Improving Horse Welfare through Assessment and Feedback

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Cover: Sofie M. Viksten and her horse HB's Foxie Flame (1996-2002), sorely missed and never forgotten. Animal cruelty is never acceptable, and it is our duty to speak up for those who cannot.
(Photo: Frida Magnusson)

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Development of Methods for Improving Horse Welfare through Assessment and Feedback

Abstract

Horse welfare is a multi-dimensional concept involving both mental and physical aspects. In the present thesis a holistic approach to assessing welfare is used through the Welfare Quality® (WQ) principles and criteria. The aim of this thesis was to develop a protocol in line the WQ® system for assessing horse welfare in Sweden and to develop a system for delivering feedback from assessments to horse owners.

In the first study an extensive literature review and discussions with national and international experts resulted in the horse welfare assessment protocol (HWAP). A pilot study showed that HWAP provided a firm basis for monitoring welfare, with high repeatability and feasibility for field use.

The second study compared an updated version of the HWAP to the official protocol (OP) used in Swedish official controls of horse welfare. Results indicated that the added level of detail and more animal based measures in the HWAP provided a more thorough welfare assessment of the individual animal than the OP methodology.

The third study used a questionnaire to investigate Swedish horse owners' decision making on the welfare of their horses and what preferences they had regarding feedback from welfare assessments. The results indicated a demand for systematic welfare assessments to provide solid information and scientifically based advice. The results were used to develop a database allowing the horse owners online access to the feedback related to the welfare assessments of their horses.

The fourth and final study evaluated how the amount of feedback from assessments (using HWAP) affected changes in horse welfare. The results showed no clear differences between the two groups and it was suggested that a six month interval between assessments is inadequate to observe significant changes. The study indicated that the educational level of the stable managers does not appear to affect the change in actual horse welfare status.

The thesis can be used as a basis for assessing horse welfare and providing horse owners with feedback. It provides an insight into the complicated subject of changing horse owners' behaviour, which is indirectly measured through horse welfare assessments.

Keywords: assessment, equine, feedback, horse welfare, implementation

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Dedication

Life is about daring to venture outside the walls of your mind and explore new things. Unbent, unbroken.

To my family and friends.

To my daughter Ida. You are the light of my life.

There is nothing more difficult to take in hand, more perilous to conduct, or more uncertain in its success, than to take the lead in the introduction of a new order of things.

Niccoló Machiavelli, 1469 – 1527, “The Prince”

Contents

List of Publications

This thesis is based on the work contained in the following papers, referred to by Roman numerals in the text:

I Viksten, S.M., Nyman, S., Visser, E.K. & Blokhuis, H.J. (2016) Developing a horse welfare assessment protocol. *Animal Welfare.* Accepted 16th May 2016.

II Viksten, S.M., Visser, E.K. & Blokhuis, H.J. (2016). A comparative study of the application of two horse welfare assessment protocols. *Acta Agriculturae Scandinavica, Section A – Animal Science*, DOI: 10.1080/09064702.2016.1186726.

III Viksten, S.M., Visser, E.K. & Blokhuis, H.J. Swedish horse owners' decision making on welfare: motivational factors and information needs. (Manuscript)

IV Viksten, S.M., Visser, E.K., Hitchens, P.L. & Blokhuis, H.J. The effects of feedback from horse welfare assessments. (Submitted)

Papers I and II are reproduced with the kind permission of the publishers. The included papers are preprints of the articles whose final and definitive forms will be published in the above mentioned journals.

The contribution of Sofie M. Viksten to the papers included in this thesis was as follows:

I Involved in planning and responsible for execution of the work. Responsible for analysis of the data and summarising results. Main responsibility for completing the manuscript with input from co-authors and support from supervisors.

II Involved in planning and responsible for execution of the work. Responsible for analysis of the data and summarising results. Main responsibility for completing the manuscript with input from co-authors and support from supervisors.

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IV Involved in planning and responsible for execution of the work. Responsible for analysis of the data and summarising results. Main responsibility for completing the manuscript with input from co-authors and support from supervisors.

Abbreviations

AB	Animal based (measure)
CV	Coefficient of variance
HAR	Human-animal relationship
HAT	Human approach test
HF	High feedback (group)
HWAP	Horse welfare assessment protocol
LCT	Lower critical temperature
LF	Low feedback (group)
MB	Management based (measure)
OP	Official protocol
RAO	Respiratory airway obstruction
RB	Resource based (measure)
RH	Relative air humidity
SD	Standard deviation
SO	Stable overall (score)
SWI	Stable welfare issue (score)
T	Temperature
TNZ	Thermo neutral zone
UCT	Upper critical temperature
WQ®	Welfare Quality®

1 Introduction

1.1 The horse-human relationship

Managing horses requires an understanding of their behavioural and physical needs, which are thought not to have fundamentally changed since their domestication around 6000 years ago (Budiansky 1997). Historically horses have been used in agriculture, the military and as a means of transport but today, in the Western world, they are mainly used for recreational purposes and equestrian sports (Visser, 2002). The Swedish horse population consists of around 362 700 horses (Statistiska Centralbyrån, 2011) and the number of horses used for recreational purposes is increasing (Manimalis, 2009; Statistiska Centralbyrån, 2011). Horse owners have a varied level of knowledge, education, experience and understanding of horses' needs, which affects their choice of husbandry and management practises. This may lead to horses' needs not being taken into full consideration, thereby compromising their welfare (Mills & Clarke, 2007; Visser & Van Wijk-Jansen, 2012; Hemsworth *et al.*, 2015).

Therefore, it is important to use horse welfare assessment to monitor welfare, provide feedback from such assessments and work towards improving welfare wherever possible.

1.2 Horse welfare

Welfare is a multi-dimensional concept which comprises physical and mental aspects such as comfort, absence of hunger, thirst, disease and fear, ability to express motivated natural behaviours and a good human-animal relationship. Existing strategies to improve animal welfare are often aimed at animals in the food producing industry and include welfare assessments and methods to increase consumer awareness. One example of such a strategy was the Welfare Quality® (WQ®) project, which was funded by the European Commission. The approach was to accommodate societal concerns as well as market demands through developing on-farm welfare monitoring systems, product information and strategies for improving welfare in cattle, pigs and poultry (Blokhuis *et al.*, 2010b; Blokhuis *et al.*, 2013).

A welfare assessment should address the above mentioned dimensions and cover freedom from suffering and distress (e.g. prolonged pain, fear, hunger and thirst), a high level of biological functioning (e.g. absence of disease, injuries, malnutrition) and opportunities for positive experiences (e.g. comfort, contentment, expression of species specific behavioural repertoire) (Fraser,

1993). To quantify welfare, adequate measures are needed in the assessment protocol. For measures to be useful, they need to be valid, reliable and feasible (Taylor & Mills, 2006). They need to describe relevant and significant aspects of what matters from the point of view of the animals, picking up on changes over time, be manageable through decisions and actions taken by the owner/manager and preferably be measurable in a relatively cheap and easy manner (Sorensen et al., 2001).

The WQ® system has four principles and 12 criteria of good welfare that ensure a holistic approach that embraces the various dimensions of welfare (see Table 1). A number of assessment protocols for different species, aiming to cover these principles and criteria, were developed within the project (Welfare Quality®, 2009a; Welfare Quality®, 2009b; Welfare Quality®, 2009c) and after its termination a protocol for horses was developed in line with the WQ® approach (Wageningen UR, 2012).

