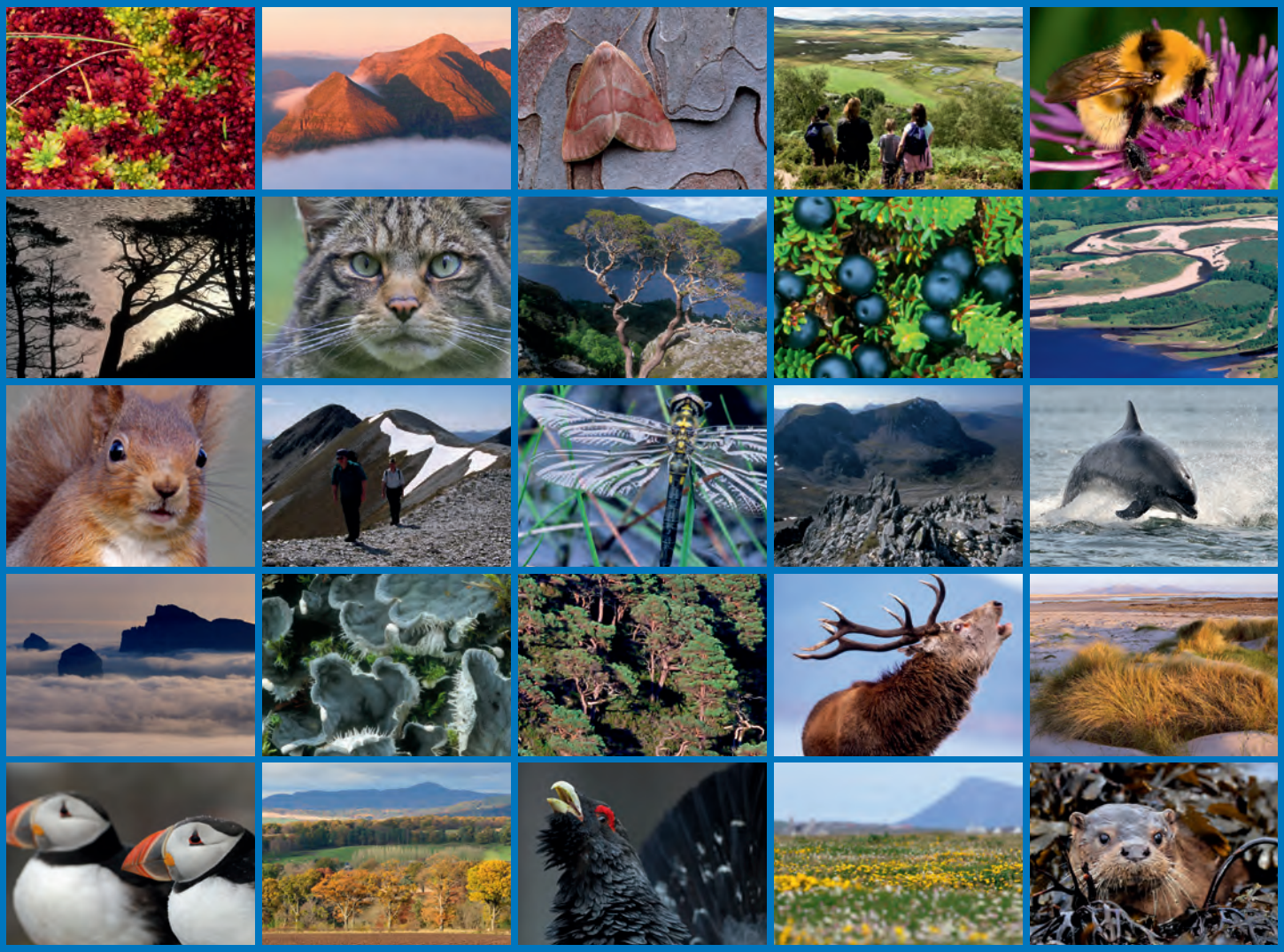
Scottish Natural Heritage
Commissioned Report No. 944

Practical indicators to assess the welfare of wild deer in Scotland



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COMMISSIONED REPORT

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Practical indicators to assess the welfare of wild deer in Scotland

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COMMISSIONED REPORT

Summary

Practical indicators to assess the welfare of wild deer in Scotland

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Keywords

Wild deer; welfare; suffering; health; bodily condition; mortality; welfare indicators.

Background

Under the Deer Scotland Act SNH must further the conservation of deer native to Scotland, the control and sustainable management of deer in Scotland, and keep under review all matters, including their welfare, relating to deer.

The Wildlife & Natural Environment Act (2011) (WANE) provided powers to SNH to take action where deer are causing damage to their own welfare or the welfare of other deer. Additionally WANE imposed a requirement for SNH to review, if certain conditions were not met: (a) levels of competence among persons who shoot deer in Scotland; (b) the effect of such levels of competence on deer welfare. Two earlier reports, by Professors Ohl and Putman (SNH Commissioned Reports 629 and 630, 2013), set out the principles by which the welfare of wild animals at the individual and group levels might be understood. As the welfare of deer is specifically included in the provisions of WANE, it follows that it is necessary to attempt to establish criteria or indicators whereby the welfare of free-living wild deer can be assessed. Published attempts to date to make such assessments of wild deer welfare have relied largely upon carcass inspection or post mortem examination; but no indicators that might be observed in living deer have been proposed or validated.

This report seeks to investigate whether such indicators are practically useful and of any value. The published evidence of measures of wild deer welfare will be reviewed. From both clinical records and experience in deer veterinary practice, indicators that have been used to assess the welfare of free-living deer in deer parks will be described. Those that may prove useful and reliable for deer managers in Scotland will be proposed, with any necessary caveats and shortcomings explained. Red deer (*Cervus elaphus*), fallow deer (*Dama dama*), sika deer (*Cevus nippon*) and roe deer (*Capreolus capreolus*) will be considered, with the emphasis on upland red deer populations. This report makes no recommendations about interventions or remedies when assessment indicates that the welfare of the deer is in a negative state.

Main findings

- Indicators of the welfare of wild deer can be divided into those that assess the bodily condition of the deer and those that assess the behaviour of the deer.

- These broadly correspond to – ‘How does / do the deer look?’, and ‘What is / are the deer doing?’
- Some indicators may be applied both statically and dynamically.
- Indicators of welfare are best used in combination and over a period of time, at least several days.
- Some possible welfare indicators suggested by earlier reports are difficult to employ in the field for wild deer or are confounded by other factors.
- There are nine indicators of welfare in wild deer that can be used by deer managers, field workers and conservationists in the field to make an assessment of the likely welfare state of the deer.

These indicators are:

1. The bodily condition of yearling animals based upon a visual pelvic condition score
2. The appearance of normal mobility and freedom from any debility, or the presence of obvious disease or injury
3. The mortality rate of the deer
4. The behaviour and activity of the deer when undisturbed
5. The toleration of close approach or handling
6. The social interaction of the deer when undisturbed
7. Foraging behaviour and appetite
8. The presence or absence of both renal and cardiac coronary groove fat deposits in yearlings
9. The bullet placement in carcasses in the larder

For populations of groups of deer that are not subject to routine culling for management purposes, the eighth and ninth indicators are not applicable unless deer have died and are available for post mortem examination.

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Table of Contents **Page**

1. INTRODUCTION 1
1.1 Background 1
1.2 The provenance of this report 1

2. METHODS 3
2.1 Literature Searches 4
2.2 Deer Veterinary Practice and Consultancy Records 5

3. FINDINGS AND RESULTS 6
3.1 The proposed indicators 6
3.1.1 Indicators of body condition and appearance – How does/do the deer look? 6
3.1.2 Indicators of behaviour – What are/is the deer doing? 6
3.2 Are the proposed indicators of welfare from the Ohl - Putman table applicable to wild deer and can they easily be used in a field situation? What does the peer-reviewed literature reveal? 8
3.2.1 Body condition and body condition scoring (fatness or leanness) 8
3.2.2 Condition of the coat and fur 10
3.2.3 Wound healing 11
3.2.4 Obvious injury or disease 12
3.2.5 Seeking and finding shelter 14
3.2.6 Social stability and social interactions 15
3.2.7 Avoidance and approach behaviours 16
3.2.8 Anxiety, stress and pleasure-related responses 17
3.2.9 Other possible welfare indicators from the literature 17

4. SPECIFIC PERCEIVED WELFARE CHALLENGES TO WILD DEER IN SCOTLAND 18
4.1 Winter die-off, exposure, winter starvation 18
4.2 Wounding from inaccurate shooting 20
4.3 The orphaning of dependent young 21
4.4 Stress caused by disturbance 22
4.5 Road Traffic Accidents (Deer-Vehicle Collisions (DVCs) 23
4.6 Urban and peri-urban deer 23
4.7 The perceived welfare challenges to wild deer in Scotland in the light of the suggested welfare indicators and the literature review 24

5. WHICH INDICATORS OF WELFARE HAVE PROVED USEFUL IN DEER PARK SITUATIONS? 26
5.1 Background 26
5.2 Challenges to the welfare of deer encountered in veterinary practice 26
5.3 Useful indicators of welfare status in park deer 27
5.3.1 Guides to body condition (fatness or leanness) 27
5.3.2 Guides to behavioural responses 29
5.4 Summary of the indicators of deer welfare that have been useful in veterinary clinical situations 30

6. SUMMARY AND CONCLUSION 32

7. RECOMMENDATIONS 32

8. REFERENCES 34

ANNEX 1: THE OHL-PUTMAN TABLE (FROM OHL AND PUTMAN 2013A AND B, 2014) 44

ANNEX 2: THE ASSESSMENT OF BODY CONDITION IN YEARLING DEER BY REFERENCE TO PELVIC CONTOURS **45**

ANNEX 3: THE PATHWAYS OF WELFARE DECLINE **47**

ANNEX 4: FIELD GUIDE TO THE LIKELY WELFARE OF WILD DEER **48**

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1. INTRODUCTION

1.1 Background

The welfare of free-living wildlife has attracted increasing attention from conservationists, veterinarians, animal behaviourists, philosophers and more recently legislators since it was first proposed in the peer-reviewed literature as an issue more than twenty years ago by Kirkwood Sainsbury and Bennett (1994). Earlier, in a more general way, philosophers like Paul Taylor (1986) had proposed broad principles whereby humans should interact with animals and other elements of the habitat and had advocated the 'Rules of Nonmaleficence, Fidelity and Restitutive Justice in respect of human interference with the environment. In more recent times the term 'Compassionate Conservation' has been coined by writers like Marc Bekoff (2013) to highlight the fact that humans are

> *"all over the place and it's arrogant to think that we can pick and choose where we have impact, for we have impact everywhere".*

The ubiquitous effect of human activity upon wild animals is set out by Czech (2013), who argues that the drive for economic growth, with concomitant habitat destruction, urbanisation, agricultural intensification, mining, logging and other extractive sectors leaves few parts of the globe free of an impact upon wild animal welfare. Recently the Netherlands and the Scottish Parliaments have enshrined into law a public duty of care to have regard for the welfare of wild animals. In the case of the Netherlands this is a general responsibility for all wild animals; in Scotland it applies specifically to deer. These jurisdictions currently stand alone with such law in the developed world (WANE, 2011; Putman, 2008a; Ohl and Putman, 2013a). In fact the revision and supersession of the longstanding Protection of Animals Act (1911) by the Animal Welfare Act (2006) and the Animal Health and Welfare (Scotland) Act (2006) specifically excludes wild animals from the obligations to exercise a duty of welfare care, unless the individual animal is "under the control of man" and specifically "not living in a wild state". Within these statutes, the consideration of animal welfare is framed almost exclusively in terms of the individual animal, not populations or socio-familial groups. The same is true of the Wild Mammals (Protection) Act (1996) and the English and Welsh Deer Act (1991).

1.2 The provenance of this report

The Wildlife and Natural Environment Act (Scotland) 2011 makes reference to the duty of the Scottish Natural Heritage to review the competence of people who shoot deer in Scotland in order to safeguard deer welfare. The Act also modifies the provisions of the Deer Scotland Act 1996, not least by inserting in Section 10 (Emergency measures to prevent damage by deer) a clause that makes the legislation include "causing damage to their own welfare or the welfare of other deer". These legal provisions place implicit responsibilities upon the enforcement agency Scottish Natural Heritage (SNH) to safeguard the welfare of the wild deer of Scotland.

This report arises from two former reports to SNH by Professors Ohl and Putman, in which the authors review historic and current concepts of animal welfare and shape an interpretation or application of these concepts to wild animals (Ohl and Putman, 2013a & b). These reports summarise the move from definitions of welfare constructed around absence of negative impacts (freedom from pain, freedom from hunger and thirst etc.) towards definitions that reflect the promotion of positive states of welfare. The authors endorse current thinking about welfare (Ekesbo, 2011; Appleby, Weary and Sandoe, 2014; Sandoe and Jensen, 2012; Ohl and van der Staay, 2012) that welfare should be considered as a continuum, not a 'good or bad', or 'positive or negative' state. Moreover these current concepts of welfare make reference to the ability of the animal or group of animals to adapt to challenges that might potentially be harmful and therefore define poor or negative welfare

in terms of the inability of the animal to alter its state and adapt to such challenges. Conversely positive welfare describes the state in which an animal has the freedom to react and adapt adequately to the prevailing circumstances or challenges. This concept of animal welfare relies upon an assessment of the internal feeling or subjective perception of the animal itself to the external stimulus, environmental condition or pathological challenge that it either faces or in which it finds itself. These more current ideas about animal welfare emphasise that welfare cannot properly be assessed at a single point in time, since the welfare of the animal is a reflection of how it reacts, responds and adapts to challenge: it must therefore, by definition, be given the time to demonstrate whether it can adapt or whether it has the freedom to make the necessary adaptation to mitigate its perception of the challenge. The contemporary view emphasises the need to take into account the variation within a population of individual animals, since there is increasing evidence that animals of the same species and the same social cohort can have differing characters, personalities and therefore responses to identical challenges (Ohl and Putman, 2013a & b; Baker, 2013).

Although good welfare science must inform the decisions and policies of government agencies, it is inevitable that they will also take account of and possibly be influenced by public opinion and perception. Best practice would require that that the biological and veterinary aspects of animal welfare, based upon contemporary peer-reviewed science, are first considered and that any ethical or moral dimension, perhaps influenced by public opinion, is only subsequently applied. This is pertinent to the field of wild deer welfare in Scotland and has been reviewed by Findlay (2007). Her report specifically considers the perceptions of the general public and stakeholders of what are defined within the report as the ethical and moral issues of wild deer welfare. From these perceptions flow expectations and, unsurprisingly, the report concludes that there is an expectation (in the mind of the general public) that welfare standards (for wild deer) should be consistently maintained and that there should be a system in place to help ensure this happens. The commissioning of this current report on practical indicators to assess the welfare of wild deer in Scotland is therefore a part of the process whereby such a system may be implemented.

As Findlay (2007) points out, a radical cull on one Scottish estate may be presented in the media as a massacre and as indiscriminate slaughter, whilst a similar cull on another estate is hailed as successful and necessary. Such ‘spinning’ by the media does nothing to improve the basis upon which the perceptions and therefore the expectations of the public about wild deer welfare are formed. The expectation in the mind of the general public that ‘something should be done’ about wild deer welfare arises from opinions and moral attitudes derived in most part from the media and the animal welfare charities. Findlay (2007) points out that in both media and public eyes deer occupy rather a paradoxical position. They are portrayed on one hand as an iconic species and on the other hand as a pest. The media exploits these two extremes.

