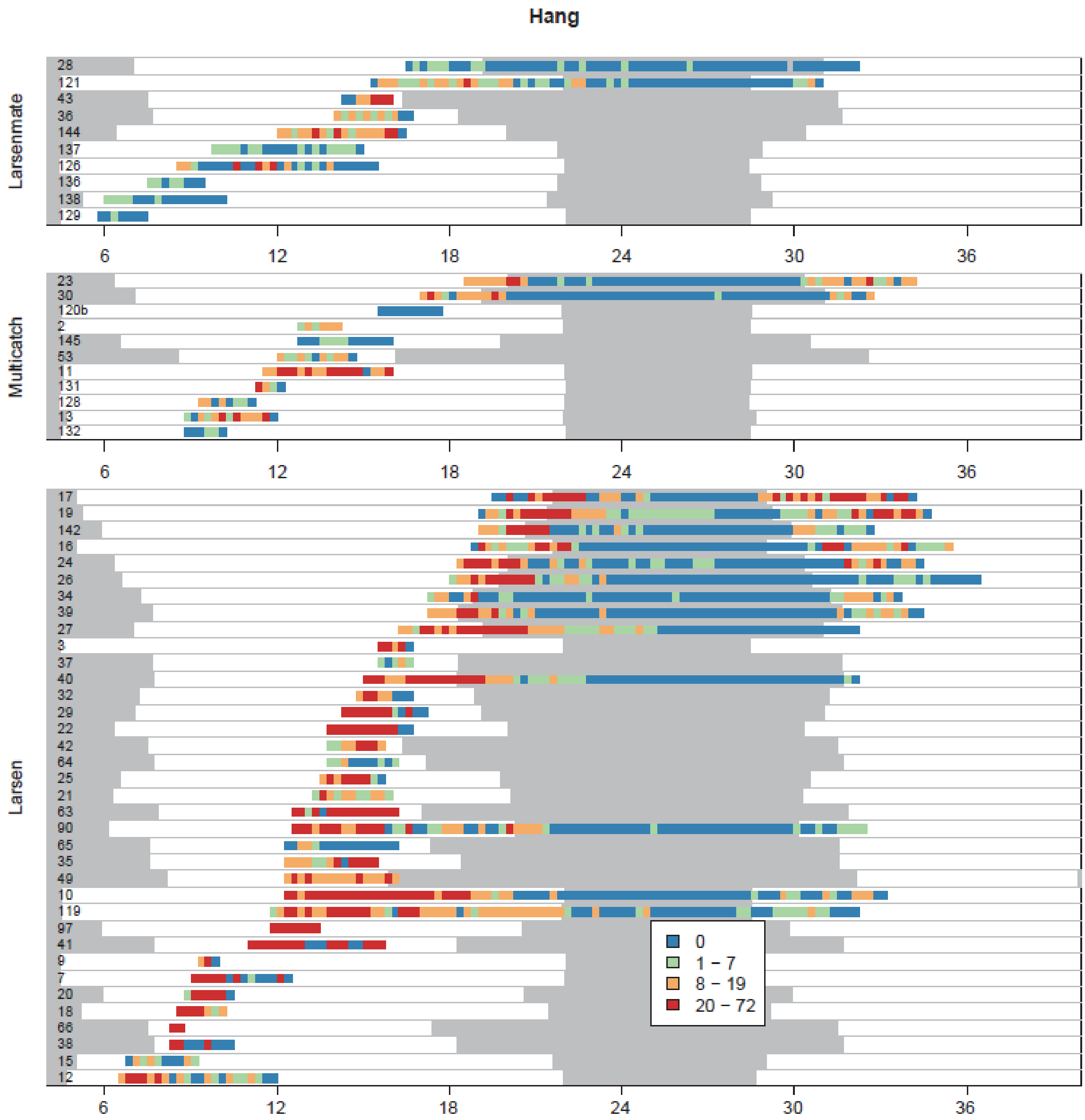

Figure 8 Intensity of hanging behaviour in captured magpies, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