Table 1. *The Welfare Quality® system covers the different domains of animal welfare under four principles: good housing, good feeding, good health and appropriate behaviour. Each principle is divided into criteria of good welfare.*

Welfare Principles	**Welfare Criteria**	
Good feeding	1.	Absence of prolonged hunger
	2.	Absence of prolonged thirst
Good housing	3.	Comfort around resting
	4.	Thermal comfort
	5.	Ease of movement
Good health	6.	Absence of injuries
	7.	Absence of disease
	8.	Absence of discomfort caused by use
Appropriate behaviour	9.	Expression of social behaviour
	10.	Expression of other behaviours
	11.	Good human-animal relationship
	12.	Positive emotional state

The protocols in WQ® use a mix of measures from three categories: animal- (AB, the animal itself), resource- (RB, the animal's environment or available resources) and management-based (MB, management practises). By looking more at the animal itself using AB measures (e.g. body condition score, coat condition, behaviour) the actual welfare status can be assessed. There are a number of AB measures available and together they can be seen as a "toolbox" where the most applicable measures for a certain condition or species are chosen (EFSA Panel on Animal Health and Welfare, 2012). RB (e.g. ventilation,

housing size, paddock surface quality) and MB (e.g. feeding regime, farrier intervals) measures are also included in welfare assessment protocols, but they are mainly risk factors and may thereby not say anything about the actual welfare status of the animal.

In order to better comply with horse welfare the title of the 8th WQ® criterion was, in accordance with Visser *et al.* (2014), altered from "Absence of pain induced by management procedures" to "Absence of discomfort caused by use". The original name refers to e.g. dehorning of cattle which is irrelevant in horses. "Use" of the horse is here defined as handling of the horse in relation to training e.g. tacking, leading, riding or driving.

1.2.1 Good feeding

Absence of prolonged hunger

Horses in the wild trickle-feed on plants, herbs and grasses with a low energy content for 16-20 hours a day. They preferably feed on roughage which is low in starch and of poor to medium quality (Cooper *et al.*, 2005; Henderson, 2007). Eating and drinking mostly occurs at ground height and horses move over long distances every day to access feed and may also alter their behaviour in order to access feed (Salter & Hudson, 1979).

Contemporary horse feeding regimes commonly include 2-6 feeding occasions per day with high quality roughage, often complemented with concentrates high in starch. Studies have shown that the amount and order of feeds (concentrates and roughage), number of feeding occasions per day and time with available roughage may influence horses' health and behaviour (Tinker *et al.*, 1997; McGreevy & Nicol, 1998; Cooper & McGreevy, 2003; Johnson *et al.*, 2004). A feeding regime can be considered adequate if it is adapted to the horses' nutritional needs (in relation to e.g. exercise), enables horses to maintain a body condition score (BCS) of 3 on a 1-5 scale (Carroll & Huntington, 1988) and does not cause behavioural issues related to feeding frustration. Inadequate feeding regimes might be related to time with available roughage, amount of feeds or management not compensating for social hierarchies (higher ranked horses get access to resources first and might hinder lower ranked individuals from reaching them) (Houpt, 1991). Social hierarchies may even influence the possibility for individually stabled horses to feed undisturbed due to visual threats from higher ranked horses in adjacent housing.

Absence of prolonged thirst

Horses drink freshwater and consume roughly between 2-7 litres per 100 kg bodyweight or 12-60 litres per day (depending on e.g. climate, type of feed given, body size and amount of exercise) (Groenendyk *et al.*, 1988; Nyman & Dahlborn, 2001; Nyman *et al.*, 2002). Inadequate water intake has negative effects on health and can cause intestinal impaction, colic, reduced feed intake and reduced BCS. The quality of the provided water is important and horses are thought to be "picky" drinkers due to taste and temperature preferences (Kristula & McDonnell, 1994). Horses can drink up to 28 litres in one bout and usually drink within 3 hours post feeding. They might drink up to 41% (mean daily water intake) more from buckets compared to automatic drinkers (Kristula & McDonnell, 1994; Nyman & Dahlborn, 2001). Consequently, the distribution and access to clean water for all individual horses is very important for their welfare.

1.2.2 Good housing

There are many studies on how stable design, size of paddocks and individual keeping of horses affect their welfare (Hogan *et al.*, 1988; Cooper & Albentosa, 2005; Forkman *et al.*, 2007; Henderson, 2007). Common welfare issues include poor air hygiene, high noise levels in the housing, slipping in housing and paddocks and chafing. These issues are somewhat similar across many farm animal species (see for example Rushen and de Passillé (1992)). Unfortunately, research results are not always considered when horse facilities are planned, designed and built which means that these issues persist even in newly built facilities.

Many traditions around horse housing stem from a time when horses were used in agriculture and in the military. These systems often include restricting horses' movements and social interactions by housing them individually in boxes and tie-up stalls with time-restricted access to paddocks. Boxes and tie-up stalls can have either whole walls, partial walls and bars or only a shoulder-height wall to separate horses from each other. This affects the quality of social interactions in the horses and is more restricting than loose housing systems. Loose housing systems with unlimited access to paddocks are increasingly common and have gained popularity in the form of semi-automatized systems in recent years. How housing regimes affect different aspects of horse welfare have been studied and reviewed by for example Henderson (2007), Chaplin and Gretgrix (2010) and Keeling *et al.* (2010).

Comfort around resting

Horses sleep either standing up or lying down but can only reach paradoxical sleep (deep sleep also known as "rapid eye movement sleep" or "dream sleep") if their head is resting on the ground in a lateral position. Horses also require sufficient space, a stable that is not too brightly lit and acceptable noise levels in order to rest. Thus, just sleeping while standing up is not sufficient for good comfort and health (Pedersen *et al.*, 2004; Raabymagle & Ladewig, 2006). The floor in horse housing is covered by bedding materials which are used for hygienic reasons, thermal comfort, to prevent chafing on horses and also as enrichment (Ninomiya *et al.*, 2004; Pedersen *et al.*, 2004; Ninomiya *et al.*, 2008). Adequate bedding can be defined as thick enough not to cause chafing from the floor on protruding parts of the horse (e.g. hocks) and dry and clean enough to ensure absence of skin problems (caused by urine and faeces).

Adequate box and stall size is traditionally determined through wither height, however Raabymagle and Ladewig (2006) and Pedersen *et al.* (2004) suggest that more research is needed to determine how much space a horse actually needs for sufficient rest and to reduce injury risks. Adequate housing enables horses to lie down and get up without bumping into the interior or getting stuck. This is difficult to assess *in situ* since it requires direct observations of the horses resting behaviour which is time-consuming.

Thermal comfort

Horses are able to maintain their body temperature with very low energy expenditure within the thermo neutral zone (TNZ) which lies between the upper and lower critical temperature (UCT and LCT). Above the UCT horses spend energy to cool down by increased breathing frequency, sweating and dilating blood vessels in the skin. With temperatures below the LCT horses attempt to increase their metabolic rate (i.e. require more feed) and use piloerection to keep warm. The values for the critical temperatures are mainly determined by physical attributes such as body insulation (i.e. subcutaneous fat, hair cover) and food intake (Morgan, 1997; Morgan *et al.*, 2002; Wallsten *et al.*, 2012). It has been suggested that the TNZ for horses ranges between -15°C to +10°C (McBride *et al.*, 1985). Horses adapt their feed and water intake, sweat, shiver, alter behaviour and use of shelter in order to adjust to various temperatures. To facilitate thermoregulation horses need access to shelter from extreme weather (sun, heat, rain, wind and snow) and access to water and feed in sufficient amounts so that they can maintain a healthy BCS regardless of weather.

Thermal comfort in the housing can be seen as adequate if signs of heat- or cold stress such as sweating or shivering are absent (Mejdell & Bøe, 2005; Burn

et al., 2009). Thermal comfort in the housing is related to how well the ventilation manages to adjust the indoor climate in relation to the outside conditions. It also depends on other factors such as the use of rugs. By regulating the air flow and Temperature (T) in the stable, the indoor Relative air humidity (RH) can be adjusted so that horses are thermally comfortable and the risk of mould growth is kept to a minimum (Nielsen, 1979). In insulated housing where the indoor T is below 10°C the sum of RH and T should not exceed 90 and if the indoor T is above 10°C the sum should not exceed 80 (Ehrlemark, 1994; CIGR, 2012).