In both Ohl and Putman (2013b) and in Findlay (2007) it is clear that wild deer welfare has been considered by way of specific worked examples, such as the supplementary feeding of wild deer or the acceptance that deer numbers need to be controlled by culling. These are, in fact, analyses of the responses to perceived problems that arise in the minds of the public, the media, the deer managers and those responsible for safeguarding the habitat, and others. They do not provide analysis or assessment of the actual state of the welfare of the deer, using the models now more currently accepted. This report will explore whether such assessments are possible and whether suggested indicators of welfare are useful.

2. METHODS

This report will not review in any greater detail the general concepts of welfare that are extensively discussed in Professors Ohl and Putman's two reports; the discussion and consideration of practical indicators to assess the welfare of wild deer in Scotland will be based upon these concepts, as they have been published by SNH and, therefore, endorsed and accepted. It will become clear, however, that such a basis is not without its shortcomings in this context although the author of this report concurs completely with the conclusions of the two former SNH publications (Ohl and Putman, 2013a & b). It will become apparent that the assessment of welfare in free ranging deer within the framework of current concepts is likely to be hindered by the difficulties of assessing adaptive capacity in wild animals and by the limited opportunity to assess wild deer over time, especially in the case of individual animals. Table 1 of Ohl and Putman (2013b) currently forms the approach accepted by SNH to form broad criteria whereby the welfare of wild deer might be assessed (Statement of Requirements for this project December 2013 Annexe 1). It is reproduced as Annexe 1 to this report for reference.

The Brambell Committee (1965) reported on the welfare of farm animals and proposed five 'freedoms' that could be used to assess welfare of both individuals and groups of animals. These freedoms were the need or requirement of animals to be free from:

- hunger, thirst or inadequate food,
- thermal and physical discomfort,
- injuries or diseases,
- fear and chronic stress,
- and are free to display normal, species-specific behavioural patterns.

This list of 'freedoms' formed the basis for accepted animal welfare for some forty years.

Table 1 of Ohl and Putman (2013b), divides the generic indicators of wild animal welfare (and, by implication from the Statement of Requirements for this report, wild deer welfare) into possible indicators that may be observed in individual deer and those that might be observed in groups of deer. The indicators are grouped according to four of the five 'freedoms' that have become the foundation for much of the welfare legislation in Europe and which arose from Brambell (1965).

Although the table prepared by Ohl and Putman (hereafter referred to as the Ohl-Putman Table) loosely uses them, it is important to bear in mind that the more contemporary paradigm of animal welfare gives greater weight to the *responses* of the animal(s) to the challenge or stressor, not the subjective assessment by the scrutineer of whether the animal(s) is/are free from them.

In the Ohl- Putman table there is no reference to 'freedom from fear and chronic stress', but the freedom to display normal behaviour is expanded to reflect the emphasis upon current "internal state" perceptions of welfare by the animal itself.

Scrutiny of the table shows that for the first three rows, headed as categories of adaptive capacity, the indicators of positive and negative welfare for individuals and groups are very similar if not identical, although framed in the plural for the group-level indicators. They are as follows:

Table 1. Suggested Indicators of Welfare (from the Ohl-Putman table)

Based on the animals' adaptive capacities	Positive indicators	Negative indicators
The animal(s) should be free adequately to react to hunger/thirst	Appetite and successful foraging behaviour Normal activity pattern Appropriate body condition	Unsuccessful foraging behaviour* Lethargy Inappropriate body condition
The animal(s) should be free adequately to react to climate conditions	Seeking and finding shelter Appropriate fur condition Appropriate modulation of body condition during seasons	Not finding shelter Bad fur condition* Body condition* worse than expected in relation to season
The animal(s) should be free adequately to react to physical injury or disease	Seeking and finding rest and shelter Functional immune system (e.g. appropriate wound healing/ lack of scouring)	Inability to seek and find shelter. Infection / inappropriate wound healing / scouring

*The table suggests that extreme or wide variation in foraging behaviour or of body and fur condition may be negative welfare indicators at the group level.

The final row of the Ohl-Putman Table is subdivided into:

- The animal(s) should be free to express its full non-social behavioural repertoire.
- The animal(s) should be free adequately to respond to social interactions.
- The animal(s) should be free to experience the full spectrum of emotional states and respond to those states adequately.

Proposed indicators of positive welfare in respect of these suggested freedoms are adequate behavioural responses to both social and non-social interactions, circumstances and challenges, as well as the execution of anxiety-related, stress-related and pleasure-related behaviours in adequate and appropriate ways. Play is given as an example of a pleasure-related behaviour. The negative indicators of these freedoms are given as persistent behavioural inhibition, lethargy, context-inadequate behaviour, social isolation, bullying and inadequate emotional responses.

This report will investigate whether these suggested indicators can be developed into simple guidelines that will be useful in the field situation and whether there are other indicators that may also be valuable in the field. Investigation will be based upon two sources of information: literature searches and a review of the clinical records of the deer park clients of Peter Green Veterinary Consultancy, Barnstaple, Devon.

2.1 Literature Searches

The librarians of the Royal College of Veterinary Surgeons performed several comprehensive searches of the peer-reviewed literature for the purposes of this report. Keywords used included deer, cervidae, wildlife, welfare, health, monitoring, body condition and diseases. After filtering, these searches yielded 793 articles, textbook chapters or papers. Abstracts of all were read and appropriate full-text documents were obtained or accessed on-line.

2.2 Deer Veterinary Practice and Consultancy Records

These records, from some 60 deer parks, over a period of 14 years were scrutinised for material relevant to this report. In particular, where deer in the public view are monitored for evidence of welfare, the criteria for such monitoring were assessed and the correlation with post mortem findings was evaluated. The usefulness of the methods used to assess deer welfare and the ease of application by deer managers will be reviewed. From the perspective of a veterinary surgeon working with deer, the possible indicators of welfare will be compared with clinical outcomes in deer and deer herds where welfare has been judged to have been compromised.

3. FINDINGS AND RESULTS

3.1 The proposed indicators

From the Ohl-Putman Table it is possible to extract suggested or proposed indicators of wild deer welfare. These can be divided into two categories: those that appear to affect the deer bodily and those that appear to affect the behaviour of the deer. They may usefully be termed Body condition and Behavioural Indicators. The first may be a reflection of the physical, physiological or pathological condition of the deer, the second a reflection of the emotional, behavioural and responsive condition or ability of the deer. 'Body condition' does not refer only to the degree of fatness or leanness, but includes other signs of bodily health The Ohl-Putman table makes it clear that assessment based upon a single indicator is unwise or unhelpful, but that as many as possible should be evaluated and integrated.

3.1.1 Indicators of body condition and appearance – How does/do the deer look?

Suggested physical, physiological or pathological indicators of welfare are:

- Body condition (fatness or leanness)
- Condition of the coat and fur
- Signs of infection
- Wound healing and / or lack of scouring (suggested as an indicator of a functional immune system)

3.1.2 Indicators of behaviour – What are/is the deer doing?

Suggested emotional and behavioural indicators of welfare are

- Appetite
- Foraging behaviour
- Activity – lethargy, hyper-reactivity
- Seeking and finding shelter
- Avoidance and approach behaviours
- Socio-positive and socio-negative behaviours; social stability, bullying
- Anxiety-related behaviour
- Stress-response
- Pleasure-related behaviour
- Play
- Isolated or atypical behavioural responses

It is immediately apparent that suggested body condition welfare indicators (fatness, fur condition etc.) are in general more easy to evaluate in a single animal and in a short time, perhaps within a single day, although the rate of wound healing can only be assessed over a longer period of time and this report does not consider it a useful indicator (see 3.2.3 below). It is noteworthy that the table specifies the freedom to react to physical injury or disease as a class of adaptive capacity, but does not indicate that obvious injury or disease is a possible welfare indicator. It takes very little time and can be undertaken on a single short observation to notice that deer are emaciated, or have poor coats, or unhealthy discharges. Most of the suggested 'behavioural' indicators, will not be easily assessed in a short time or with a single observation, and may be more pertinent to groups or herds of deer. Foraging behaviour, bullying, levels of activity versus lethargy and other 'behaviours' can only be assessed by observing deer for a significant time, at least over a period of a week.

In short, it may be possible easily to assess suggested body condition welfare indicators by means of a still photograph, whilst behavioural indicators would be very hard to evaluate from a single frame.

Clearly, body condition welfare indicators at any given time may be declining, improving or remaining constant and a single observation cannot assess any change for the better or for the worse. But two factors are important: first that a severely emaciated deer or a deer with obvious serious injury or disease is, by all definitions, in a more negative welfare state at the time than a deer in normal body condition even if that state is improving. Secondly, such findings in a number of deer in a given population should give cause for concern irrespective of whether their condition is improving (see 3.2 and 5.2 below).

It might also be suggested that the body condition indicators, the degree of fatness or leanness and apparent state of physical health of the deer hark back to more traditional views of how welfare should be assessed, whilst the behavioural and responsive indicators, are perhaps more in tune with current welfare science. The question for this report however, is not which indicators are moulded by which philosophy of animal welfare, but which, if any, are useful and relevant to field workers on the hills and in the forests of Scotland.

It follows from this that because the welfare indicators of body condition may be more easily empirically measured at a given time, they could be classed as *static* indicators, whilst behavioural indicators can only be assessed over time and therefore could be termed *dynamic* indicators.

In the context of this report it is important to emphasise that for the assessment of the welfare of wild deer in Scotland, contemporary paradigms of welfare require that several assessments of body condition indicators over several days are made before conclusions are reached about the actual welfare of the deer. Although body condition indicators *can* be assessed on a single observation, it is far better to observe them repeatedly to monitor the changes in body condition. In contrast, behavioural indicators of welfare can *only* be properly assessed over a longer period.

The Ohl-Putman Table and indeed the two reports on wild animal welfare from which it derives (Ohl and Putman 2013a and b) focus almost exclusively upon the assessment of welfare in living animals. Wild deer fall within the very small subset of British wild animals for which post mortem inspection and carcass evaluation is widely undertaken. Other mammals including hares and rabbits, and birds such as pheasants, ducks and wild geese are also subject to some post mortem assessment since all are consigned to the game meat trade. It is, however, only for deer that individual carcass inspection is routinely performed and for which a structured, externally moderated qualification is available to those who cull and process deer in game larders. Deer Stalking Qualification Level One provides basic but accredited training in carcass inspection under EC Game Meat directives and this system offers the opportunity for some post mortem assessment of ante-mortem welfare in wild deer.

Possible post-mortem aids to the assessment of wild deer welfare have been discussed at 3.1.1, but it is again apparent that any such indicators can only provide evidence of physical, bodily health and condition of the deer at the time of death and cannot offer any assistance to the indicators that seek to assess the inner state or emotional response or appropriate behaviour of the deer before it died. Larder work may therefore be useful, since it may corroborate or underpin traditional, body condition welfare indicators that can to some extent be measured, weighed or analysed in the laboratory. More dynamic behavioural welfare indicators do not benefit from such empirical unpinning. Empirical measurements of the degree of fatness, or leanness, fat reserves, mineral and nutritional status, parasite burdens and other measures of health or disease provide data that can be easily compared and

cross referenced across populations and across time, whilst records of behaviour, responses and adaptations are far less easy to collate systematically. There may therefore be a bias towards reliance upon body condition indicators, when current welfare philosophy favours the behavioural indicators.

3.2 Are the proposed indicators of welfare from the Ohl - Putman table applicable to wild deer and can they easily be used in a field situation? What does the peer-reviewed literature reveal?

3.2.1 Body condition and body condition scoring (fatness or leanness)

The assessment of 'body condition' is a fundamental and routine part of domestic animal husbandry, whether the animal is kept for meat, milk, wool or egg production. In this context, 'body condition' has a more restricted meaning and is a reference to the fatness or leanness of the animal, without reference to other signs of the bodily health of the animal. Thin and emaciated animals perform poorly. For cattle, sheep and other ruminants, as well as for horses Body Condition Scoring (BCS) systems have been used for many years and have been shown to correlate well with carcass fatness (Russel *et al*., 1969; Nicholson *et al.*, 1987; Wright, 1985; Carroll and Huntingdon, 1988). All these systems are based upon the manual palpation of the living animal, concentrating upon the skeletal landmarks of the pelvis, spine and ribs and assessing by firm digital pressure the degree to which they are covered by soft tissues. Most systems are based upon a scale on which the lowest score represents the poorest bodily condition and the highest score represents morbid obesity. Some scales are proposed as 1-5, some 1-10, some 0-5, but those with fewer numerical scores are often divided into half scores!

For all domestic livestock the lowest possible BCS is considered to represent a welfare issue for the individual animal concerned and to be an indicator of poor performance of the flock or herd if several animals are affected (see Code of Practice for the Welfare of Horses, Ponies, Donkeys and their Hybrids, DEFRA 2009, Codes of Recommendations for the Welfare of Livestock: Sheep DEFRA 2020, Cattle 2003).

Sixty years ago Riney (1955) proposed a body condition scoring system for free ranging red deer in New Zealand, using a scale of 1-5, as part of a study to determine the usefulness of several indicator(s) of bodily condition, although he concluded that the BCS was not the most useful. BCS assessments have been advocated and used in the deer farming industry for some time for both red deer (Audige, Wilson and Morris, 1998) and fallow deer (Muller and Flesch, 2001) and BCS charts have been published for both species (Muller and Flesch, 2001). Accurate and reproducible BCS assessments are best made by manual and digital palpation of the soft tissues covering the skeletal landmarks, but in cattle Broring *et al.*, (2003) and in deer Muller and Flesch (2001) suggested that visual BCS assessment is not worthless and can correlate reasonably both with palpation of the live animal and with other post mortem indicators of fatness. This however, raises the question of whether BCS is a measure of welfare, since if the livestock and meat production industries place an emphasis upon condition as a measure of fatness, it should be assumed, as Putman (2005) points out, that BCS scales are likely to be skewed upwards, towards a bodily condition that optimises carcass weights or milk production. If BCS assesses only the subcutaneous fat, in practice in the livestock industry the lowest score is unlikely to represent the extreme state of emaciation in which muscle tissue has been catabolised because all fat deposits have been depleted. Yet until all fat deposits (reserves) have been depleted, it may be questioned whether the degree of *thinness* of the individual animal represents a welfare issue per se although extreme hunger almost certainly does (Tucker *et al*., 2013).

In deer, as with other ungulates, fat deposits are laid down in order of bone medullary cavity (marrow) fat, internal abdominal and thoracic fat (mesenteric, renal, cardiac) and finally

subcutaneous fat. Fat reserves are mobilised in the reverse order when dietary intake is insufficient to maintain bodily condition and thermoregulation (Riney, 1955; Fuller *et al*., 1986). This means that a BCS system that measures only subcutaneous fat will yield a low score when fat over the skeletal landmarks is exhausted, but will give little evidence of remaining internal fat in the abdomen, thorax or medullary cavities of the bones. In sika deer Yokoyama et al (2000) found that femoral and mandibular medullary cavity fat were the best predictors of winter survival and that severe nutritional stress could not be assessed by reference to kidney fat.