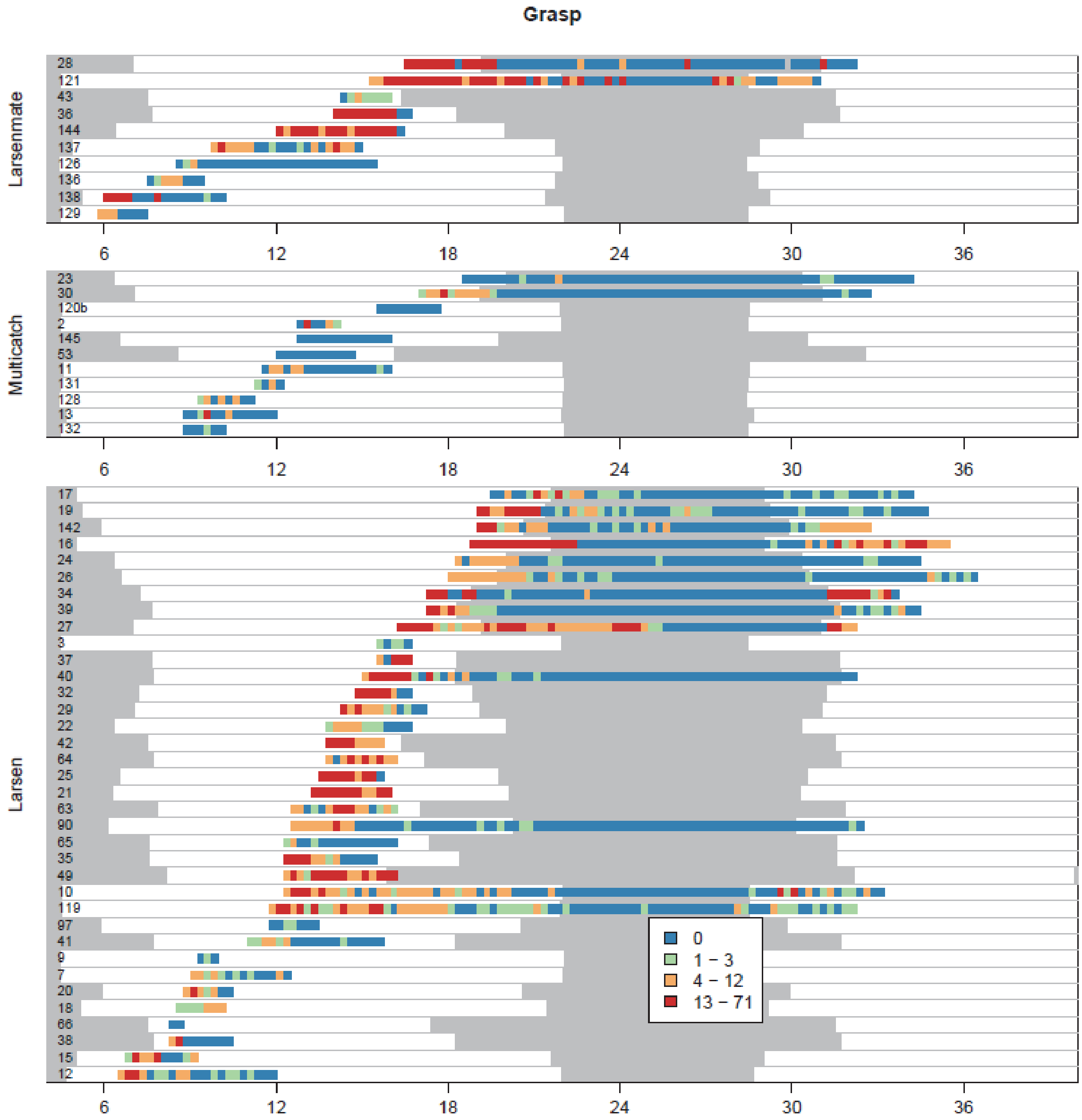

Figure 9 Intensity of grasping behaviour in captured magpies, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