Ease of movement

Horses are physically adapted to move a large part of the day at a low speed whilst grazing. Therefore, restricting their movement may contribute to various health- and behavioural disorders (McGreevy *et al.*, 1995; Heleski *et al.*, 2002; Johnson *et al.*, 2004; Odlander, 2010). The size and quality of the housing and paddocks affect the behavioural possibilities of horses. Housing size should allow horses to stand up, move freely and allow them to get up and lie down without bumping into the interior.

Studies have shown that smaller paddock sizes cause increased occurrence of aggression, pacing and less resting compared to larger paddocks. It was also concluded that the larger paddocks did not result in more running or playing and that no increased risk of injury was apparent (Hogan *et al.*, 1988; Henderson, 2007; Jørgensen & Bøe, 2007). Horses are kept either individually or in groups in paddocks, mostly depending on the owners' preferences. Group kept horses display many social behaviours beneficial for welfare: mutual grooming, play and taking turns in lying down to rest (Pedersen *et al.*, 2004; Chaya *et al.*, 2006; Lee *et al.*, 2011; Werhahn *et al.*, 2011). Horses are often grouped according to gender to reduce aggression in the paddocks. However, there is no evidence that this is effective. Instead, it seems that space allowance, management of feeding and early life social experience of the horses have a greater importance to minimise risks of injury in group kept horses (Jorgensen *et al.*, 2009; Hartmann *et al.*, 2012).

1.2.3 Good health

Absence of injuries

Lameness is a common welfare issue in horses and other domesticated animals; it causes discomfort, possibly pain and affects the animal's behaviour, performance and production (Cole *et al.*, 2005; Thomsen *et al.*, 2008). Lameness in horses is a multifactorial welfare issue thought to be related to back pain, also

frequently occurring in horses (Landman *et al.*, 2004). Horse owners usually perceive lameness as problematic mainly due to the effect it has on the use of the horse (Cole *et al.*, 2005). Detecting lameness at an early stage is important for minimizing negative welfare effects and initiating treatment. Traditionally detection is done by subjective observation (Fuller *et al.*, 2006; Keegan *et al.*, 2010) but new technology now enables a more objective detection (Back *et al.*, 1993; Fuller *et al.*, 2006; Keegan *et al.*, 2012). Subjective assessment of mild lameness has low repeatability although a "live" evaluation is more reliable than observing videotapes (Keegan *et al.*, 2010). A diagnosing assessment of lameness can only be performed by a veterinarian. The purpose of the welfare assessments in this study is a first level of detection of issues that can then be further diagnosed and treated by a veterinarian.

The expression "no hoof - no horse" is quite accurate; regular balancing and caring for hooves is important to prevent lameness and other welfare issues related to movement (Balch *et al.*, 1997; Redden, 2003; Johnson *et al.*, 2004). The quality of the hooves is affected by factors such as feeding regime, farriery intervals, various diseases and climate (Redden, 2003).

Wounds are a common form of injury to horses and range from a small scratch to large open wounds in need of veterinary attention (Mejdell *et al.*, 2010). Wounds can result from aggression between horses (e.g. due to insufficient resources or unsuitable group-composition) and/or inappropriate (unsafe) design of stables and passages to and from paddocks (Knubben *et al.*, 2008). Assessing acute wounds with a scoring system can be done in a highly repeatable (inter observer results) way by trained non-veterinarians (Mejdell *et al.*, 2010).

Absence of disease

Indoor stable climate has a high natural occurrence of bacteria, fungi, dust and endotoxins from bedding materials and feed (Mazan *et al.*, 2004; Hotchkiss *et al.*, 2007; Samadi *et al.*, 2009; Wålinder *et al.*, 2011). Mould is also commonly occurring and will thrive in high air humidity (Nielsen, 1979) which is common in stables when ventilation is insufficient. Indoor stable climate is a well-known trigger of airway inflammation in horses and the longer time a horse spends in the stable, the more it gets affected by poor air quality (Mazan *et al.*, 2004; Hotchkiss *et al.*, 2007).

Hampered breathing along with a deteriorated general state are often a clear sign of disease in horses (Mazan *et al.*, 2004). Other symptoms such as coughing and nasal discharge can be signs of respiratory problems or of Recurrent Airway Obstruction (RAO) which is thought to be a commonly occurring condition in

leisure horses (Mazan *et al.*, 2004; Hotchkiss *et al.*, 2007). Ocular and nasal discharges in horses are normally clear, any signs of thickened mucus or runny eyes and nose are considered signs of disease (Burn *et al.*, 2009).

Skin disorders on the body and legs are a well-known cause of reduced welfare and lameness in animals (Winckler & Willen, 2001). Crusts, dry or flaky skin and any other abnormal states on the horse's body are easily seen and considered a sign of illness (Scott & Miller, 2011). Skin disorders are often connected to the use of rugs, occurrence of biting insects, trauma causing skin breakage (e.g. due to clipping) and insufficient grooming (White & Yu, 2006; Scott & Miller, 2011). The occurrence of insects, summer itch and eczema often leads to itching in the mane and tail, sometimes to the point where all hair is scratched off and open wounds appear (White & Yu, 2006; Scott & Miller, 2011). Equine pastern dermatitis and hoof rot are commonly occurring and caused by environmental and managerial factors such as poor hygiene, wet and muddy paddocks, wet bedding and poor grooming. These common conditions may lead to infections, chronic conditions and lameness if left untreated (Akucewich & Anthony, 2007; Colles *et al.*, 2010).

The coat condition can reveal signs of metabolic disorders and general lowered welfare (Thatcher *et al.*, 2008; Suagee *et al.*, 2011). A healthy coat is shiny despite season and a winter coat is onset in late autumn and shed appropriately during spring. A long, matte coat in summertime is not a normal state and neither is an excessively long, wavy or thick coat in winter.

Absence of discomfort caused by use

The use of horses may influence their behaviour, health and general welfare in different ways depending on training and management regimes (Hausberger *et al.*, 2009; Normando *et al.*, 2011; Hockenhull & Creighton, 2012). How the use of horses relates to welfare has been thoroughly studied; for example by Søndergaard and Ladewig (2004), McGreevy and McLean (2009) and Hockenhull and Creighton (2012). There are many variables involved which makes it difficult to directly relate use and welfare issues. However, certain issues are generally accepted as being relevant regardless of how the horse is used (e.g. racing, recreational riding or driving) (Schmidt *et al.*, 2010; Hockenhull & Creighton, 2012). Generally, it can be said that horses spending a lot of time with restricted movement in the stable, in combination with intense, short training sessions, are subjected to an increased risk of injuries (Odlander, 2010).

Back soreness is a common welfare issue in horses which can be related to incorrect saddle fit, training regimes that are not adapted to the individual horse, behavioural problems and lameness (Fruehwirth *et al.*, 2004; Landman *et al.*,

2004; Weishaupt *et al.*, 2006; Latif *et al.*, 2010; Lesimple *et al.*, 2010; Normando *et al.*, 2011). Back pain results in poor welfare no matter the cause due to the experienced pain and its effect on the horses' everyday life.

Chafing from equipment is a welfare issue that is uncomfortable for the horse and can lead to serious skin disorders, secondary infections and even necrosis if left untreated (White & Yu, 2006; Scott & Miller, 2011). Chafing and wounds from equipment have several possible causal factors: insufficient cleaning of the equipment or the horse, inappropriate fitting, sensitive skin or the use of wet or broken equipment. Studies on equipment chafing have shown that assessment in the field is repeatable and highly significant for welfare (Pritchard *et al.*, 2005).

Horses used for riding and driving are controlled by applying and removing pressure on the body, head and in the mouth. Equipment varies with area of use but it is common to use a bridle (with or without bit) which may cause injury to the horse's mouth and skin if the pressure is constant and is always applied in the same place (Tell *et al.*, 2008; Cook, 2011).