Deer cope much less well with adverse weather conditions than cattle or sheep of comparable body mass; they experience a greater intensity and duration of cold stress than cattle or sheep in conditions likely to be encountered in Scotland (Simpson *et al*., 1978) and even cold adapted species like caribou and moose may lose muscle mass as well as fat reserves during normal winters in their home ranges (Taillon *et al*., 2011; Gingras *et al*., 2014; Parker *et al*., 1984) although reindeer and caribou (*Rangifer sp*) appear to differ from other northern ungulates in their ability to gain weight and lay down fat in the winter if they have endured a summer of nutritional deprivation (Couturier *et al*., 2009). Winter inanition, or 'metabolic shutdown' is well recognised in temperate climate deer species including red and roe (Clutton-Brock *et al*., 1982; Haigh and Hudson, 1993; Andersen *et al*., 2007; Turbill *et al*., 2010); the same may be true for fallow deer in cold northern winters, but during warm Australian winters fallow deer do not lose appetite or condition if fed properly (Muller and Flesch, 2001). Deer in northern Europe differ from cattle and sheep in that catabolism of muscle as an energy reserve appears to be a normal part of their physiological annual cycle, especially in pregnant females, which are laying down protein in the embryo in utero over the winter at a time when their appetite reduces. Deer also excrete rather more protein than cattle and sheep in urine and faeces; appetite and metabolic rate reduce in response to daylight length (Haigh and Hudson, 1993). A body condition scoring systems for deer therefore needs to encompass the full range of normal, healthy body conditions within the centre or optimum parameters of the scale and leave the lower or lowest scores for body conditions that are genuinely a reflection of malnutrition, disease or other challenge to which the deer is unable to adapt or respond.

A significant amount of investigation has been directed towards the best indicators of body condition in deer of several deer species. As indicated earlier Riney (1955) considered his BCS system to be less valuable than the post mortem combination of kidney fat index and other biometric measurements This was corroborated by Challies (1978), who examined 4,226 red deer in southwest New Zealand between 1967 and 1974. He formulated a condition score based upon a 'standard' or expected weight that was determined by jaw length as an indicator of body size. More recently Matiello *et al*. (2009) have compared a three point BCS (poor medium and good condition) with kidney fat index and measurement of back fat just forward of the tail in red deer in an Italian alpine habitat in early autumn. They concluded that back fat is a simple and reliable indicator of condition, but none of their 274 deer carcasses had a complete absence of kidney fat, indicating that none were in a state of malnutrition or emaciation that would give rise to a welfare concern. Finger *et al*. (1981) found a good correlation between kidney fat index and body condition in white tailed deer, but as indicated earlier a complete absence of kidney fat is not an indicator of complete depletion of reserves.

In Poland Czyzowski *et al*. (2008) examined 54 red deer hinds and suggested that a chest capacitance index was a good measure of condition and a similar weight/chest girth index was proposed for white tailed deer by Martinez and Hewitt (1999). In moose however, measurements of chest girth and total body length were found to be reasonable estimators of absolute mass but it was necessary to factor in a subjective BCS estimation to make the mass prediction more reliable (Hundertmark and Schwartz, 1998). McGillis (1972) compared the kidney fat index with the body condition and back fat in 623 moose and concluded that in

this species body condition was poorly correlated with both back and kidney fat, especially in calves. Emaciated calves were recorded with measurable kidney fat remaining. In wapiti studies, Cook *et al*. (2001a and b) showed that for live animals BCS and back fat were most related to condition compared with other proposed indices or techniques, whilst for deer carcasses, kidney fat and carcass scores were most related to fat and to estimates of gross energy. They therefore proposed that an arithmetic combination of a rump BCS and a measurement of rump fat thickness was the most sensitive and accurate index of true condition. Gerhart *et al*. (1996) proposed a 'body reserve index' obtained by multiplying BCS and body mass as the best estimator of body fat, and therefore likely pregnancy in caribou and reindeer. Vicente *et al*. (2007) reported that the mass of the spleen was correlated with body condition in red deer but was independent of nematode burden only in adult hinds.

In studies of living and dead deer back fat has been measured ultrasonographically (Cook *et al*., 2001a; DelGiudice *et al*., 2011; Stien *et al*., 2003), but this requires both technical equipment and technical skill. Stien *et al*. (2003) showed how variables could be generated by inexperienced or incorrect use of the ultrasound probe.

The assessment of the bodily condition of deer by visual inspection or by manual palpation (of live deer or carcasses) is therefore clearly possible and the scoring of this assessment on a numerical scale is also therefore feasible. If assessment of internal fat deposits and biometric measurements of the deer are not available, which will be the case when wild deer are observed in their habitat, on balance the literature suggests that a BCS system is an acceptable, if rather rough, way of objectively recording bodily condition. The scale is irrelevant, although experience has shown that attempts to divide the scale into more than 5 increments are of little value (see 3.2.1 above. There are two important caveats. In view of the fact that deer regularly metabolise muscle protein as well as fat during the course of the winter, since they have relatively limited reserve resources (Simpson *et al*., 1978), any BCS scale should not simply reflect the degree of rump or back fat under the skin, but should also reflect catabolism of pelvic and lumbar muscles at its lowest scores. It is also important to realise that thinness, or very poor bodily condition is not, by itself an indicator of a welfare problem. Geriatric hinds with absent incisor teeth may become very thin before they die of old age, especially in winter (Loe *et al*., 2006). Whether this should be regarded as a natural part of deer biology in the absence of predators is open to debate (White *et al*., 2011) and would form part of the ethical and moral framework necessary to make decisions about intervention.

The published literature is therefore somewhat divided about the value of BCS in wild deer. Certainly it is not considered to be, by itself, an accurate and infallible tool by which to assess deer welfare. But the balance of opinion leans strongly towards the view that it has a place and can contribute useful information towards a welfare assessment (see 5.2 below).

3.2.2 Condition of the coat and fur

There is little in the peer-reviewed literature to substantiate the anecdotal opinion that deer in poor health or condition have coats that appear different from those of healthy deer in good condition (Putman, 2005). Evidently stalkers and deer managers believe from experience and observation that unhealthy or malnourished deer have scruffy, or 'staring' coats, and that this is especially true of young deer. There may be several explanations for both the opinion and the observation. To begin with, in farm animal husbandry it has long been received wisdom that the condition of the coat and fur is an indicator of health and that this applies especially to beef and dairy calves (Miller and Robertson, 1959). Deer management is by nature traditionally a rural pursuit and those engaged in day-to-day estate and farm management are likely to extrapolate their livestock knowledge to wild deer. It is also known to be the case that late born red deer calves and hinds still heavily lactating change their summer coats and grow their winter coats later than early born calves and hinds without a

calf at foot (Clutton-Brock *et al*., 1982). Both these classes of deer are likely to be in poorer bodily condition than others in the herd and to struggle with thermoregulation. The winter pelage is significantly better at maintaining skin surface temperature than the summer coat, so the delayed and scruffy coat changes may be accompanied by pilo-erection in an effort to keep warm, which in turn gives rise to a fluffy or 'stary' appearance (Parker and Robbins, 1984).

There are also pathological skin conditions that affect the quality and appearance of the coat. Heavy infestations of external parasites such as keds and lice may cause hair loss, patchy or scruffy coat changes and even abrasions from rubbing. Such parasites are almost ubiquitous on wild deer, but are usually present at a level that does not affect the coat; individual animals with much heavier infestations are likely already to be affected by other problems giving rise to ill-thrift and disability. The parasites themselves are not the cause of the ill thrift, but debilitated deer succumb to higher levels of external parasite burden because of depressed immunity and reduced normal grooming (Goddard, 1994; Bildfell *et al*. 2004). (See also 3.2.3 below).

The literature therefore suggests that delayed coat change in the autumn and obvious evidence of skin parasites, visible from a distance, could be an indicator of more negative welfare, but that these should not be given great weight in a welfare assessment and would be weather dependent.

3.2.3 Wound healing

The Ohl-Putman Table suggests that 'appropriate wound healing' is an indicator of a 'functional immune system'. This makes sense, in terms of general veterinary medicine, but rates of wound healing are subject to many other influences that have far greater capacity to delay repair. In ungulates these include infection, movement (especially if the wound is in mobile tissues near a joint), skin temperature (therefore season), attention from flies and other insects, rainfall and soil type in the habitat (Stashak and Theoret, 2008). In highly socially structured groups of animals, particularly primates, there is evidence that wound healing may be delayed by subordinate social status and this is believed to be a function of stress-derived gluco-corticoids (Archie *et al*., 2012). It must be emphasised that the comparative rates of wound healing in primate troops are recorded when all other factors that may affect wound healing are either constant across the troop or are factored out in the statistical analysis. The issue of wounding by shooting will be discussed later (4.2 below).

Whether or not wound healing is a useful welfare indicator in wild deer is therefore questionable, but it raises the possibility that immunocompetence itself may be manifest in other ways. Gilot-Fromont *et al*. (2012) assessed the immunological phenotype in French roe deer from two separate populations by means of both cellular and humoral parameters in blood. They concluded that immunological parameters related to innate immunity were correlated with better bodily condition and a more productive, nutritious habitat, whilst immunological parameters that indicated adaptive immunity were positively correlated with poorer body condition and less productive home ranges. There was no correlation with age or sex or with concurrent parasite burdens. In another study Debeffe *et al*. (2012) showed that in French roe kids, heavier individuals dispersed further as juveniles and sub adults than their lighter counterparts. Individual dispersal and travelling distances from the place of birth are of lesser significance in gregarious deer like red and fallow but in red deer cellular haematological indicators of immune status such as leukocyte, lymphocyte, erythrocyte and platelet counts appear to correlate somewhat with testicular size in males and then with eventual antler size: more immunocompetent stags tending to have larger testes and larger antlers. However across the whole population the immune status varies more between sexes and between seasons (Gaspar-Lopez *et al*., 2011). In wild rodents there are strong correlations between levels of infection, immunocompetence and bodily condition

(Beldomenico *et al*., 2008) and in a study of lactating red deer hinds deliberately kept short of food the hinds suffered little in terms of immunocompetence, but their dependent calves showed increased levels of immunoglobulins and slower growth rates than calves of dams fed properly (Landete-Castillejos *et al*., 2002). This suggests that malnutrition in hinds gives rise to poorer calves not only because of absolute reduction in milk quality and quantity, but also because the calves need to divert extra resources to fighting infection and away from growth.

The literature therefore does not assist in teasing out the cause-and-effect relationships of bodily condition, growth, immunological status, infection and stress. It seems safe to assume that a deer in poor bodily condition in comparison with its peers is likely to have poorer innate immunity and probably poorer adaptive immunity, to have higher stress-related gluco-corticoids and be more prone to infection, but for the deer manager on the hill who has observation alone as a tool, only the body condition and behaviour are available as indicators of the other possible factors.

3.2.4 Obvious injury or disease

Bullet wounding will be dealt with at 4.2 below. Whitehead (1996) reported a catalogue of injuries to Scottish hill red deer he had recorded over a fifty-year period. These included injuries from fighting in the rut, injuries from falling down cliffs and screes, injuries from foreign bodies, injuries from fences, blindness and various entanglements in nets, rigging, rucksacks, buckets and even trees. It is interesting that Whitehead does not mention road traffic accidents, which was perhaps a reflection of the mid twentieth century distribution and prevalence of both deer and vehicles. The Ohl-Putman Table does not include obvious injury or obvious disease as a welfare indicator, but quite correctly emphasises that welfare is compromised if the deer is unable properly to respond to such challenges.

Traumatic injury should be considered separately from infection or disease. Injured deer have a remarkable ability to recover and thrive after trauma: fractures appear to heal rapidly, three-legged deer cope well and even hold hinds, stags and bucks blinded in one eye from rutting injuries continue to compete in subsequent seasons (Chapman and Chapman, 1997; Green, 2003). Traumatic injuries including healed fractures account for the greatest proportion of reports of carcass abnormalities to the British Deer Society (personal unpublished data). Traumatic orthopaedic injury, even apparently severe injury such as limb fracture, may therefore not be cause for immediate euthanasia on humane grounds, but may rather be a good example of the applicability of current welfare concepts, because if the deer is able to adapt to the immediate injury by seeking shelter and remaining undisturbed and if it is able to feed and maintain itself whilst inherent physiological repair mechanisms deal with the trauma, the welfare of the deer may remain positive and the outlook for the survival of the deer may be favourable (Ohl and Putman, 2013a). Extreme soft tissue injuries such as evisceration, very large open wounds into muscle or extensive skin loss carry a much less favourable prognosis (Stashak and Theoret, 2008), because of the very high risk of infection, peritonitis and septicaemia.

Because of their vulnerability to stress-related metabolic disease, their inherent fear of humans, of confinement and of isolation from other deer, there is little doubt that the welfare of an individual injured deer is far more adversely affected by handling it and attempting to rescue and rehabilitate it in a hospital, home or clinic than by leaving it in situ if it is mobile and can feed (Green, 2003). There is limited evidence of behavioural responses to pain in deer but Webster *et al*. (2006) showed that yawning, grooming, standing still, scratching and lying down were seen more in deer that had just been de-antlered and after the analgesic had worn off compared with controls. There is increasing evidence that pain in ruminants may be overlooked because the most consistent response is simply quietness, which is misinterpreted as stoicism (Stafford, 2013).

With individual deer, it is inevitable that a degree of subjective anthropopathism will be brought to bear upon the assessment. A deer moving with a swinging, badly fractured, lacerated limb will always be perceived by the human observer to be in pain and distress because such an injury would be painfully shocking to the human. This is not a spurious or valueless factor in the assessment; indeed veterinary practice and the Courts of Law regularly make decisions about animal 'suffering' and criminal culpability based on such perceptions. It is entirely reasonable and advisable for a deer manager to seek to 'put out of its misery' a deer encountered in such a state, but the fact remains that many such deer would, in fact recover to a remarkable extent. The majority of healed fracture cases encountered through deer veterinary practice work are reported as incidental findings in deer that were normally mobile and in good condition before they were shot (unpublished personal data). The legislation makes provision for the humane destruction of deer out of season, at night and by any reasonable means if the deer is so badly injured or in such a condition that there is 'no realistic prospect of recovery' (Wild Mammals Protection Act 1996, WANE 2011) or if it killed 'to prevent suffering' (Deer Scotland Act 1996).

Disease of wild deer is different from injury. In common with all higher vertebrates, healthy deer have a complex and finely balanced relationship with commensal bacteria, essential digestive bacteria, environmental bacteria and a host of viruses, helminths and arthropods. No thriving, healthy deer in Scotland will be free of some internal and external parasites or of potentially pathogenic bacteria and viruses, but in this state the healthy deer is maintaining a balanced relationship with them. Clinical infection or pathological infestation is established when the pathogen (bacterium, virus, parasite) overwhelms the defensive mechanisms of the deer at either a local or systemic level. A wound becomes infected when bacteria that initially were present as contaminants multiply locally in dead tissue or discharges and become established in and around the wound. This is local infection. The resulting response is both inflammatory and immunological. There may be local pain and if the wound is on a limb the deer may become lame. If the local response is insufficient, the infection may become regional or even systemic, in which case the deer may become very ill.