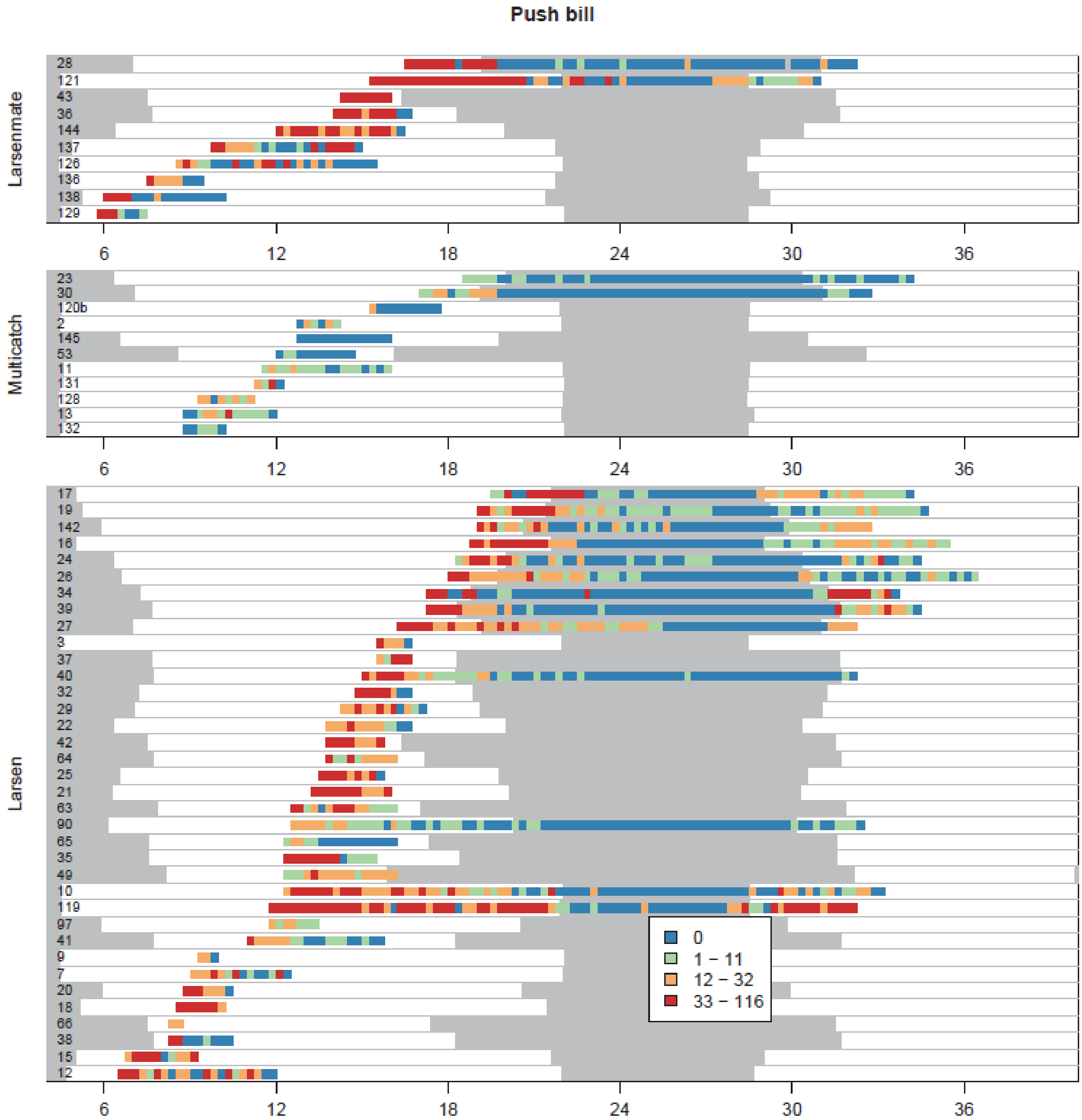

Figure 10 Intensity of 'bill pushing' behaviour in captured magpies, colours represent number of instances of behaviour recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

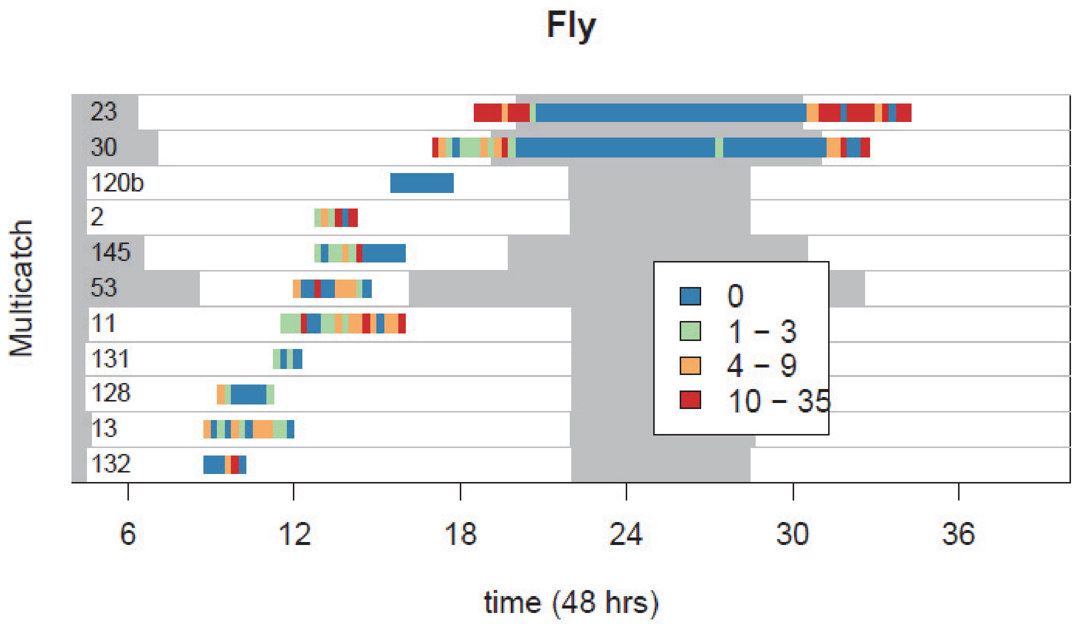

Figure 11 Intensity of flying behaviour in captured magpies, colours represent number of instances of behaviour (i.e. when a bird took off to fly) recorded per 2 minute sample (one sample for each 15 min period). Also shows day (white) and night (grey) and is split by trap type.

ANNEX 2: EXAMPLES OF CORVID TRAP INJURIES

Figure 1 Examples of abrasion above the bill (scored 1 to 4 from left to right, top to bottom).

Figure 2 Examples of abrasions below the bill (scored 1 to 4 left to right, top to bottom)

Figure 3 Examples of bill damage (scored 1 to 4 left to right, top to bottom). Bottom right bird was kept as a call bird and the wound healed very quickly.

Figure 4 Examples of claw damage. Top left: skin abrasion on toe around claw. Top right: tip of claw broken off. Bottom: claw broken off.

Figure 5 Examples of bill abrasion in buzzards. Top right: feather matting due to rain and bird activity. Bottom: This bird was wing-tagged and then re-caught twice. It was seen visiting traps on many subsequent occasions and was still present a year after it was tagged.

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ISBN: 978-1-78391-406-7

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

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