1.2.4 Appropriate behaviour

Behaviour is the expression of an animal's perception and interaction with its environment and is a necessary part of welfare assessments (Pritchard *et al.*, 2005). According to Cooper and Mason (1998) behaviour can relate to welfare in four ways; as an indicator of poor welfare; a means of adapting to the environment; its performance can itself be harmful; or it can have little direct impact on the performers quality of life.

Expression of social behaviour

Under free-living conditions horses live in mixed groups with a clear social hierarchy established through short-duration aggression, age, gender and relations to others in the group (Houpt, 1991; Scheibe *et al.*, 1998). Social behaviours in groups include communal feeding and drinking, allogrooming, and play. Play and other social behaviours in groups are thought to be an expression of positive emotions as well as a means to reduce stress (Christensen *et al.*, 2002; Van Dierendonck *et al.*, 2010). Contemporary managerial regimes might not cater for these natural social needs. Horses are for example often kept in individual stables from a young age which may cause social deprivation. This and other managerial regimes such as abrupt weaning early in life can cause onset of abnormal behaviours in horses (Mason, 1991; Latham & Mason, 2008; Visser *et al.*, 2008). Many recreational horse owners choose individual stables to prevent injuries, perhaps due to a lack of understanding of the horses' natural needs and the actual risks of injury. Studies have shown that housing horses in

groups can be done in a way that reduces risks of injury to both horses and people and have been reviewed e.g. by Keeling *et al.* (2010) and Hartmann *et al.* (2012).

Expression of other behaviours

Undesirable behaviours in horses include for example aggression towards people and other horses and performance of stereotypies. Regardless of which undesirable behaviour a horse displays, it is important to investigate and understand the underlying reasons and eliminate them in order to improve welfare (Jorgensen *et al.*, 2009; Fureix *et al.*, 2012).

Aggressive behaviour is often related to chronic pain, back problems (Fureix *et al.*, 2010) or social instability (Knubben *et al.*, 2008). Aggression is a welfare concern mainly in two ways; the behaviour might cause social isolation (due to concern for other horses) and possibly even euthanasia of the horse.

Stereotypic behaviour can be defined as "repetitive, invariant behaviour patterns with no obvious goal or function" (Mason, 1991) or a "repetitive behaviour induced by frustration, repeated attempts to cope and/or central nervous system dysfunction" (Nagy *et al.*, 2009). Stereotypies are studied across many species and are reviewed by e.g. Cooper and Albentosa (2005) and Mason (1991). There is research suggesting that stereotypies in horses are induced by having the same feeding routines for years (Cooper *et al.*, 2000; Forkman *et al.*, 2007; Van Dierendonck *et al.*, 2010) or by partial or full social deprivation (Visser *et al.*, 2008). Some researchers may argue that stereotypy is a means of coping, this is however not quite proven and difficult to interpret (Cooper & Mason, 1998). It has also been argued whether or not to include stereotypy as a welfare indicator, especially since it might be a remnant from previous management and not a result of the current one. Here it is argued that it must be included since it indicates possibly sub-optimal management regimes and environments, even for horses under the same conditions that do not display the behaviour (Henderson, 2007). Any managerial regime that increases stereotypy is reliably decreasing welfare (Mason & Latham, 2004).

Stereotypic behaviours in horses can be divided into two categories: oral (e.g. bar-licking, tongue-rolling, self-mutilation, cribbing, wind-sucking and wood-chewing) and locomotory (e.g. weaving, box-walking, pawing and kicking) stereotypies. Oral stereotypies often relate to an unfulfilled motivation to graze, limited social contact, isolation or gastrointestinal problems (Cooper & Albentosa, 2005; Henderson, 2007; Wickens & Heleski, 2010). Under free-living conditions horses trickle feed throughout the day, in captivity most horses have time limited access to roughage which may cause health- and behavioural issues (Tinker *et al.*, 1997; Henderson, 2007). Stable enrichments such as horse-balls, various mineral blocks, hanging toys and other artificial enrichment items

are sometimes supplied to decrease stereotypy, most are however not scientifically tested for their actual effectivity (Nicol, 1999; Jørgensen *et al.*, 2011). Enrichment in the form of mirrors placed in the horses housing environment have been implied to decrease frequency of weaving and head-nodding, probably due to mimicking social contact (McAfee *et al.*, 2002). One can however question from an ethical point of view whether or not enrichments should be used as a replacement for social contact with other horses.

Locomotory stereotypies such as milling, pacing, box-walking and weaving are often related to an unfulfilled motivation to move and reach other horses (i.e. unfulfilled needs for social contact). Treatment of all types of stereotypies should involve identifying the cause of the behaviour and decrease the horse's frustration e.g. through increased turnout in sufficiently large paddocks, less restrictive stabling and increased social contact (Hogan *et al.*, 1988; Nicol, 1999; Cooper *et al.*, 2000; Normando *et al.*, 2011).

Good human-animal relationship

Use of horses involves a relationship referred to as the human-animal relationship (HAR) which also includes the match between horse and rider which is a significant welfare aspect (Axel-Nilsson, 2015). The HAR has great importance for horse welfare since a negative HAR may lead to aggression, aversive behaviour at training and possibly even euthanasia (Buckley *et al.*, 2012). HAR is assessed through behavioural tests and in other farm animals this includes testing avoidance-distance, fear of handlers, novel objects and human approach tests (Waiblinger *et al.*, 2006; Forkman *et al.*, 2007; Knierim & Winckler, 2009).

In horses, mainly three categories of HAR tests are used: involving a motionless person, an approaching person or a person who strokes the horse (Hausberger *et al.*, 2008). When assessing the HAR it has been recommended to use more than one test (Waiblinger *et al.*, 2006). Aspects of housing and management regimes may influence the HAR and underpins the importance of knowledge about horses' behaviour and learning abilities at training and handling (McGreevy, 2007; Hausberger *et al.*, 2008; Buckley *et al.*, 2012; Hockenhull & Creighton, 2012). Handling routines and the number of handlers may affect results of HAR-tests. Therefore, horses performing differently in HAR-tests do not necessarily have a different welfare status. Some studies also suggest that HAR-tests may be influenced by breed, genetic effects and sex, meaning that results may not relate directly to welfare but instead temperament and "horsonality" (Visser, 2002; Hausberger *et al.*, 2008).

1.3 Various horse welfare assessment protocols

Generally, systematic welfare assessments are part of a cycle of assessments and feedback to achieve a higher level of welfare (Figure 1). A number of protocols are now available for horses (AHIC, 2011; Wageningen UR, 2012; AWIN, 2015; Viksten *et al.*, accepted) but international standardisation of protocols is lacking (Main *et al.*, 2014) which hampers meaningful comparison and interpretation of results worldwide. The purposes of the various protocols differ and some, such as the Swedish official protocol (OP), focus specifically on establishing legislative compliance (Statens Jordbruksverk, 2007; Statens Jordbruksverk, 2012a). Others aim more to assess the actual welfare status of the horses and provide a basis for improvement ("assess and improve"); for example the "Australian Welfare Protocol" (AHIC, 2011), the "Assessment Protocol for Horses" (Wageningen UR, 2012), "Welfare Assessment Protocol for horses version 1.1" (AWIN, 2015) and the "Minimum standards of horse care in the state of California" (Miller, 2010). To assess the actual welfare most of these protocols include mainly AB measures that are scientifically evaluated and available for most criteria as defined by WQ® (Dalla Costa *et al.*, 2014). Some countries supply advice on best practice, e.g. "Equine Industry Welfare Guidelines Compendium for Horses, Ponies and Donkeys" (NEWC, 2008) in the UK and "Gids Goede Praktijken" (Sectorraad Paarden SRP, 2011) in The Netherlands, but such advice is not necessarily enforced.

Protocols not only need to assess horse welfare in a reliable manner, they also need to take into consideration any local variations, cultures and husbandry methods that may require alterations and adaptations.