In the same way, a potentially pathogenic virus may be inhaled or ingested and may multiply in local lymph nodes of the throat or bowel for a while before the defence responses of the deer eliminate or suppress it. If, however the viral multiplication exceeds the capacity of those mechanisms to deal with the challenge, the deer may become viraemic and may manifest clinical signs of virus disease.

The factors that determine whether or not a deer can meet the challenge of a potential pathogen are complex and inter-related. As noted above (3.2.3) immunological competence is clearly important and there is growing evidence that stress-related immunosuppression predisposes to infection in natural populations (Beldomenico, 2008). The immunoglobulins ('antibodies') that circulate in the bloodstream are proteins; protein deficiency from malnutrition increases susceptibility to infection (see 4.1 below) and immunosuppression is a recognised condition in pregnant ruminants on sub-optimal diets (Evermann, 2002). But poor condition, malnutrition, exposure and hypothermia cannot explain vulnerability to all infection and disease: as examples, outbreaks of epizootic haemorrhagic disease and eastern equine encephalitis in free ranging deer in the USA have apparently swept through populations of healthy deer (Schmitt *et al*., 2007; Prestwood *et al*., 1974) and the current relentless spread of Chronic Wasting Disease in the USA appears not to be linked to poor condition or other obvious immunosuppressive factors (Almberg *et al*., 2011). Such outbreaks or epidemics have not recently affected UK deer; although there have been regional or localised outbreaks ('hotspots') of bovine tuberculosis and lungworm in recent years (Ward *et al*., 2008; Green, 2008).

Parasitic disease is especially complex in respect of the relationship between parasite and host, since in evolutionary terms a parasite would be unsuccessful if it became so

pathogenic to the host species that it caused population and therefore opportunity decline. This balance of parasite burden to host tolerance is mediated by host immunity and there is good evidence that immunological naivety and immunosuppression are both precursors to clinical disease (Taylor *et al*., 1996). This may be pertinent to the proposal in the Ohl-Putman Table that 'lack of scouring' is also an indicator of immunodeficiency. Whilst it may be such an indicator in parasitic disease, the link is by no means as straightforward in non-parasitic diseases such as bacterial and viral enteritis, which also give rise to loose faeces. It is also questionable whether 'scouring' should be given more weight than other signs of disease, such as coughing or profuse nasal discharge, both of which are equally noticeable in wild deer.

In both red deer and roe deer showing no clinical signs of enteric parasitism (no diarrhoea, emaciation or other apparent disability) there is reported correlation of bowel parasite levels with body condition (Irvine *et al*., 2006; Rehbein *et al*., 2000; Zaffaroni *et al*., 1997; Sigonds-Pichon *et al*., 2000), although Gilot-Fromont *et al*. (2012) were unable to confirm this in roe deer and in red deer Vicente *et al*. (2007) found the correlation only in male deer in respect of lungworm infestation. Liver fluke, on the other hand, can be tolerated without apparent effect, especially in fallow deer (Lazzeri *et al*., 2002). In southern England there are regular reports of adult roe deer dying in winter and from personal experience and investigation the majority of these appear to be associated with parasitic gastritis of the abomasum caused by nematodes of the genus Ostertagia (unpublished personal records).

There is a question about whether the presence of disease in a deer herd represents a welfare concern when the deer are coping with the challenge and are not succumbing to the point of collapse. Intervention might be justified in order to limit the spread of disease or protect the welfare of other species (for instance in an outbreak of Foot and Mouth Disease, in which the deer themselves would probably be only mildly affected) but such intervention would not be on the basis of compromised welfare of the deer themselves. There is also evidence that intervention in the form of therapy or prophylaxis for one disease may exacerbate another: the feeding of anthelmintics to free living African Cape Buffalo (*Syncerus caffer*) has recently been shown to increase severity and incidence of bovine tuberculosis in the treated herd (Ezenwa and Jolles, 2015).

In summary, the literature and current welfare frameworks suggest that the welfare of individual wild deer may be jeopardised if they are unable to flee from close human contact because of injury or ill health, or if their injury is undoubtedly going to be fatal. Orthopaedic injuries such as limb fractures are less threatening to welfare in wild deer than extensive soft tissue injuries. In the case of groups of wild deer, evidence of widespread clinical disease giving rise to increasing malaise and even death would be an indicator of more negative welfare. The presence of injury or disease in a single deer or a group of deer may be assessed by means of body condition, static indicators (obvious presence of the lesion or pathology, emaciation, immobility etc) but behvioural, dynamic indicators should also be assessed (is / are the deer improving or declining over time, is there any evidence of response or adaptation that improves the welfare of the deer?).

3.2.5 Seeking and finding shelter

Moving to the behavioural, dynamic indicators, rather than the body condition, static, indicators of welfare suggested by the Ohl-Putman Table, it is important to remember that the deer of Scotland are naturally all arboreal species (Putman, 1988; Geist, 1999), that is, their preferred and original habitat is woodland or woodland edge. The presence of large numbers of red deer on the open, unwooded uplands of Scotland is a very recent phenomenon in evolutionary terms and cannot be explained by anything other than anthropogenic influences. Clutton-Brock *et al*. (1982), quoting Richie (1920) reveals that as recently as seven thousand years ago more than 50% of Scotland's land surface was

wooded. The isle of Rum, where the red deer have now been intensively studied for more than sixty years was once heavily wooded and the indigenous red deer became extinct in about 1787 when the last of the forest was cleared. They were subsequently re-introduced as part of the Victorian enthusiasm for establishing 'deer forests' in the eighteenth century, but the boom in deer forest creation (from nine 'forests' in 1790 to two hundred and thirteen in 1912) saw the deer restored, but not the trees or the woodlands. The deer of the open Scottish uplands therefore represent an early example of what Czech (2013) describes as the most important source of global wildlife suffering – habitat destruction. He makes the following points:

> *"Many wild animals survive an initial onslaught of habitat destruction only to be stranded in a foreign inhospitable environment… When thermal cover is destroyed, wild animals must spend precious time and energy to regulate body temperatures, decreasing or eliminating other activities such as feeding, playing or reproducing. When hiding cover is lost, wild animals enter a constant state of fear or stress instinctively seeking cover in vain from predators that may or may not be present".*

Scotland's wild deer may be iconic, and the Monarch of the Glen makes an impressive Victorian Caledonian totem (Findlay, 2007). However, the observations of LINK to RACCE (2013) that thousands of deer die on the hill in harsh winters and that their bodies pile up against the forest fences is a salutary reminder that the deer cope badly with life on the open hill. Their death up against the woodland fences is testimony to their inherent drive to find shelter in the woods from whence their recent ancestors came.

Having made the obvious point, it is, however, only right to point out that woodland and forest are not the only potential shelter available to wild deer. Gulleys, hollows and relatively low growing ground cover, even heather and bracken, can afford significant protection from wind chill and exposure (Putman and Langbein, 2003; Putman, 2008b). The extent to which female white tailed deer sought refuge in dense conifer woodland was more a function of snow depth than of temperature or wind and on bright days the deer preferred to be out of the dense canopy to gain the benefits of solar radiation (DelGiudice *et al*., 2013).

The maintenance of internal body temperature is an important part of mammalian and avian homeostasis irrespective of ambient temperature. It consumes a considerable proportion of energy resources when skin surface temperatures fall significantly below the lower thresholds of metabolic acceptability for any given species. Core temperature of the abdomen, thorax and brain must be maintained for the animal to survive (Cunningham and Klein, 2007). This will be discussed at 4.1 (below), but normal behaviour of any mammal includes the drive to seek shelter when ambient temperature, rain, snow or wind risk are compromising the ability to maintain core warmth. Failure to seek shelter in such conditions indicates either disability that prevents movement or incipient hypothermia or systemic disease that has depressed responsiveness, or it is evidence of habituation to a situation where the animal has learned that there is no adequate shelter. All of these reasons can be considered to represent welfare issues. The indicator of negative welfare in the individual or group is the failure to seek or to find shelter when shelter is obviously necessary.

The literature therefore indicates that the absence of available shelter in severe weather or the failure to seek it when it is available are both indicators of more negative welfare for the deer.

3.2.6 Social stability and social interactions

The social structure of red deer herds and the relationship between the sexes and the age cohorts has been well documented by Clutton-Brock *et al*. (1982). Similar work, although not based on one population over a long period, has also been reported on roe deer (e.g.

Andersen *et al*., 1998; Cibien *et al*., 1989) and fallow deer (e.g. Apollonio, 1998, 1989; Focardi and Pechiolli, 2005; see also Chapman and Chapman, 1997). Whether their social structure is based upon herds, natal groups, bachelor groups, harems or a solitary lifestyle, all healthy deer in a positive welfare state interact with others of the same species in ways that maintain social stability. The structure and inter-relationships may vary according to season; the rut in all species affects these relationships, but abnormal social behaviour and evidence of breakdown in social structure may be an indicator of negative welfare in the group and of a negative welfare state in an individual if it is excluded from the structure completely. Hanlon *et al*. (1995) recorded increased aggression between deer when farmed red deer were deliberately mixed repeatedly preventing the establishment of a stable social structure. Aggression between farmed hinds was also greater in animals afforded no visual cover in their paddocks compared with those in paddocks where screens were erected behind which the deer could hide from each other (Whittington *et al*., 1995).

For free living wild deer such indicators will vary between species: a solitary roe buck may not be unusual but a solitary young red deer hind might be. It will also vary with the season: a young stag being harassed by an older stag in October may be part of rutting behaviour, but a young stag being repeatedly bullied by another stag when both are in velvet might be cause for concern. Anthropogenic influences may be significant. The habitat destruction that has left red deer on the open hill has already been discussed, but social structure may be artificially fractured by other human interventions such as attempts to feed deer in winter (Boyce, 1989; Petersen and Messmer, 2007; Putman and Staines, 2004) and stock fencing (Harrington and Connover, 2006).

Increased intra-group aggression, bullying, fighting out of the rut and the social exclusion of individuals in gregarious species may therefore be used as an indicator of group welfare.

3.2.7 Avoidance and approach behaviours

One of the important elements of contemporary approaches to welfare is the acceptance that there is considerable variation within a population of personality, innate responsiveness and ability to adapt (Ohl and Putman, 2013b; Baker, 2013). In the assessment of behaviours at group level it is therefore essential to understand that there will be a range of behaviours and a range of responses to any given common stressor or challenge. Amongst red deer some are inherently more inquisitive than others (Pollard and Littlejohn, 1995). There is evidence that hunter selection favours less bold and more fearful wapiti being left in a given population (Ciuti *et al*., 2012). There is some evidence that increasing use of the deer habitat for leisure pursuits in northern Europe, including Scotland is giving rise to chronic, albeit low-level stress and anxiety because of repeated disturbance. Scottish red deer habituated to walkers altered their night -time foraging even when the paths were quiet and thereby missed out on the best grazing (Sibbald *et al*., 2011). Even semi-domesticated reindeer in Norway exhibited avoidance behaviours up to 12km away from human activity (Skarin and Ahman, 2014). The winter-feeding of wild forest reindeer reduced slightly their flight distance from humans on foot, but not to the point where approach within 80 m was tolerated (Nieminen, 2013).

Overall and within obvious parameters wild deer in a positive welfare state will flee the approach of predators and humans and be cautious in their investigation or toleration of unfamiliar stimuli. Behaviour that falls outside these parameters, such as the toleration of close human approach or unusual boldness in seeking food may be an indicator of a poor welfare state, at both the individual and group levels.

3.2.8 Anxiety, stress and pleasure-related responses

To some extent, this category of behavioural response indicator overlaps with others. The absence of normal grooming, stretching out, basking in the sun, playfulness, mock sparring and other behaviours that signal positive welfare cannot be assessed by cursory inspection or by a fleeting glimpse of the deer exhibiting normal avoidance behaviour and disappearing over the hill. But when it is possible to remain undetected and to observe deer for part of their daily cycle of activity, such behaviours should be apparent.

3.2.9 Other possible welfare indicators from the literature

Many assessments of wild deer welfare have relied upon the inspection or measurement of carcasses and many behavioural indicators require undetected observation. Various possible alternative indicators have therefore been proposed that do not require interference with or measurements of deer carcasses in the larder, or can be collected in the field without catching the deer. These are, in truth, mostly indicators of health rather than welfare, but in as much as they appear in texts discussing welfare they cannot be ignored.

Levels of circulating leptin, cholesterol, triglycerides, creatinine, Insulin Growth Factor 1, thyroxin, triiodothyronine, betahydroxybutyric acid and urea / creatinine ratios have all been proposed as possible body condition indicators in various deer species (Chitwood *et al*., 2014; Lopez-Olivera *et al*., 2013; Tollefson *et al*., 2010; Bishop *et al*., 2009; Barbosa *et al*., 2004; Milner *et al*., 2003; Martines and Hewitt, 1999). Urine recovered from snow has been assayed for urea nitrogen, allantoin, potasium and 3-methylhistidine as possible indices of body condition (Carbanac *et al*., 2005). Scrutiny of these reports indicates that none have proved consistently reliable or useful.

Faecal cortisol has been analysed as an indicator of glucocorticoid activity in deer (e.g. Konjevic *et al*., 2011), but seasonal and species variations in circulating glucocorticoids, especially in ruminants that exist in a permanent state of gluconeogenesis, mean that interpretation as an indicator of welfare is not straightforward.

4. SPECIFIC PERCEIVED WELFARE CHALLENGES TO WILD DEER IN SCOTLAND

The potential responsibilities of care for upland Scottish red deer were considered by Putman (2008b) and his whole review will not be repeated here, but in so far as the possible practical indicators may be brought to bear upon some of the specific issues raised, these issues will be briefly considered.

4.1 Winter die-off, exposure, winter starvation

Ruminants are more dependent upon bacterial activity in their gut than many other mammals, since their staple food source is cellulose based and the rumenal flora ferments this to produce precursors of nutritional carbohydrates before the true gut begins. Almost no digestible carbohydrate enters the small intestine for glandular digestion and absorption as glucose, which is the usual digestive arrangement in non-ruminants. Essentially, all the glucose available to ruminants with typical natural forage diets originates from gluconeogenesis in the liver, where the volatile fatty acid proprionate enters the Krebs cycle at cellular level as succinate. Ruminants also differ from primates, rodents and carnivores in their fastidious conservation of glucose: they do not produce fatty acids for milk fat in the udder from glucose, but rather from ketone bodies or acetate and they do not synthesise fatty acids in the liver, but only in adipose tissue where it is synthesised from acetate. This system of perpetual reliance upon gluconeogenesis places particular metabolic stresses upon ruminants, especially when they are lactating and need glucose for conversion to lactose and in pregnancy when the demands of the placenta and foetus can only be met by glucose or amino acids (Cunningham and Klein, 2007). Even amongst ruminants there are differences. Cattle and sheep have greater reserves than red deer and cope with winter cold stress better (Simpson *et al*., 1977).

The maintenance of core temperature is a critical imperative for mammals. If the temperature of the abdominal and thoracic organs falls below about 38^{o}C the heart will suffer arrhythmia and death will ensue. Heat is lost by mammals in a variety of ways: by convection into cold air or cold water in contact with the body, by conduction when the body is in contact with cold ground, by radiation into the surrounding environment and by evaporation when sweat, saliva and respiratory moisture is converted to water vapour. Heat to maintain core body temperature is produced by muscular activity, either by voluntary movement or by shivering, and by metabolism of carbohydrates, fats and proteins (Cunningham and Klein, 2007). Deer are unusual amongst ruminants in their seasonal reduction of both core temperature and heart rate as part of their winter inanition (Turbill *et al*., 2010).