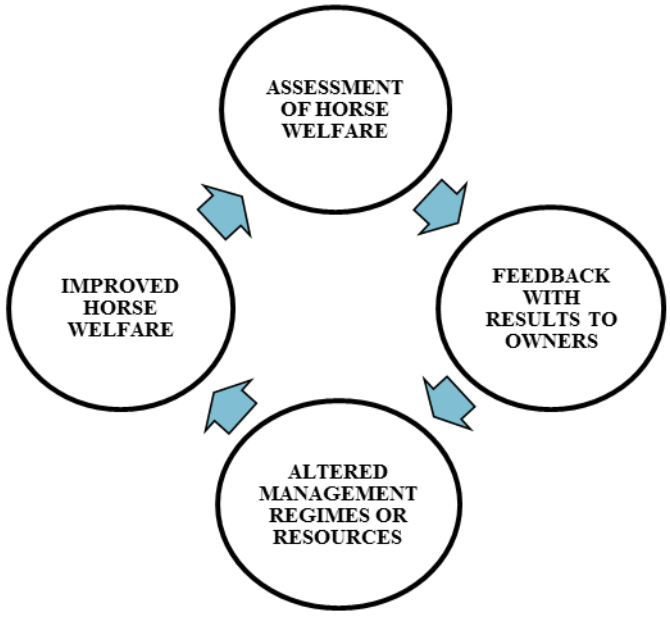

Figure 1. Model of a systematic horse welfare assessment system.

1.4 Horse welfare assessments in Sweden

Traditional assessment protocols for horses such as the official protocol (OP) used in Swedish official horse welfare controls (Statens Jordbruksverk, 2012a) comprise numerous measures. The majority of these are resource based (RB) measures and simply ensure that the environmental conditions comply with legal requirements. In the last decade protocols using mostly RB measures have been criticised for not assessing the actual welfare status of the animals (Bracke *et al.*, 1999; Blokhuis *et al.*, 2003). Indeed, although the available resources are clearly relevant to welfare, their relation to the animals' actual welfare status is not always clear. Factors such as management, husbandry methods and genetic background can profoundly influence the relation between the quality of a resource and the actually achieved welfare (Blokhuis *et al.*, 2013; Hemsworth *et al.*, 2015). Consequently, there has been increased international focus on implementing animal based (AB) measures and identifying related risk factors to safeguard and improve welfare. Unfortunately, such an effort has not yet been made for the Swedish OP.

1.5 Feedback and improvement

Previous studies have shown that horse owners differ in the way they gather information about horse welfare, which knowledge of welfare they have and whether or not they actually implement that knowledge (Visser & Van Wijk-Jansen, 2012). Factors such as attitude, motivation, previous experience and social contexts also affect the horse owners' intentions and behaviour which in turn affects horse welfare (Hemsworth *et al.*, 2015). This can be described using the theory of planned behaviour (Figure 2). The theory is used to explain human behaviour which is affected by an individual's *intention* to perform the behaviour, i.e. motivational factors (Ajzen, 1985; Ajzen, 1991). This is in turn dependent on a person's *attitude* towards the behaviour, which is influenced by previous experiences. Intention is also influenced by *subjective norms*, e.g. social pressure to perform the behaviour, and also by *perceived behavioural control*, e.g. the persons confidence that he or she can perform the behaviour (Ajzen, 1985).

In order for someone to accept feedback from welfare assessments and use it to implement actual changes, studies have shown that the receiver of the information needs to believe in the results and in the assessment (Jansen *et al.*, 2010). This belief and perceived behavioural control depends on a number of factors and animal owners and farmers are of course also part of a wider social context that needs to be taken into consideration (Ajzen, 1985; Jansen *et al.*, 2010; Visser & Van Wijk-Jansen, 2012). By raising awareness of how horse owners' behaviour is causing welfare issues there is an opportunity to change their attitude, subjective norms and thereby their behaviour. To establish this sort of self-insight through facts from horse welfare assessments may be challenging, not least since the owners are generally not intentionally causing welfare issues.

Although several protocols for assessing horse welfare have been developed, international standardisation is lacking and legislation varies even between neighbouring countries. There are official controls of animal welfare in some countries, however, official protocols sometimes lack sufficient AB measures to assess the horses' actual welfare status. There is also a lack of feedback systems that aim to implement scientifically based advice in order to improve actual horse welfare.

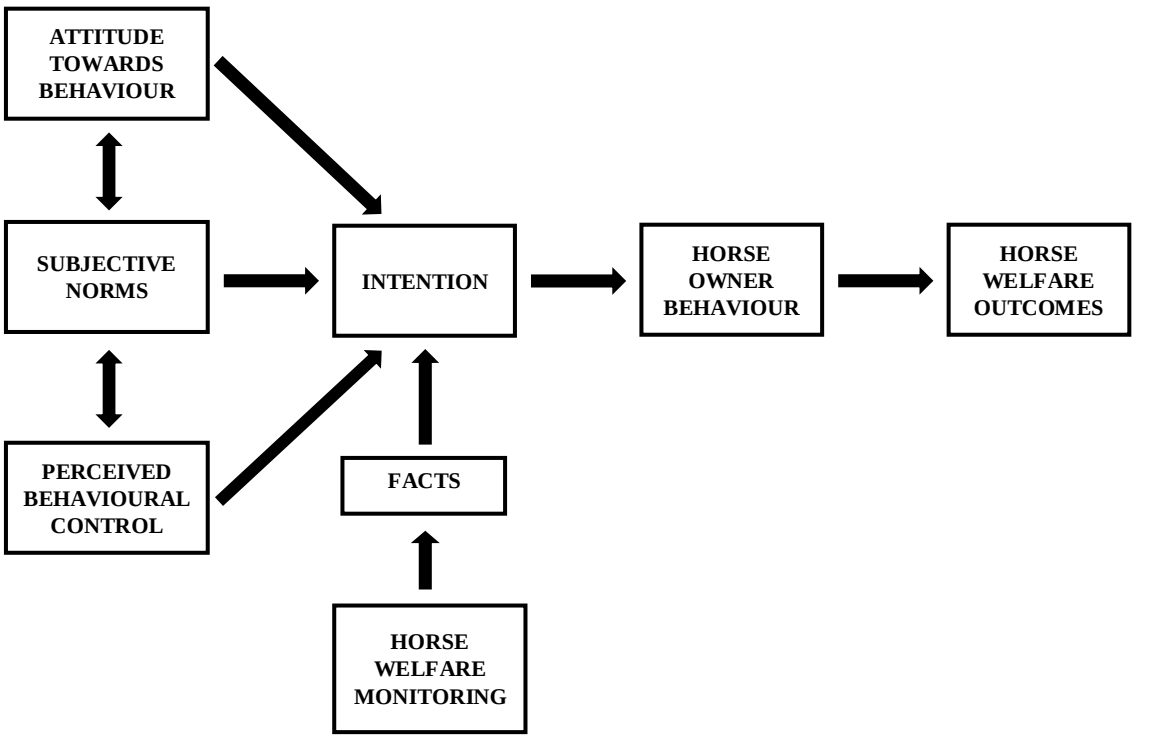

Figure 2. The theory of planned behaviour, adapted from Ajzen (1985) and Hemsworth *et al.* (2015).

2 Aims of the thesis

The general aim of this thesis was to contribute towards the development of a systematic horse welfare assessment and feedback system. The developed system was tested under Swedish conditions. Emphasis was put on developing a feasible system with the potential to be applied in systematic horse welfare assessments in Sweden and potentially internationally.

The four studies presented in this thesis each addressed important parts in the development of the system; developing an assessment protocol and a feedback system and testing them under real life conditions.

The more specific aims of the thesis were:

- To develop and test a draft welfare assessment protocol in line with the Welfare Quality® system (Study I).
- To compare the developed protocol with the protocol used in Swedish official controls (Study II).
- To investigate motivational factors behind horse owners' decision making in horse welfare and what they consider relevant aspects of feedback from welfare assessments (Study III).
- To evaluate how feedback from welfare assessments provided to horse owners affect actual horse welfare (Study IV).

3 Materials and Methodology

This chapter gives an overview of materials and methods used in the four studies in this thesis. For the complete descriptions and details, see Paper I-IV.

The first study was conducted from October until December 2011 (Paper I). The second study was performed from January until March 2014 (Paper II). The third study included a questionnaire that was available on the internet from August until October 2014 (Paper III). The fourth and final study was conducted from January until October 2014 (Paper IV). All field studies were conducted in Uppsala and Stockholm counties in the mid-region of Sweden.

All assessments were done by the author of this thesis, Sofie M. Viksten, who had previously worked as an animal welfare officer in Sweden for two years, had been handling horses on professional and recreational level for over 20 years and had received training in lameness assessment and applicable physical examinations of horses.

3.1 Ethical statement

All studies were approved by the Uppsala Ethical Committee, permit no C145/11 and C319/11.

3.2 Study I

The aim of Study I was to develop a draft protocol for assessing horse welfare and to test its feasibility under field conditions in a pilot study.

Composing the draft protocol

Over 100 scientific papers published between 1988 and 2011 were reviewed and yielded a list of welfare measures in three categories: animal- (AB, measured on the animal itself), resource- (RB, the animals' environment and available resources) and management based (MB, dependent on managers' decisions and management practices). All measures were discussed with experts (in Sweden and abroad) who had considerable experience of horses and welfare assessment: three veterinarians with different fields of expertise, one certified (by the Swedish Board of Agriculture) equine physiotherapist, two certified (by the Swedish Board of Agriculture) farriers, three animal scientists (PhDs) and two animal welfare officers working for the Swedish government. Each measure was discussed in terms of: 1) relevance to welfare; 2) feasibility in situ; 3) reliability;

4) the WQ® criterion in which it should be placed and 5) how to score it (scale and definition).

The title of the 8th WQ® criterion was, in accordance to Visser *et al.* (2014), altered from "Absence of pain induced by management procedures" to "Absence of discomfort caused by use" since the original name refers to practises such as the dehorning of cattle which is irrelevant in horses.

After expert discussions 47 non-invasive measures (15 AB, 24 RB, and 8 MB) were considered relevant, potentially reliable and feasible for inclusion in the HWA protocol (Table 2).

Table 2. *The selected measures in the horse welfare assessment protocol (HWAP) categorised within the framework of the welfare principles and criteria of the Welfare Quality® approach (Blokhuis et al., 2013). The title of the eighth criterion was altered from "Absence of pain induced by management procedures" into "Absence of discomfort caused by use" (Visser et al., 2014).*

Welfare Principles	**Welfare Criteria**	**Measures in HWAP**
Good feeding	1. Absence of prolonged hunger	BCS Distance to next horse feeding point (roughage) Height of feed (concentrate trough and roughage) Time with available roughage
	2. Absence of prolonged thirst	Availability and cleanliness of water in stable and paddock Type, height, function and flow of drinker
Good housing	3. Comfort around resting	Housing size (group, box or tie-up stall) Noise level
	4. Thermal comfort	Sweating or shivering Sum of RH and T in stable Open fresh air inlets in stable
	5. Ease of movement	Time in training Housing type (group, box or tie-up stall) Ceiling height Paddock size Time in paddock Access to pasture on grass
Good health	6. Absence of injuries	Lameness Hoof quality Farrier intervals Wounds Bumping into things or slipping when moving from stable to paddock Paddock surface quality

Welfare Principles	Welfare Criteria	Measures in HWAP
	7. Absence of disease	Roughage fed without water Order of feed (concentrates vs roughage) Coughing Signs of hampered breathing Ocular and nasal discharge Mould and condensation in stable Skin and coat condition Signs of scratching in tail and mane
	8. Absence of discomfort caused by use	Equipment chafing Rug cleanliness
Appropriate behaviour	9. Expression of social behaviour	Possibility of social contact Group size in paddock
	10. Expression of other behaviours	Occurrence of undesirable behaviour Enrichment for feed seeking behaviour
	11. Good human-animal relationship	No measures included
	12. Positive emotional state	Visual horizon in stable

3.2.1 Stables, horses and assessments

For safety reasons no naive horses were used, some horses were also excluded for other practical reasons (e.g. veterinary visit or planned euthanasia between assessments). Neither brood-mares, foals nor stallions were included in this study. Assessments took place at two riding schools in mid Sweden during late autumn. The riding schools were selected because they each had more than 10 horses and had personnel available to assist the assessor. In Stable 1, 15 of the 22 present horses and ponies were used in the study. They were of various breeds (Gotland pony, Swedish Warmblood, Swedish Coldblood and Norwegian Fjord horse), ages (4-23 years), gender (1 mare and 14 geldings) with a mean wither height of 1.37 (± 0.2) m. Four horses (6 at the second assessment) were individually stabled in boxes and 11 (9 at the second assessment) in tie-up stalls. The horses were ridden for 11.7 (± 7.9) hours per week, the stable was about 30 years old with mechanical ventilation and a ceiling height of 2.71-3.0 m. In Stable 2, 22 of the 30 present horses were used in the study; these were of various breeds (Thoroughbreds, Swedish and Polish Warmbloods), ages (6-19 years), gender (4 mares and 18 geldings) with a mean wither height of 1.64 ± 0.1 m. Twelve (13 at the second assessment) were housed in individual boxes and 10 (9 at the second assessment) in tie-up stalls. The horses were ridden for 14.8 (± 4.1) hours per week, the stable was less than 10 years old with a computerized mechanical/natural ventilation system and a ceiling height of 2.96-8.4 m. All

horses in the study had a bedding of wood shavings, were stabled at night and kept in groups of various sizes in paddocks during the day. Stable 1 kept horses in mixed gender groups and Stable 2 separated horses according to gender in the paddocks.

All horses returned from pasture (complete rest and ad libitum access to grass) just before the first assessment. Assessments started at 6 am before the horses were fed and let out into the paddocks. The simplified lameness assessment was novel to both stables that did not have a routine of assessment on a hard even surface.

Table 3. *Horse welfare assessment protocol measures conducted after entering the stable, whilst horses were eating their morning feed. Presented in the order they were assessed, the way they were scored and with further description of each measure. AB = animal, RB = resource, MB = management based.*

Measure	**Score**	**Description**
Sum of RH and T in stable	Sum of RH and T (ºC) 0 = < 80 if T >10 ºC, < 90 if T<10 ºC 1 = > 80 if T >10 ºC, > 90 if T<10 ºC	RB, Measured just outside boxes and stalls when stable doors are still closed using a RH and T meter
Noise	0 = acceptable level not considered noisy 1 = considered noisy/loud	RB, Estimation if above or below 65 dB by audibly perceiving noise in stable

Table 4. *Horse welfare assessment protocol measures conducted in boxes or tie-up stalls whilst the horses were eating their morning feed. Horses stood in their box or tie-up stall and were only held by personnel if they showed aggressive or avoidance behaviours*

Measure	**Score**	**Description**
Occurrence of undesirable behaviours	0 = none 1 = occurrence of unwanted behaviour. Onset of behaviour noted.	AB, Direct observation of aggression or stereotypy during morning feeding and before being let out into the paddock in the morning. Information from owner regarding onset.
BCS	1 = very poor 2 = moderate 3 = good 4 = fat 5 = very fat	AB, Fat deposits on neck, back and ribs assessed according to Carroll and Huntington (1988)
Thermal discomfort	0 = no sweating or shivering 1 = sweating or shivering	AB, Direct observation of whole body
Hoof condition	0 = normal 1 = abnormal shape or severe cracks	AB, Scored in stable by visual assessment of all four hooves
Wounds	0 = no wounds or chafing 1 = chafing or wounds with hair loss and broken skin 2 = severe wounds in need of veterinary treatment	AB, Scored in stable, location of wound or chafing noted, whole body assessed. Separated from wounds in areas where equipment touches horse (scored as equipment chafing)