The phenomenon of winter die-off is well known in deer subject to adverse weather conditions in winter and has been described in many other wild populations with up to 80% of the population dying (Boyce, 1989; Young, 1994). Natural mortality in deer in Scotland has been reviewed by Putman (2008c). In the report of the Farm Animal Welfare Committee of DEFRA (FAWC, 2013) winter die off was flagged as the greatest welfare concern in deer parks in the UK. The cause of death is multifactorial, but at a group level the populations of ungulates subject to catastrophic rates of mortality in single episodes appear always to have some common characteristics: they are present in high density in the landscape and they are exposed to a combination of reduced food or water intake and increased climatic stress. These combinations are malnutrition and cold winters in the temperate zones and drought associated with high temperatures in the tropical zones (Young, 1994).

The physiology of red and fallow deer predisposes them to severe metabolic pressures when winter cold, wet and wind are combined with reduced bodily reserves and reduced availability of forage. Unlike domestic ruminants, deer enter a period of metabolic shut-down or winter inanition (Adam, 1994; Clutton-Brock *et al*., 1982; Haigh and Hudson, 1993; Andersen *et al*., 2007; Turbill *et al*., 2010; FAWC, 2013), during which their reduced

metabolic rate has three important consequences: it depresses their appetite, it depresses their food conversion efficiency and it reduces their ability to maintain their core temperature. From mid winter to early spring red and fallow deer have significantly reduced ability to gain weight or lay down fat reserves, irrespective of the amount of forage they consume.

The mortalities seen in the red deer on the hill in Scotland (and in deer parks elsewhere) therefore have an understandable pathogenesis. Stags lose considerable amounts of body weight in the rut, when they are extremely active and eat very little (Clutton-Brock *et al*., 1982). Unless they are able to make up this weight loss by access to good, nutritious food after the rut they will enter the mid winter with low fat reserves, whilst the hinds, which have been grazing throughout the rut, will almost certainly enter the coldest part of the winter in better condition. If severe weather closes in after Christmas all the deer will reduce their metabolic rates, have reduced appetites and will be unable to consume sufficient to maintain body weight and body temperature and will rely upon body tissue reserves. Exposure on the open hill increases the effect of cold, wind and wet. Once fat reserves are used up the deer will start to catabolise muscle tissue, but their ruminant system of gluconeogenesis means that they quickly risk becoming ketotic and if this occurs they will become depressed and completely inappetant and will pass the point where feeding can assist them. Calves and yearlings are likely to die first because they will, on average have the poorest reserves at the end of the autumn (Clutton-Brock *et al*., 1982, 1987). Stags and bucks will succumb before hinds or does; this is especially true of the males that were most active in the rut. In roe deer the first winter mortality rate is also relatively high. Putman (2008b), citing Gill (1994) suggests that in England the mortality of roe kids may be extremely high, even 100%. As noted earlier winter death of numbers of adult roe in England has been associated with Type II ostertagiasis (unpublished personal records).

The problem is compounded by the fact that foraging activity in winter is more costly in terms of energy and time expenditure, and by the lack of shelter on the open hill. Fallow deer in northern England and Scotland are at the limit of their geographical range and are essentially a Mediterranean species; they thrive in Australia but struggle in Scotland (Muller and Flesch, 2001). Winter die-off in woodland or forest populations of red deer or fallow deer is not reported and has not been reported to the British Deer Society in the past twenty years, although in overstocked deer parks it is not unusual (Putman and Langbein, 2003; Personal client and BDS records, unpublished 2015).

In particularly severe weather another mechanism is important: simple physiological exposure. Red deer, especially the young, have relatively poor coats in terms of thermal insulation (Simpson *et al*., 1978; Semiadi *et al*., 1996; FAWC 2013) and even ‘fat’ animals have relatively little subcutaneous fat compared with sheep, which have better fleeces and more fat covering (Simpson *et al*., 1978). If the ambient conditions are so cold and so severe that heat is lost at a greater rate than it can be produced, the deer will die of hypothermia as their core temperature falls below the mid 30s^{o}C, irrespective of reserves. Good bodily condition will not guarantee survival in extreme conditions: an obese human will soon die of exposure in Arctic conditions if not properly clothed or sheltered and the same is true of deer. A deer herd in good bodily condition and with moderate fat reserves could, in theory, suffer deaths because of acute exposure if there is insufficient shelter in very extreme cold and wind, but such an occurrence is extremely unlikely in Scotland, where winter die-off is more likely to be a terminal event after a period of nutritional and environmental austerity.

The signs of a significant winter die-off are obvious: deer are found dead in periods of severe weather, especially in periods of snow cover and persistent sub-zero temperatures. The dead deer are likely to in poor condition. There may be deer lying or wandering around with depressed responsiveness to normal stimuli. In reindeer, lying curled up is an indicator of depression from malnutrition (Nilsson *et al*., 2006). Supplementary feeding once the deaths have started will not prevent more. This represents a welfare issue at the group level, but the

negative welfare state for the group did not begin when the deaths started; it began when the deer were unable to adapt to winter by finding shelter and by laying down reserves at a time when their metabolism would have enabled them to make use of extra food. The individual deer, dying in such an episode, are clearly in a severe negative welfare state, but unless they are succumbing to extreme acute exposure, this state will have been a chronic experience for the deer and will pre-date their recumbency, depression, collapse and death by several weeks.

4.2 Wounding from inaccurate shooting

Ohl and Putman (2013a) describe the problem of wounding by shooting as an "old chestnut" and Putman 2008b reviews the considerable difficulties in making any kind of empirical assessment of the true prevalence of bullet wounds amongst deer subject to culling by rifle. Studies of wound tracts in carcasses (e.g. Urquhart and McKendrick, 2003, 2006; Cockram *et al*., 2011) may give an indication of how many shots were required to kill the deer under inspection, but this cohort will always represent the animals for which the wound or wounds were fatal in the short term, since the carcasses were recovered in a sufficiently fresh enough state to be consigned to the human food chain. Such studies cannot make any assessment of the number of animals wounded but insufficiently disabled to allow a second shot and that of those that escape and are not found at follow-up. This cohort of wounded beasts may be divided into those that eventually recover completely, those that die within days from complications such as peritonitis and those that are rendered permanently crippled.

Even amongst the carcasses receiving two bullets, it is hard to tell which animals needed a second shot to drop them or to finish them off, and which deer were shot a second time on a 'just in case' basis, when the first shot was in fact a fatal one (Urquhart and McKendrick, 2003). Putman (2008a) states that it is generally accepted that in the culling of deer by shooting about 10% of animals receive a second shot because they do not immediately fall to the ground, but again, this does not mean that 10% of deer are not fatally wounded by the first shot. The problem of distinguishing between a 'miss' and a wounded deer that runs away is well recognised, as is the rider to the problem, the overwhelming tendency of the shooter to conclude that it was a miss, rather than facing up to the consequences of having wounded the animal. Hopefully, the introduction of the Deer Stalking Qualifications and the Best Practice Guides will have improved the accuracy and responsibility of those who shoot (or shoot at) wild deer. Urquhart and McKendrick (2003, 2006) discuss the factors that may affect rifle accuracy on the hill and point out that although modern commercially built rifles and optics may be consistently capable of acceptable accuracy at relatively long distances, human error, poor light, poor weather and especially cross winds reduce accuracy significantly. Target rifle shooters are exquisitely sensitive to cross winds, using calibres and bullet weights equivalent to those used in deer shooting. They are aware that cross winds nearer the rifle have far more down-range effect upon the bullet strike point than those nearer the target and can alter point of impact considerably (Newick, 1989).

Clinical records indicate that wounding of deer during culling in deer parks is not as prevalent as is evidently the case with wild deer culling. Most deer are head-shot at shorter distances than in Scottish hill stalking. In the infrequent event of a deer being wounded the majority of parks are securely enclosed and the deer can be followed up and dispatched more easily than is possible in the wild.

Putman (2008b) ponders whether a wounded deer 'suffers' and whether wounding that results in the relatively swift death of the deer is a welfare issue because of the effect of what he calls 'physiological shock'. Certainly medical reports of battlefield injuries suggest that severe pain is not immediately experienced by soldiers wounded by bullet(s) and that evacuation and transportation elicit most pain (Buckenmaier *et al*., 2009). Beecher (1956)

reported that, with comparable wounds, soldiers shot in battle experienced less pain than civilians shot in crimes and that civilians pleaded for narcotic pain relief more than soldiers did. This raises the inevitable questions about the perception of pain and suffering on the part of the wounded deer. There is little published work on the behavioural evidence of pain in deer. Webster *et al*. (2006) found that de-antlering of stags in velvet increased the incidence of yawning, grooming, standing still, scratching and lying down after the analgesic had worn off compared with matched stags that were simply handled but not operated upon. These may be indicators of pain. In ruminants generally, quietness and stillness are sometimes the only behavioural indicators of pain, certainly in domesticated livestock (Stafford, 2013). These signs are misinterpreted as stoicism or tolerance of pain. In wild deer a degree of depression or inactivity may therefore be predicted in animals that are in a poor welfare state because of pain (see 3.2.4 above).

WANE (2011) recognises the potential or actual contribution that wounding by shooting has on wild deer welfare and makes provision for a register of competent persons to be established if deemed necessary. As a minimum deer managers and stalkers should be aware that disregard of prevailing conditions of light, cloud and especially wind, and over-confidence in long range shooting by guests or employees may be taken as indicators that deer welfare is at risk. An indicator of deer welfare on a given estate may therefore be the presence of regular or frequent carcasses in the larder with contaminated abdominal bullet wounds, multiple body wounds or wounds to the limbs.

4.3 The orphaning of dependent young

The calendar of closed and open seasons for deer shooting in the UK has historically been based upon trophy shooting for males and late pregnancy, lactation and juvenile dependency for females. Putman (2008b) considers that the Scottish shooting seasons pose little welfare risk for the orphaning of dependent red deer and roe deer juveniles because he takes the period of parturition for red deer from mid May to the end of June and for roe deer from late April to the end of June. In the case of the Rum red deer, Clutton-Brock et al recorded that more than 70% of conceptions occurred in the second and third week of October over the course of their study. With a gestation length of 234-236 days, this puts the parturition date firmly within the dates suggested by Putman (2008b). Results of recent studies on the Rum deer appear to show an advancement of certain breeding indices such as conception and birth dates in response to climate change (Moyes *et al*., 2011). Scrutiny of veterinary consultancy records shows that the number of very late red deer calves and fallow deer fawns, delivered in English deer parks between September and November, has increased since 2000 (unpublished personal data), but such neonates still represent no more than twenty individual animals in an overall female population of several thousand. Deer park managers appear to be under the impression that the rut and therefore the calving period has become extended in the past ten years, although whether this is factual or simply anecdotal has not been evaluated. There are similar anecdotal reports of low level, rather lingering recent red deer ruts in parts of Scotland (e.g. Jackson, 2012). Any red deer calf delivered after August 31st will have been conceived after Christmas and any fallow fawn born in September and October will have been conceived even later.

Wild red deer calves attempt to suckle their dams until they are well over six months old, by which time 50% of their attempts at suckling are rejected by the hind (Clutton-Brock *et al*., 1982). Calves are by no means nutritionally dependent on their dams for this extended period: most red deer farms wean calves from the hinds before the rut, at a little less than three months old in order to allow the hinds the best opportunity for early conception and to accustom the calves to concentrate feeds (Haigh and Hudson, 1993). Putting the calves into age cohorts with other weaners, where social interactions can quickly be established, mitigates the possible effects of social isolation caused by such early weaning.

The shooting of a female after the start of the Scottish open season for female red, sika, fallow or roe deer (21st October) is therefore extremely unlikely to generate a welfare issue for any accompanying calf at foot on the basis of nutritional dependency. In red deer at least, and probably for the other gregarious species the sub-adults do appear to be dependent upon their dams since first winter survival is correlated with the maturity and therefore the experience of the dam. Other factors, such as birth weight and sex, also have an effect upon survival to the yearling stage (Clutton-Brock *et al*., 1982), but this does suggest that a weaned calf or fawn is reliant upon its mother to know where the best winter sustenance or shelter may be found. In a study of white tailed deer, male fawns orphaned after weaning had an overall survival rate to 30 months of age of 67% from non-hunting risks, compared with only 15% for males that were not orphaned and when all risks including hunting were included the orphaned deer survival rate was 46% compared with only 7% for non-orphaned deer. This rather surprising finding was partly explained by the fact that only 9% of the orphaned deer migrated from their natal home range, whilst 86% of the non-orphaned deer either migrated or were expelled by their dams (Holzenbein and Marchington, 1992).

The legislation permits the shooting of dependent young without reference to age to prevent suffering if the dam has been or is about to be killed. In the case of unweaned juveniles, this is patently sensible, but after weaning it is impossible to be certain about the age at which a young deer becomes socially independent. An argument could be made that in herding species with strong natal band social structure, the culling of the alpha female risks the welfare of all subordinate band members.

4.4 Stress caused by disturbance

This was considered at 3.2.8 above. Based upon the fact that resources are directed towards investigating the effects of disturbance upon wild deer, it seems that in northern Europe and North America there is some increasing awareness that the people availing themselves of leisure opportunities in ‘wilderness’ areas may be having an adverse effect upon the deer. It seems that there are differences between species: wild reindeer eventually reduce their flight distances when constantly disturbed by cross-country skiers, snow shoe trekkers and other outdoor activities (Reimers *et al*., 2010), which may be a latent indicator of the very ancient suitability of reindeer for domestication, but moose appear never to become accustomed or habituated to such disturbance. Moose show increased levels of activity for up to two hours after being disturbed and human activity around settlements and houses is clearly perceived as a predation risk by moose (Neumann *et al*., 2010, 2011; Lykkja *et al*., 2009). Scottish red deer in home ranges through which large numbers of hill walkers pass on a daily basis become habituated to some extent to the disturbance, although they give the paths a wider berth on busy days than on quiet ones. The habituation also alters their night-time grazing, when there is no use of the paths, and they choose to ignore good grazing close to the paths (Sibbald *et al*., 2011). The recreational use of the landscape has been shown to increase vigilance in Scottish red deer, although the effect is less in woodland compared with open landscape. Increased movement manifests increased vigilance over the course of the day and increased aggregation. In low open cover the deer may remain lying down even though they are increasingly alert and vigilant in response to disturbance; recumbency should not be interpreted as an indicator of positive welfare in red deer in the open, since they may not be relaxed and stress free in such circumstances. Not surprisingly, over all, deer on the open hill were more vigilant in the stalking season than the closed season, but not to the extent that population welfare was significantly impacted (Jayakody *et al*., 2008).

In Japan sika deer behaviour was considerably altered by the onset of the open season for shooting (Kamei *et al*., 2010). Roe deer are also more vigilant during the shooting season and this increased vigilance reduces their time spent feeding; the increased vigilance causes them to choose caution and discretion above food availability (Benhaiem *et al*., 2008). Roe

are, however, an extremely adaptable species and although increasing disturbance may alter behaviour and even social group size, there is no evidence that it affects breeding success or population growth, as the ingress of roe into peri-urban areas testifies (Hewison *et al*., 2001).