Measure	Score	Description
Coughing	0 = no 1 = yes	AB, Noted when horses fed in the morning and during physical assessment.
Hampered breathing	0 = normal 1 = hampered	AB, Observing flank movement for about one minute
Ocular discharge	0 = absent 1 = present but slight around corner of eye 2 = present and running down cheek or all around eye	AB, Direct observation of both eyes
Nasal discharge	0 = present but slight and uncoloured 1 = present and coloured/thick	AB, Direct observation of both nostrils
Skin condition	0 = normal 1 = flaking, crusts etc.	AB, Coat was separated with fingers all over the horse and any occurrence of abnormality was scored 1
Coat condition	0 = normal 1 = matte or partially long 2 = matte and abnormally long or ragged	AB, Season taken into consideration so that a winter coat was not assessed as long, whole body assessed
Mane and tail	0 = normal 1 = some signs of scratching 2 = severe signs of scratching with broken skin	AB, Observation of tail and mane (both sides)
Equipment chafing	0 = none 1 = some hair loss or rugged coat 2 = hair loss or wounds	AB, Observation of areas on horse where equipment touches (e.g. head, under saddle, on legs) on both sides of body, Kept separate from other wounds not in these areas.
Rug cleanliness	0 = clean 1 = hairy or dirty	RB, Inside of rugs assessed on horses supplied with rugs (all rugs, both for indoor and outdoor use)

Table 5. *Horse welfare assessment protocol measures conducted whilst horses were led to the paddock from the stable.*

Measure	Score	Description
Bumping into obstacles or slipping when moving to paddock	0 = no slipping, tripping or bumping 1 = one of the above occurred 2 = two or more of the above occurred	AB, Direct observation of horses when moving from stable to paddock in the morning
Lameness	0 = no lameness 1 = lame or very stiff, uneven steps 2 = not weight bearing on one leg	AB, Assessed on hard surface in walk and trot 10 m from front, 10 m from side and 10 m from behind, horse led by stable personnel

Table 6. *Horse welfare assessment protocol measures conducted in the stable whilst horses were in the paddock.*

Measure	**Score**	**Description**
Housing type	0 = group housing 1 = box 2 = tie-up stall	RB
Ceiling height	Height in meters	RB, Measured from bedding to ceiling with laser meter
Housing size	Box or stall size in m^2	RB, Measured from wall to wall with laser meter
Possibility of social contact	0 = see, touch, smell and hear other horses 1 = one or two of these missing 2 = two or more missing, social isolation	RB, Measured by observing horses in box or tie-up stall and placed in context with size of horse, height of partitions) and opportunities for contact in paddock
Visual horizon	No of sides with possibility for the horse to see around it in the housing.	RB, Bars or partly open partitions count as a visual horizon/side, as does open windows where the horse can stick its head out.
Mould	0 = none 1 = some damp patches 2 = visible mould and dampness	RB, Observation of boxes and tie-up stalls, especially walls and ceiling
Condensation	0 = none 1 = some at vents and windows 2 = visible and dripping/running	RB, Observation of boxes and tie-up stalls, especially walls, ceiling, vents and windows
Fresh air inlet	0 = direct delivery of air 1 = indirect 2 = no inlet or completely closed	RB, Observation of air inlets and how they bring air in to the individual box or tie-up stall
Enrichments	0 = haynet, haybar, edible straw o other enrichment present 1 = no enrichment	RB, Enrichments aimed at encouraging feed seeking behaviour and prolonging feeding time in the stable
Distance to adjacent feeding point	0 = > 2 m 1 = < 2m	RB, Measured between feeding points for roughage from middle in one roughage pile to middle of the roughage pile in adjacent box or tie-up stall
Roughage height	Height in meters	RB, Measured from middle of haynet/haybar etc. to bedding or scored as 0 m if placed directly on bedding
Height of concentrate trough	Height in meters	RB, Measured from bottom of trough to bedding
Water available in stable	0 = yes 1 = no or frozen	RB, Determine water availability in the stable
Height of drinker in stable	Height in meters	RB, Measured from middle of bucket or bottom of automatic drinker to bedding
Drinker function stable (automatic only)	0 = functions 1 = does not function	RB, Drinker pressed to assess difficulty to release water or if water squirts
Drinker flow (automatic only)	0 = 8 l/min or more 1 = less than 8 l/min	RB, Measured by pushing gauge for 1 minute and measuring the volume released into a bucket
Cleanliness of water in stable	0 = clean 1 = slightly dirty 2 = dirty and slimy	RB, Visual inspection to check for presence of manure, dirt or algae in the water

Table 7. *Horse welfare assessment protocol paddock measures assessed when horses are present.*

Measure	Score	Description
Paddock size	Mean m^2 per horse and group	RB, Estimated using a digital map or measured directly with a laser meter if feasible
Cleanliness of water in paddock	0 = clean 1 = slightly dirty 2 = dirty and slimy	RB, Visual inspection to see presence of manure, dirt or algae in the water
Water available in paddock	0 = yes 1 = no or frozen	RB, Score whether water is frozen (0) or not (1)
Paddock surface quality	0 = dry and even space for all horses 1 = muddy and/or uneven or nor enough dry space for all horses 2 = uneven, mud reaching over hooves, not enough dry area for all horses	RB, Direct observation of surface in whole paddock

Table 8. *Horse welfare assessment protocol information from the stable manager.*

Measure	Score	Description
Estimated time with roughage available	0 = at least 6 h/day 1 = 3-6 h/day 2 = less than 3 h/day	MB, Record feeding episodes occasions (information from stable manager) and amount of roughage per day (from lists of feed)
Time in training	Hours per week	MB, Information from stable manager
Time in paddock	Hours per day	MB, Information from stable manager
Group size	Number of horses per paddock	MB, Information from stable manager
Pasture access	Weeks per year	MB, Information from stable manager.
Farrier intervals	Weeks between farrier visits	MB, Information from stable manager
Roughage fed without water	0 = no 1 = yes	MB, Information from stable manager
Order of feed types	0 = concentrates fed together with or after roughage 1 = concentrates fed alone or before roughage	MB, Information from stable manager

Additional information about the horses such as age, gender, height at withers, breed, main type of use and veterinary history (known diseases etc.) were also gathered by interviewing the stable managers.

Assessments were repeated in Stable 1 after 25 days and in Stable 2 after 16 days by the same assessor to test the reliability of each measure. The time period between assessments was considered long enough to minimise risk of the assessor remembering previous results whilst conducting the second assessment and short enough to minimise actual changes occurring. The assessor did not review or analyse results between assessments to further minimise risk of bias in results. Stable managers received no feedback between assessments.

RH and T were recorded using a RHT meter (Geo Fennel model FHT100) outside before entering the stable and inside before the horses were taken out.

All measures of length in the stables, feed heights, box size etc. were recorded with a laser distance meter (Leico Disto model D2).

3.2.2 Data management and statistics

All data was tested for normality using the Ryan-Joiner test. The results of each individual horse were compared between assessments and repeatability was estimated using Cohen's kappa and Kendall's tau for ordinal data. Results from kappa analyses were interpreted using the Landis and Koch (1977) scale. Normally distributed data was analysed using a paired t-test. Coefficient of variance (CV, presented in square brackets) were used to analyse continuous data. Percentage agreement and Standard deviation (SD) was calculated for applicable measures. All analyses were run at 5 % significance level using a computer statistics package (Minitab® version 16.1.0., Minitab Ltd. UK).

Horses that were assessed in only one of the two assessments were excluded from analysis. The measures individual feeding amounts, height at withers, age, time of onset of undesirable behaviour and yearly access to pasture on grass were also excluded since they derived from information stated by the stable manager and did not change between assessments (Table 8). Measures with 100 % agreement between assessments were not analysed (Table 11).