Elk were most disturbed by ATV riding and least disturbed by horse riding with the effects of people hiking and hill climbing in between these two (Naylor *et al*., 2009). In a wilderness landscape elk responded to disturbance by motorised ATVs at a kilometre distant. (Preisler *et al*., 2006). Individual disturbance episodes may temporarily elicit a sympathetic autonomic flight response in a prey species; this cannot be interpreted as a compromise of welfare. Deer have evolved in what has been termed a 'landscape of fear' (Laundré *et al*., 2001). The behavioural response of becoming vigilant, adrenalin-dominated and fleeing a perceived threat is entirely natural for deer and is an indicator of good welfare status, provided the deer are able to flee. When such behaviour is constantly necessary and the sympathetic autonomic state persists to the detriment of parasympathetic functions such as ruminating, digesting and being anabolic, welfare may be compromised and health status may deteriorate. There is however, evidence that over time both red deer and fallow deer may become tolerant of even persistent disturbance. As an example Richmond Park in London receives up to 30,000 visitors daily throughout the year, accompanied by thousands of dogs, many of which are allowed to run loose. There is constant traffic through the park, and regular large-scale visitor events. The 650 red and fallow deer roam freely throughout the park and cannot escape the inevitable disturbance. Yet the deer pass all the welfare indicators suggested (see 5 below) and there is no evidence of increased mortality. Conception rates are high and appear to compare favourably with wild deer. Such habituation to disturbance may belie subclinical stress and current research is underway to assess Central Nervous System glucocorticoid receptor variations in fallow deer from a variety of parks across England (Ohl and Putman, personal communication, 2014).

In summary, there are few welfare impacts upon wild deer in Scotland as a result of current levels of disturbance, but these impacts should perhaps be monitored.

4.5 Road Traffic Accidents (Deer-Vehicle Collisions (DVCs)

These will not be discussed in detail here; DVCs in Scotland have been considered in depth by Langbein and Putman (2006) and by Dandy *et al*. (2009). DVCs are best considered as agents of injury and therefore, in as much as welfare is compromised in the individual animal, they are broadly similar to wounding by shooting. Where there are DVC 'hot-spots' or stretches of highway that generate greater numbers of DVCs than other comparable sites, it may be possible to argue that there is a welfare issue at the population level, but this is not easy to pursue.

4.6 Urban and peri-urban deer

The report by Dandy *et al*. (2009) upon the management of roe deer in the peri-urban central belt of Scotland mentions that both the general public and the deer managers interviewed considered that the welfare of the roe deer in these habitats was at risk. No frequencies of occurrence were given, but respondents to the questionnaires and delegates at the workshops expressed the views that urban and peri-urban roe deer risk abuse and injury from dogs and from unsuitable weapons, such as bows and crossbows. The use of lurchers to bring down deer in public parks was voiced as a concern, as was the problem of deer becoming trapped or hung up on fences.

It has not been possible to access details of criminal proceedings against those accused of such crimes in Scotland; the Scottish Government website page on wildlife crime emphasises the problem of deer poaching in rural, not urban situations north of the Border.

Scrutiny of veterinary records and personal experience in England suggests that killing deer by illegal means is actually more prevalent in the countryside than in the urban areas where deer are present and that many more deer become hung up on fences and obstacles on farmland than in towns. The reason that an urban general public perceives such incidents to be a significant welfare problem is perhaps a reflection of several factors: a single roe deer trapped on a fence or killed by a dog in suburban Glasgow is likely to be more newsworthy and may be personally encountered by more people than would be the case in the Highlands. The witnesses of such incidents in an urban situation may be more distressed than their rural counterparts who may be more relaxed about seeing a dead sheep in a field or a dead deer on the verge. This is not to say that deer poaching and deer on fences are not welfare issues for the individual deer, but it is hard on the basis of the report by Dandy *et al*. (2009) to conclude that this is a greater problem in peri-urban situations than elsewhere simply because it is a peri-urban one. To be fair, the authors do not make this conclusion but report the perception.

From experience, there may be other elements of a peri-urban existence that may affect the welfare of the deer. Based upon a limited number of cases in England, there appears to be a higher incidence of rumenal foreign bodies (plastic bags, pieces of rope, food containers and other litter) in peri-urban deer, suggestive of bin-raiding or scavenging. This appears to be a greater problem in the peri-urban fallow deer of Greater London and the south east of England than in roe deer, but a few such foreign bodies have been recovered from roe resident in other peri-urban areas as well. Very few have appeared to have affected the condition of the deer and most have been encountered as incidental findings when the deer was dressed out. Despite the high numbers of muntjac (*Muntiacus reevesi*) in urban areas of southern England, no such findings have been encountered in this species in the course of my routine deer veterinary practice work.

4.7 The perceived welfare challenges to wild deer in Scotland in the light of the suggested welfare indicators and the literature review

The analysis at 3.1.1 and 3.1.2 suggested that the welfare indicators proposed by the Ohl-Putman table fall into two categories: those that *can* be assessed quickly, on a single-take basis (degree of fatness/leanness, condition of the coat, signs of infection, signs of poor wound healing, scouring and, by implication, the presence or absence of obvious disease or injury) and those that can *only* be assessed by observation or inspection over time (appetite, foraging behaviour, seeking shelter, avoidance and approach behaviours, social interaction, bullying, playfulness etc.). The literature review hones these proposed indicators and confirms that some of both categories are potentially useful, whilst others are less easy to apply in the field to wild deer. Evidence of wound healing as an indicator of immunocompetence is of very little value, the condition of the coat has limited value and elements of social stability/social interactions such as play, and anxiety responses are very hard to assess in free ranging wild deer. This report has noted that although body condition indicators can be assessed quickly and on a single observation, it is important to make several such observations to monitor the changes in body condition indicators before conclusions about the actual state of welfare are reached.

When the proposed welfare indicators are reviewed in the light of the perceived welfare challenges to wild Scottish deer, it becomes clear that some indicators can be considered to have both a static and a dynamic application. The immobility of an injured or dying deer may be immediately obvious, especially if it is in extremis or severely disabled. This can be assessed quickly; it forms part of the appearance of the deer. It is then a body condition, static indicator. Equally, the disinclination of a deer or group of deer to move away from close human approach may be an indication of abnormal behaviour, of malaise or of lethargy. Malnutrition or disease may suppress normal avoidance behaviours; this is a behavioural dynamic indicator based upon observation of behaviour over time.

Very poor body condition or emaciation may be easily assessed immediately as a 'static' indicator, but, as has already been emphasised, declining body condition, with the deer losing weight over time to the point of emaciation is an application of repeated single observations in a dynamic way and informs the observer about the actual welfare state of the deer much more meaningfully than a single snapshot.

The *perceived* welfare challenges detailed above can be condensed into a few *actual* challenges: deer may be injured by bullets, by motor vehicles or by other deer. The result is usually a single injured deer. The welfare indicators in the case of an injured deer are the same, irrespective of the cause of the injury. Deer may become severely debilitated by infection, parasitism, malnutrition, exposure to severe weather without shelter, mineral deficiency or metabolic disease. The result is almost invariably a thin deer or a group of thin deer which get to the point of showing behavioural changes before they die. The welfare indicators of thin or chronically sick deer are likely to be the same, irrespective of the cause of the decline.

Social structure and stability may break down and adversely affect welfare when deer are unnaturally crowded and food is in short supply. Such conditions may arise because of gross over-population within an enclosed area or because of congregation at limited feeding sites, whether artificial or natural. Long term isolation of individuals adversely affects welfare status, especially in the gregarious species, irrespective of the cause.

The actual challenges to the welfare of the wild deer of Scotland appear therefore to be quite limited. There have been no reports of outbreaks of disease in Scottish wild deer causing severe acute clinical signs or sudden death. The broad signs that reveal that deer are moving further down the welfare spectrum are therefore simple and can be summarised into three types:

- Severe decline from fatness to leanness that the deer is unable to halt or reverse leading to extreme debility, malaise and possibly death. Causes include malnutrition, exposure and pathological challenges.

- Injury that the deer is unable to restore or heal leading to chronic debility. Causes include shooting, road vehicle collisions, injuries caused by other deer and miscellaneous traumas.

- Breakdown in social structures and stability leading to anxiety, stress and abnormal behaviour. Causes include over-crowding, competition for limited resources, orphaning and disturbance.

As the broad signs of compromised welfare or more negative welfare in wild deer are relatively limited, it follows that the detection of declining or improving welfare in wild deer will rely upon a relatively limited number of practical indicators. The indicators that have been found valuable in clinical veterinary practice will be discussed below.

5. WHICH INDICATORS OF WELFARE HAVE PROVED USEFUL IN DEER PARK SITUATIONS?

5.1 Background

From scrutiny of veterinary practice records, which give details of some 60 urban and rural deer parks and farms over a fourteen year period it is clear that for most clients the necessity for veterinary intervention and attention has been less than would have been the case for most domestic livestock enterprises. Not all the parks and farms have been 'active clients' for the whole period, indeed some have only sought veterinary assistance when there have been problems, such as a winter-die off or the outbreak of disease. All the parks have either fallow deer or red deer, many have both. Two parks have fallow, red and sika deer, one has fallow and sika deer and two parks have sika deer alone.

Some clients have benefitted from regular six monthly or annual welfare visits. These have particularly been provided to parks with high public exposure and with the perceived risk of scrutiny or criticism on welfare grounds. The regular reports to and welfare assessments of these deer parks have been used to rebut objections to the culling of the deer, the management of the deer and even to the keeping of the deer at all. The assessment of English parkland deer welfare has always been problematic; as FAWC (2013) explains, whether the deer are considered wild or not is a long-term bone of contention and their status varies according to the legislation and enforcement agency under consideration.

In order to achieve some consistency in assessment, certain measures or parameters of health and welfare have been developed for use in the course of this work. Almost all the client parks shoot deer to control numbers; a few have vasectomised males to prevent breeding and a few small urban parks insist on live capture and either translocation or post capture euthanasia to limit populations. It has therefore been possible in almost all client deer parks to compare assessments of welfare in the living herds in the park with findings in the venison house when the carcasses have been dressed out, or with dead deer euthanised after capture.

5.2 Challenges to the welfare of deer encountered in veterinary practice

As a parallel phenomenon to the winter die-off of deer in the Highlands of Scotland, the records show that in the deer parks concerned there have been six episodes of significant winter die off, when numbers of deer have been found dead. No park has suffered more than one episode. Excluding mortality of fawns and calves the mortality rates have been between 5% and 12%, with a greater number of males succumbing than females. Many parks record a regular unexpected winter mortality of between 1 and 3% of adults, that is, excluding rutting injuries, road traffic accidents and culling. It may be that deer park management has improved in the past thirty years: Hayden *et al*. (1992) record that between 1980 and 1988 the adult winter mortality in Phoenix Park in Dublin varied between 6% and 15%. In the winter of 1985/86 approximately 13% of the adult red deer of and 11% of the adult fallow deer in Richmond Park London died unexpectedly; the population at that time exceeded 1,000 deer, it is now maintained at around 600 animals (Putman and Langbein, 2003; Bartram, J., personal communication).

In addition to winter die-off, there have been outbreaks of fatal disease caused by liver fluke, lungworm of various species, the nematode Ostertagia, the bacterium Pasteurella and the virus responsible for Malignant Catarrhal Fever. Numerous non-fatal diseases and conditions have been encountered, including bovine tuberculosis, bacterial Yersiniosis, various enteric nematode parasites and mineral deficiencies.

In some parks the assessment of the welfare of the living deer has been prompted only by the discovery of dead deer or very sick deer.

Unsurprisingly, in view of all the forgoing discussion, the indicators of welfare have been reduced to those that assess bodily condition and the obvious signs of disease and those that assess behaviour.

5.3 Useful indicators of welfare status in park deer

5.3.1 Guides to body condition (fatness or leanness)

5.3.1.1 Body condition scoring

Clients have been encouraged to become familiar with a five-point BCS scale of 1-5 (Appendix 2). This is based upon the possible ranges of condition in park red and fallow deer. The scale was originally proposed as 0-5, but as this in fact gives six possible scores, it has been more recently modified for simplicity to five. The BCS scoring system has proved of little value in sika deer because their condition has very rarely fallen below optimum. Few problems have been encountered in sika deer, other than liver fluke and an accumulation of heavy metals; the sika deer under the veterinary care of this veterinary practice have almost invariably fared better than the red deer or fallow deer in similar conditions.

As outlined above (3.2.1) a BCS scoring system for deer must take into account the fact that deer have comparatively little subcutaneous fat, even when they are in good condition. The lowest point on a BCS scale for deer must therefore recognise not only when subcutaneous fat reserves are depleted, but also when muscle is lost because of the catabolism of protein. The relative proportions of body regions vary with age in red fallow and roe deer: in older deer the hindquarters appear to become more rounded, the back sags and the shoulders may become more prominent (Putman, 2005; Prior, 1995). In any given parkland deer herd at any given time there will be a range of bodily conditions and experience has proven that some dominant males and females may remain in good condition, even fat, when others in the herd are struggling. This is especially the case in late winter when supplementary winter-feeding may be offered and when dominant individuals may monopolise the feeding stations. For these reasons the BCS scale is best used by applying it to a single cohort of animals; in red deer and fallow deer the bodily condition of yearling males (prickets, spikers, brockets) and yearling hinds and does has proved most useful. By limiting the application of the scale to these animals, it has proved possible to come to a reasonable, if rough, assessment of the condition of the herd. The condition of the calves and fawns should be ignored for this purpose for two reasons: first, a first-winter mortality of weaned calves and fawns is an expected phenomenon of wild red and fallow deer; secondly deer park managers are encouraged to cull poor late calves and fawns as they will never make good beasts and their high demands upon the dam may delay her conceiving and so generate a late births the following season. Many parks therefore have only ‘good’ calves and fawns when the condition of the deer is assessed at the end of the rut.

The BCS scale for application to yearling males and females concentrates almost entirely on the pelvis. This is because it is the easiest bone/tissue structure to assess visually, it is unaffected by gut fill, in red deer and fallow deer it is less affected by pilo-erection (fluffing out of the coat in the cold) than the back and shoulders and it is not masked by a thickened neck mane in red deer. The extent of muscle coverage of the pelvis is best assessed by viewing, or photographing the deer at a slight angle, so that the slope of the skin from tuber sacrum to tuber ischium can be evaluated. If this line is perfectly flat, the deer is in acceptable condition and any convexity (upward rounding) of this line indicates better, and then good condition or even obesity. When the pelvic tissues sinks inward and the line from tuber sacrum to tuber ischium becomes obviously concave, the deer is in sub optimal condition. The tuber coxa then becomes much more apparent and the line from tuber coxa to tuber ischium is also markedly concave (see Appendix 2 for diagrammatic explanation).

A BCS of 1 would be emaciated to the point of being skeletal with very marked concave sinking in of pelvic soft tissues, which follow the contours of the dorsal aspect of the pelvis. This can only occur when gluteal muscles have been reduced in size by protein metabolism (catabolism). Few deer survive to this degree of weight loss, usually succumbing to exposure or concurrent disease before this point is reached. In practice, park managers soon learn by experience to score their deer, comparing summer body conditions with winter ones. The scale and scoring is bound to some extent to be subjective, but experience has shown that it is reproducible across parks and between park managers. Photographing the deer allows for a more objective application of the BCS system; simply by looking through the photographic frames and picking out the yearlings managers can score them easily by looking at the pelvis.

In deer park situations the BCS system is best used (in conjunction with other assessments) in the autumn at the end of the rut. By ignoring the condition of the mature males, which may be badly 'run up', the overall condition of the herd can be gauged by reference to the yearlings. If more than 50% of them appear to be in pelvic BCS 2 or below, experience has shown that supplementary winter-feeding should be introduced immediately, or herd numbers should be reduced considerably.

Body condition scoring is best used as a dynamic indicator: are the BCS of the yearlings declining or improving between the end of the rut and the approach of the Christmas season. If a consultancy visit is arranged and veterinary inspection is undertaken BCS may be used as a static indicator on the day, if significant numbers of yearlings are discovered to be in BCS 1.

5.3.1.2 Carcass measurements and assessments

Putman and Langbein (1992, 2003) have suggested carcass weight thresholds of park deer in the autumn that indicate that there is a high risk of a winter die-off event in the approaching late winter and that supplementary feeding is necessary. These weights are 24kg hog-dressed for male fallow yearlings (prickets) and does, 50kg for male red deer yearlings (prickets, spikers, brockets) and 46kg for red hinds. When these threshold weights were applied across the range of deer parks in the course of veterinary work, it became clear that there was a problem in assuming that all English park deer approximate to the same adult or yearling skeletal size. Deer park managers recognise that some herds have inherently smaller deer compared with others. As examples, the fallow deer of one park (Park A) were found to be consistently smaller in frame than the fallow deer of another park. (Park B) As outlined earlier (3.2.1.) biometric measurements traditionally rely upon metapodial length of either fore or hind limbs, jaw length, chest circumference or whole body length. None of these has proved useful in the course of routine larder work, since the limbs are usually discarded early, the deer are usually head-shot, the head is removed before hanging and the chest is often spread artificially to aid cooling. For this reason a measurement of ischial width has been adopted, whereby the span across the outside surfaces of the two tuber ischii is measured with engineering callipers before skinning. Experience has shown that this measurement is hardly affected by degree of fatness, and if sharp callipers are employed, they can be easily pressed against the bones.

The mean ischial width of the fallow does sampled in Park A has been found to be 1150mm and for the Park B 1380mm. Fallow deer survive in Park A with minimal winter feeding (forage only) when autumn doe carcass weights are regularly as low as 19kg, but in Park B winter die off occurred when autumn doe carcass weights all exceeded 24kg. In fact, in Park A where the fallow deer are generally small in frame, a doe carcass in autumn weighing 22 kg may be found to have excessive kidney fat and in Park B a doe weighing in at 22 kg might be found to be depleted of all reserves and in poor condition.

In the same way, for yearling male red deer, mean ischial width of these deer in autumn in Park C has been found to be 1340mm and in Park D 1490mm. Corresponding mean carcass weights of yearling red deer have been found to be 45.5kg in Park C and 67kg in Park D, with neither park suffering winter die-off and neither feeding to the extent recommended by Putman and Langbein (1992, 2003).

For these reasons, absolute weights have been abandoned in the assessment of park deer condition, but reference is made to fat reserves. Most park deer managers shoot the deer in the head and most preserve the heart for inspection or consumption. The kidney fat index is regularly measured (the ratio of renal weight to peri-renal fat weight), but as Challies (1978) explains, it is sometimes difficult to determine where to stop removing fat for measurement in deer in very good condition. The presence of any kidney fat indicates that the deer was not in such poor bodily condition before killing that it represented a concern on welfare grounds. Experience has shown that the fat in the coronary groove of the heart is however, the last visible fat to disappear in deer in very poor condition. It may be replaced by gelatinous tissue indicative of serous atrophy. If the hearts are available, the absence of both renal and coronary groove fat in more than 25% of yearling deer after the rut has proved a reliable indicator that the herd as a whole is in poor condition and at risk of a winter die-off. The coronary groove fat may be more difficult to assess in wild deer shot on the hill, where chest shots are recommended and hearts are often badly damaged, but if even a portion of the heart is available, coronary groove fat is obvious as a white band around the circumference of the heart, especially after the heart has cooled and set in the larder.

Carcass measurements are by nature static indicators. They assess the deer at the point of death and cannot provide any information about whether the welfare of the deer was declining or improving. None the less, in conjunction with dynamic indicators such measurements have proved useful and should not be ignored.

5.3.2 Guides to behavioural responses

The extensive discussion above (3.2.4-8) describes how a range of challenges, stressors or adverse influences may affect the behaviour of deer and how these might indicate that the welfare of the deer is becoming or has become more negative. The welfare of the deer will decline if the animal or animals are not able to adapt to mitigate the effect(s) of these influences upon both the bodily and the mental state of the animal(s). It will be obvious, however, that irrespective of the range of challenges, the range of possible alterations in the behaviour of the deer is limited. Subtle signs of pain such as yawning, abnormal grooming patterns or scratching may be both difficult to assess and may be elicited by other stimuli or factors. The easily noticeable behavioural alterations in wild deer therefore come down to either reduced activity or excessive activity.

5.3.2.1 Reduced activity

Pain, exhaustion, metabolic weakness, exposure, debility from disease will all tend to make a deer or a group of deer less active. This may be subtle. Deer simply lying down in an open landscape is not necessarily an indicator of well being (Jayakody *et al*., 2008), but neither is it necessarily an indicator of weakness or debility. In deer park situations, useful indicators of poor welfare appear to be the reaction to normally arousing stimuli and the speed and character of the movement of the deer thereafter. Healthy deer in a positive welfare state will be bright, alert and responsive. They will react in a predictable way to the approach of humans, dogs, vehicles and other potentially threatening challenges according to their habituated practice. Urban park deer in a city centre will tolerate an approach to within 20 metres, some deer park fallow bucks will approach vehicles and picnics in search of titbits; when these deer back off or run away because of something to which they are unconditioned, they do so vigorously and actively, although they may not go very far.

A key sign that a deer is unwell, debilitated, depressed or otherwise in difficulty is that it allows approach to distances that are unusual for that situation and that when it does respond, it moves slowly or stops moving away within an unusually short distance. It is impossible to give absolute guidance on such parameters as flight distance, but an experienced deer manager should be alert to any unusually sluggish behaviour, any unusual toleration of approach and any evidence of depression, especially if it is exhibited over a period of days. Whatever the cause, such signs are indicators of a poor welfare state in both individuals and groups of animals.

The end point of reduced activity is recumbency and inability or disinclination to rise. Wild deer in such a state, tolerant of close approach or even of handling, are likely to be in extremis. Deer that fail to seek shelter when shelter is available, lying out in the open in extreme weather, are also exhibiting reduced or depressed behavioural responses; again, the knowledgeable deer manager will recognise what is unusual for the deer in such circumstances. If they are also emaciated, with a pelvic BCS of 1 or 2, it is extremely unlikely that they will survive, even if they are provided with shelter and feed. Groups of deer in such a state are an indicator of incipient group mortality.

5.3.2.2 Increased activity

Poor or unstable social relationships, or stress upon a whole group may be revealed by unusual levels of what appears to be irritation with peers or subordinates. When park deer are stirred up and herded into constrained areas for the purposes of park management, or for gathering for tuberculin testing, it is not uncommon to see adults fighting briefly with each other or picking on juveniles. This is especially true of hinds and does and less the case of males in velvet. Fighting between both males and females outside of the rut period has been observed and reported in deer parks where disturbance is high and the deer have no refuge. Such increased bullying, sparring and quarrelling is testimony to group pressure and poor welfare, even though no physical harm or injury may be inflicted.

In wild, field situations it is hard to imagine when such behaviour might be encountered, but deer continuously disturbed or artificially corralled into a limited area by dogs, walkers or other activities may exhibit such signs. If the stress is only transient and the deer can return to their usual activities and relationships, episodes of stressful disturbance such as this can be tolerated by the deer, but regular harassment of wild deer will inevitably reduce their welfare.

When hunger cannot be satisfied by normal foraging, red and fallow deer may become agitated and show abnormal appetite, or pica. Park deer in winter mortality episodes have been seen licking railings or chewing pressure treated fencing posts, or eating litter. This behaviour may become rather manic and may continue even when the deer are approached and even when supplementary food is provided as a response to the die-off, by which time it is almost always too late to save the worst of the deer.

Deer in parks that are harried or pursued for longer distances or longer times show obvious signs of distress and may succumb to fatal myopathies. Before they eventually come to a standstill, both red and fallow deer pursued by dogs or relentlessly moved by continuous shooting will show mouth breathing, followed by prolapse of the tongue from the side of the mouth, excessive salivary foaming and shortening of the stride as the muscles stiffen.

5.4 Summary of the indicators of deer welfare that have been useful in veterinary clinical situations

From clinical records of deer parks where welfare monitoring has been undertaken, a combination of indicators of health and welfare has proved most useful. When deer are not

being culled, pelvic condition scoring of yearlings, assessment of activity and responsiveness across the herd, and signs of clinical disease have proved valuable. In combination, on a number of occasions these have prompted intervention that has remedied the situation. In some circumstances particularly badly affected animals (pelvic BCS 2 or below, or with obvious clinical disease) have been culled out of season to establish the cause of the problem in the herd.

Where deer are being culled, carcasses may be examined. Veterinary post mortem examination may establish the presence of infectious disease or mineral deficiency. If the deer are simply looking poor, the assessment of renal and cardiac coronary groove fat (or rather its absence) in a significant proportion of yearlings has been taken as an indicator, in combination with pelvic condition scoring and signs of lethargy or depression, of winter stress in the herd caused by inadequate nutrition, adverse weather, inadequate shelter or a combination of these. In cases where these indicators have been appreciated early enough, either supplementary feeding with multiple feed stations or radical reduction of the numbers has resulted in improvements in condition and avoided winter die-off. When these indicators have been noticed only in January or February, there have been several cases where strenuous efforts to feed and provide shelter have failed to stop numbers of deer dying and others barely surviving through to the spring.

It is important to emphasise that proper assessment of welfare of a deer herd cannot be made on the basis of a single observation or as the result of the inspection of a single day's cull. Deer in poor condition or deer affected by disease may be declining or recovering. In park situations the veterinary surgeon is not usually consulted until the deer manager has observed decline. In wild deer populations, unless the deer manager is faced with significant numbers of dead deer and others in extremis, the assessment of the welfare of the herd must be made over a period of at least several days. The assessment of the welfare individual deer in very poor condition can usually be made more rapidly.

These indicators are most easily applied to red deer, fallow deer and sika deer, species that have a gregarious, herding social structure. They are less easy to apply to roe deer, but have been used to good effect on individual deer. Pelvic condition scoring from observation, absence of cardiac coronary groove fat and its replacement with serous atrophy, unusually sluggish or unresponsive behaviour have all been seen in roe deer affected by disease or malnutrition. Winter die-off from malnutrition and exposure alone has not been recorded in roe deer the veterinary practice records. Investigations of winter deaths have revealed infectious, parasitic or toxic aetiologies.

6. SUMMARY AND CONCLUSION

In common with all sentient animals, the welfare state of wild deer is on a continuum of very poor welfare to very good welfare and is in a constant state of flux or change as the deer are challenged and respond to challenges.

Indicators of the welfare of wild deer can be divided into body condition signs, some of which can be empirically measured and observations of deer behaviour, which may rely upon more subjective assessments. From both an extensive review of the literature and from experience with free ranging deer in deer parks the following indicators appear to be of value:

Indicators that can be assessed on a single day

- Body condition (fatness or leanness)
- Presence or absence of obvious signs of injury or disease
- Response to close human approach and stimulation
- Carcass condition

Indicators that are assessed over at least a week

- Changes in body condition (alteration in the degree of fatness or leanness)
- Foraging behaviour and appetite
- Activity – lethargy, hyper-reactivity
- Seeking and finding shelter when necessary
- Alterations in normal or expected avoidance and approach behaviours
- Evidence of normal/abnormal social interaction – bullying, unnatural isolation, fighting out of season

Based upon these findings the following recommendations can be made.

7. RECOMMENDATIONS

The assessment of wild deer welfare must include a number of indicators and if possible, and should be conducted over a period of time. Whilst body condition indicators will be more easy to evaluate quickly, these are limited and reflect more outdated concepts of welfare if they are based on a single observation, since it is impossible to know whether the welfare state of the deer is declining or improving without observation over time. Exceptions to this principle would be deer in terminal extremis or with very severe and obviously irreparable wounds. The assessment of the welfare state of a group or herd of deer is best undertaken over a period of days, as dynamic indicators of behaviour and response cannot be assessed by a single observation and these indicators are more useful in determining the welfare state in the light of current concepts.

Deer managers, field workers and conservationists wishing to assess the welfare status of wild deer should make use of the following practical indicators and should note changes in these indicators over time:

- The bodily condition of yearling animals based upon a visual pelvic condition score scale of 1-5. If many or most of the yearlings score low (pelvic BCS 2 or below), herd and individual welfare is likely to be more negative. Yearlings in pelvic BCS above 2, especially in winter, indicate positive welfare.

- The appearance of normal mobility and freedom from any debility, or the presence of obvious disease or injury that disables the deer over time and limits movement and feeding.
- The mortality rate of the deer. Death in the rut from fighting and limited death of calves/kids/fawns in their first winter is normal in Scottish red, roe and fallow deer and does not necessarily indicate negative welfare in the group. The sudden death of unexpected numbers of deer of varying ages is an indicator of declining welfare in the group.
- The behaviour and activity of the deer when undisturbed. Unusually depressed or sluggish behaviour (unusual for the deer under observation) suggests declining welfare.
- The toleration of close approach or handling. Wild deer in a positive welfare state are cautious of human presence and flee attempts to approach or handle them. Deer that permit close inspection or even handling are likely to be in a severely negative state of welfare.
- The social interaction of the deer when undisturbed. Deer in a healthy, positive welfare state are usually settled, relaxed and may show evidence of playfulness, sparring, grooming or inquisitive behaviours. Increased agitation, bullying, squabbling or increased milling around in groups of deer that are usually settled is an indicator that welfare is declining.
- Foraging behaviour and appetite: Manic or grossly abnormal appetite or food choice indicates declining welfare.
- The assessment of carcass condition of yearlings based upon the presence or absence of both renal and cardiac coronary groove fat deposits. Absence of any fat at these sites is an indicator of more negative welfare, especially in combination with very poor bodily condition. Fat around the kidneys and in the coronary groove indicates that the welfare state of the deer at the time of death was not unacceptably negative.
- The bullet placement in carcasses in the larder. Carcasses with multiple bullet wounds, especially to the limbs and abdomen, should be unusual. There should be evidence of single, fatal wounds in most of the carcasses, indicating that death was humane and swift and that welfare was not unacceptably compromised. The presence of many carcasses with multiple wounds is highly suggestive that welfare of the deer before death was unreasonably reduced and that this was a pattern of effect across the group.

These indicators are all best used as dynamic indicators, although some are clearly limited to single observation, static usage.

Table 2. Recommended Indicators of Welfare

Welfare indicator	**Static, single observation**	**Dynamic observation over at least a week**
Pelvic body condition score of yearlings	□	□
Normal mobility, freedom from debility, injury, disease	□	□
Mortality rate		□
Normal activity, evidence of lethargy, sluggishness		□
Toleration of close approach or handling	□	□
Social interaction		□
Foraging behaviour and appetite		□
Kidney and coronary groove fat deposits of yearlings	□	
Bullet placement in carcasses	□	

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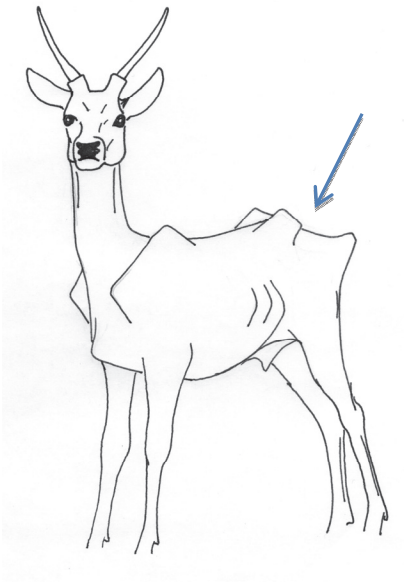
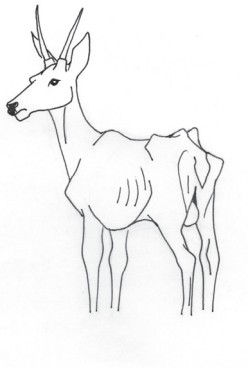
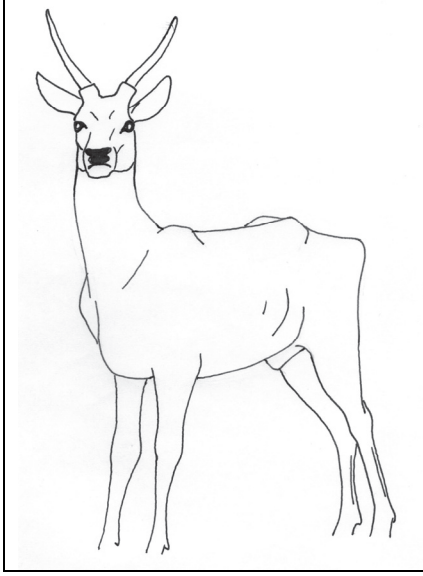
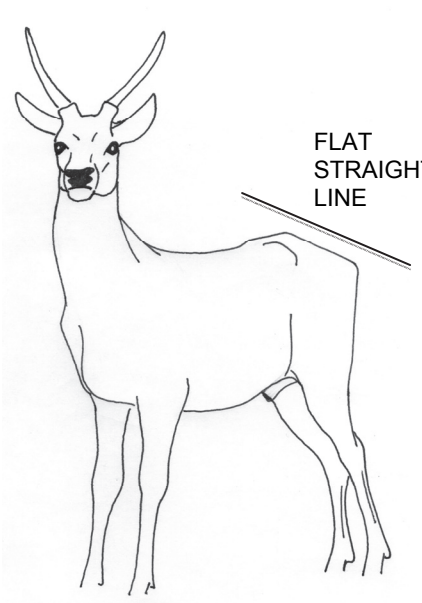
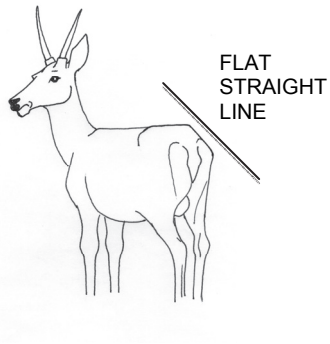
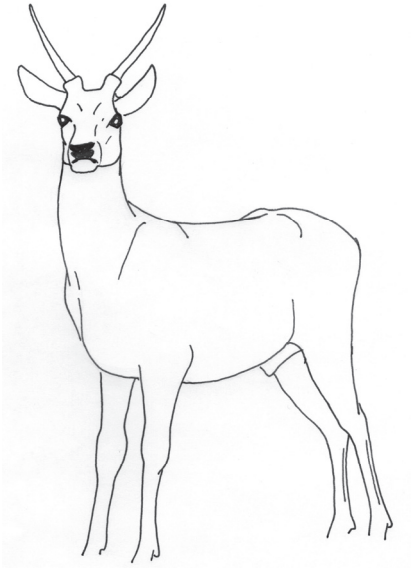
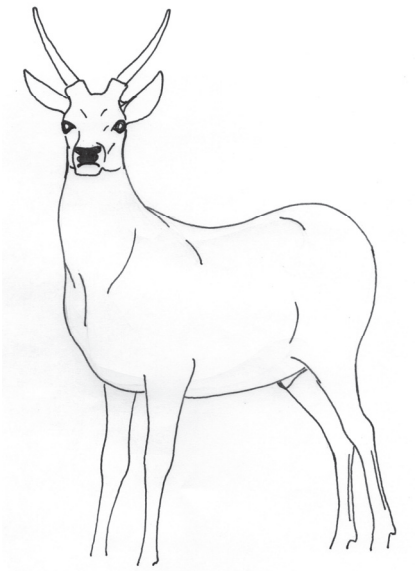
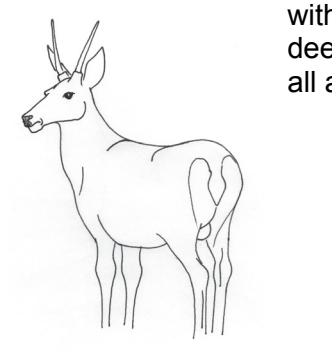
ANNEX 1: THE OHL-PUTMAN TABLE (FROM OHL AND PUTMAN 2013A AND B, 2014)

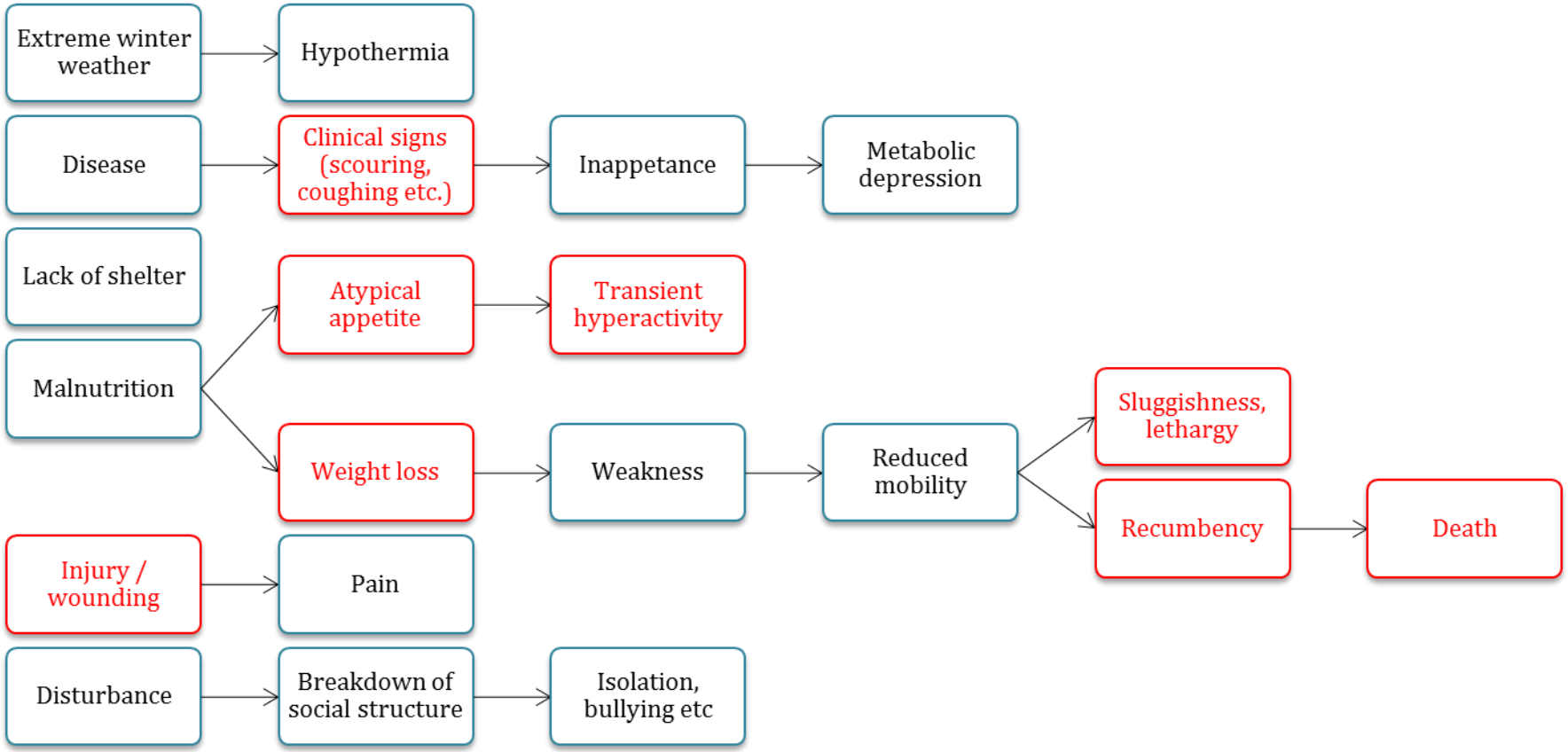
Generic Indicators of welfare at the individual and group level, respectively: assessment should not be based on any single indicator but should attempt to integrate information from as many of these indicators as possible.				
Based on the animals' adaptive capacities	**Individual level**		**Group level**	
	Positive indicators	**Negative indicators**	**Positive indicators**	**Negative indicators**
The animal(s) should be free adequately to react to hunger/thirst.	Appetitive and successful foraging behaviour Normal activity pattern Appropriate body condition	Unsuccessful foraging behaviour Lethargy Inappropriate body condition	Appetitive and successful foraging behavior and activity pattern as a group Normal variation of body condition	Unsuccessful foraging as a group; successful foraging only in minority of group members [extreme variation within group)
The animal(s) should be free adequately to react to climate conditions.	Seeking and finding shelter Appropriate fur condition Appropriate modulation of body condition during seasons	Not finding shelter Bad fur condition Body condition worse than can be expected in relation to season	Seeking and finding shelter for all group members Appropriate modulation of variation in fur and body condition during seasons	Not finding shelter or finding insufficient shelter for the group Fur and body condition bad throughout the group or in extreme variation
The animal(s) should be free adequately to react to physical injury or disease.	Seeking and finding rest and shelter Functional immune system [e.g. appropriate wound healing]	Inability to seek and find shelter Infection/inappropriate would healing	Functional immune system [e.g. appropriate wound healing]	Signs of infection across [parts of] the group
The animal(s) should be free to express its full non-social behavioural repertoire.	Adequate behavioural responses to non-social circumstances/challenges [covering both avoidance and approach behaviours]	Persistent behavioural inhibition, lethargy, context-inadequate behavior	Adequate behavioural responses to non-social circumstances/ challenges that involve the group as a whole [covering both avoidance and approach behaviours]	Behavioural responses that do not involve the whole group
The animal(s) should be free adequately to respond to social interactions.	Adequate behavioural responses to social interactions [covering both socio-positive and socio-negative behaviours]	Persistently being bullied; social isolation	Social stability within the group [as displayed by adequate socio-positive and socio-negative behaviours]	Social instability; splitting up in sub-groups
The animal(s) should be free to experience the full spectrum of emotional states and respond to those states adequately.	Executing anxiety-related behaviour and stress-responses as well as play-or other pleasure-related behavior in appropriate context	Inadequate emotional responses [lethargy, hyperreactivity]; absence of adequate emotional responses	Displaying anxiety-related behaviour and stress-responses as well as play-or other pleasure-related behavior at the group-level and in appropriate context	Absence of pleasure-related behaviour; inadequate emotional responses [lethargy, hyperreactivity] at the level of the group

ANNEX 2: THE ASSESSMENT OF BODY CONDITION IN YEARLING DEER BY REFERENCE TO PELVIC CONTOURS

<table>
<tr>
<td>  </td>
<td>BCS. 1. The pelvic contours are markedly concave. The skin is drawn in tightly against the pelvic bones. All bone prominences are sharp and angular. The deer is skeletal, although neck and shoulders may be obscured by thick mane.
 
The pelvis is best assessed by looking at the deer from an angle, not straight sideways not looking straight on or facing straight away. There is obvious space between the thighs. Ribs and spine are visible.</td>
</tr>
<tr>
<td>  </td>
<td>BCS.2. The pelvic contours are concave, sagging inwards a little, rather than being flat. The bone landmarks of the pelvis are clearly visible. The outline of the rib cage, but not necessarily the ribs, is visible</td>
</tr>
</table>

	BCS. 3. The contours and outlines of the soft tissues of the pelvis, stretched between the bone landmarks are all flat. From all angles the silhouette of the rump skin and muscles is a straight line. The bone landmarks of the pelvis are not all obvious. 
	BCS. 4. The outline and contours of the pelvic soft tissues are convex and slightly rounded. The bone landmarks are difficult to make out. The spine and ribs cannot be appreciated and the prominences of the shoulders are gently rounded.
	BCS.5. The deer is obese. The contours of the pelvis are markedly convex and rounded. The bone landmarks of the pelvis are all well covered. There is no sign of the ribs and the points of the shoulders are rounded and hard to make out. The neck is thick with flesh, not hair. The deer appears 'round' from all angles. 

ANNEX 3: THE PATHWAYS OF WELFARE DECLINE



ANNEX 4: FIELD GUIDE TO THE LIKELY WELFARE OF WILD DEER

Groups of deer

	YES	NO
First, assess the *appearance* of the deer		
Are there of signs of disease such as scouring, coughing, snotty noses etc? in several members of the group		
Look at the yearlings (prickets, staggies, yearling hinds). Are a significant number of these in Body Condition Score 2 or below?		
If you can inspect carcasses, has all the fat from around the kidneys ***and*** around the central groove of the heart disappeared in young males and females (excluding calves)?		
Have several deer from this population been found dead unexpectedly recently?		
Then assess the *behaviour* of the deer		
Are there deer in the group that are lying out in exposed places when you would expect them to seek shelter?		
Are there deer in the group that are tolerating closer than usual approach by people?		
Are there deer in the group that appear lethargic and sluggish when they are disturbed?		
Is there evidence of unusual or desperate choices of food by members of the group?		
Is there evidence of unusual bullying, fighting or squabbling amongst the deer		

If you have ticked several of the red YES boxes, you should be concerned for the welfare of the deer, especially if these indicators are becoming more obvious over a period of days

Individual deer

	YES	NO
First, assess the *appearance* of the deer		
Is there of any obvious sign of wounding or traumatic injury?		
Is there any obvious sign of disease such as scouring, coughing, snotty nose etc?		
Is the deer in Body Condition Score 2 or below?		
Does the deer appear to be completely alone and isolated from other deer?		
Then assess the *behaviour* of the deer		
Is the deer unable to move normally? (It appears very lame or disabled)		
Does the deer appear unwilling or unable to eat properly?		
Are you able to approach the deer to within a close distance, or even handle it?		
If the deer does move away when approached, does it appear sluggish and lethargic?		
Is the deer lying in a place where you would not expect it to be or to remain?		

If you have ticked several of the red YES boxes, you should be concerned for the welfare of the deer, especially if these indicators are becoming worse over time.

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