3.3 Study II

The aim of Study II was to compare an updated version of the HWAP from Study I with the Swedish OP used for official controls of horse welfare in Sweden.

3.3.1 Assessments in situ

The study was conducted between January and March 2014 and included 26 stables (8-56 horses per stable) consisting of 17 riding schools, 3 livery yards, 3 tour riding stables, 2 private stables and 1 public demonstration stable. A total of 497 horses (ages 3-36 years; 341 geldings, 152 mares, 4 stallions) that were used for various purposes (113 all round, 355 riding school/educational, 9 working equitation, 3 dressage, 8 show jumping, 1 circus, 3 driving, 3 western, 2 broodmares) and kept in various housing conditions (43 group, 372 box, 82 tie-up stall) participated in the study. These housing conditions are representative of those to be found in Sweden (Enhäll *et al.*, 2012).

The stable owners or managers were contacted via telephone and selected for inclusion in the study if they had at least eight horses and a staff member available to handle horses during lameness assessment. The stables chosen also represented various housing systems. The horses' welfare status was unknown to the assessor prior to assessment.

The HWAP assessment began in the early morning and an OP assessment (Statens Jordbruksverk, 2009; Statens Jordbruksverk, 2012b) was carried out in the afternoon of the same day. All assessments were conducted by the same assessor who had extensive experience of both HWAP and OP protocols and had previously worked as an animal welfare officer in Sweden.

Assessments were carried out using an updated version of the HWAP (Viksten *et al.*, 2016); the alterations and additions compared to the draft version are shown in Table 9. These alterations were based on experience gained during the pilot test of the HWAP and its results (Viksten *et al.*, accepted). Measures were scored in line with the WQ® approach and mostly on a scale of 0-2 where 0 reflected the least severe and 2 the most severe with regards to negative effects on welfare. Some measures were binary: 0 = not present or 1 = present. Body condition scoring (BCS) was measured on a scale from 0 to 5, for example, 0, 0.5, 1, 1.5, 2, etc. (Carroll & Huntington, 1988; Wright *et al.*, 1998). Apart from lameness assessment, which was conducted outside, all AB measures were conducted with horses loose in the boxes or haltered in tie-up stalls. The horses were only haltered and held by personnel if they were aggressive or showed avoidance. RH and T were recorded using a RHT meter (Geo Fennel model FHT100) outside before entering the stable and inside before the horses were taken out.

All RB measures in the OP (e.g. housing size) were assessed in the stable before the horses were brought in from the paddock. Where there was group housing other horses could be present during assessment. The OP includes answer options regarding compliance with each control point: yes, no, not assessed or not applicable.

All measures of size in both protocols (trough heights, box lengths, widths etc.) were recorded with a laser distance meter (Leico Disto, model D2).

Table 9. *Additional measures incorporated in the draft horse welfare assessment protocol (HWAP) (Viksten et al., accepted) presented in the order they were assessed along with the scoring and definition.*

Measure	Score	Description
Measured whilst horses were feeding in the morning		
Undesirable behaviour	0 = Calm; no aggression or undesirable behaviours 1 = One or a few horses displaying undesirable behaviour or aggression 2 = Several horses displaying aggression or undesirable behaviour	Direct observation of interactions between horses whilst feeding. Stereotypies excluded.
Measures assessed in group housing, boxes or tie-up stalls whilst the horses were eating in the morning.		
Back palpation	0 = No soreness or pain 1 = Horse reacts by avoidance or aggression and tension of back muscles	Manual palpation from withers to the SI-joint.
Mouth health	0 = No injuries 1 = Depigmentation OR chafing 2 = Depigmentation AND chafing OR open wounds	Observation of lower part of mouth and corners of mouth by folding it out with thumbs.
Undisturbed feeding	0 = Possibility to eat without visual contact or threat from other horses 1 = No possibility to eat without visual contact or threat from other horses	Observation of each horse whilst feeding on roughage.
Behaviour towards assessor	0 = Positive; interested with ears forward, may include sniffing or moving towards assessor with body or head 1 = Neutral; not interested in assessor, no movement 2 = Aggression or avoidance; threatening with ears pinned back, visual threat, kicks or avoidance	Horse assessed during the approach and touching involved in physical measures.
Measures assessed with horses present in the paddocks		
No of drinkers	Horses per drinker	Horses per available water drinker in paddock.
Assessed throughout the day		
Risk of injuries	Note of items causing risk of injury	Direct observation of whole stable and paddock.

3.3.2 Comparing protocols

The criteria and principles of good welfare applied in the WQ® approach (Blokhuis *et al.*, 2010a) were used to group the measures in each protocol to allow comparison of the coverage of different welfare domains, relative differences in detection of welfare issues and risk factors (i.e. number of stables where a welfare issue was present) and the numbers of measures from each

category (AB, RB and MB) were included in the different domains. The title of the 8th WQ® criterion was, in accordance with Visser *et al.* (2014), altered from "Absence of pain induced by management procedures" to "Absence of discomfort caused by use" since the original name refers to procedures like dehorning of cattle or beak trimming in chickens which are irrelevant in horses. The time needed to complete an assessment with each protocol was also recorded.

3.3.3 Data analysis

The results of assessments were entered into Microsoft Office Excel 2010 spreadsheets. Since the scoring scales differed between protocols, all results for each measure were converted to an average for the stable and then to "welfare issue present' ("mean score > 0" in the HWAP and "non-compliance" in the OP) or 'no welfare issue' ("mean score = 0" in the HWAP and "compliance" in the OP). Body condition was scored as 'present issue' if any horses in the stable had a BCS that deviated from 3. Visual horizon (the horse's ability to see out over the border of its own stable, i.e. to see and interact with other horses in the stable or yard) was scored as "present issue" if any horse in the stable lacked visual horizon (i.e. 0 sides of the housing), indicating that there was at least one horse that had no ability to interact with its surroundings.

3.4 Study III

The aim of Study III was to use a questionnaire to investigate the motivational factors behind horse owners' decision making on horse welfare, to find out where they gather information on horse welfare and to ask them how they would like to receive feedback from horse welfare assessments.

3.4.1 Questionnaire

A Swedish questionnaire with 17 questions (translation in Table 18) was distributed online to horse owners (owning or being responsible for one or more horses). The questions, most of which were multiple choice with more than one response possible, concerned experience in horse management, information sources, motivational factors for decision making and preferences regarding feedback of results from a systematic horse welfare assessment (Table 18). The owners accessed the questionnaire via the websites Hippson (www.hippson.se), Hästsverige (www.hastsverige.se) and social media such as Facebook and Twitter. The questionnaire was designed and completed in Netigate (www.netigate.com) whose software was also used to compile results into tables

and figures displaying the percentage response rates for each question (sometimes several responses possible for one question). All answers were presented along with the number of respondents for each question.

3.4.2 The database

According to results from the questionnaires in Study III and questionnaires sent to participating stables in Study II and IV, there was a need to compare results and see them in a clearer way than in the computer files provided in the feedback. Therefore a database was created where horse owners will be able to log on and see the results from horse welfare assessments presented on individual and group level. Results can also be displayed in tables and are provided with explanations of the measure used. The results can be compared to golden standards and results of other stables (all anonymous to each other). The beta-version of the database can be accessed at www.horsewelfare.se, for more information please contact the author of this thesis.

3.5 Study IV

The aim of Study IV was to determine whether two different types of feedback had any effect on actual horse welfare by assessing and re-assessing a group of stables.

3.5.1 Stables, horses and assessments

Twenty-one stables out of the 26 in Study II were used (three livery yards and 18 riding schools) with a total of 365 horses (ages 5-6 years; 251 geldings, 110 mares, 4 stallions) from various housing conditions (22 horses kept in group loose housing, 283 single box, 60 single tie-up stall). Stable managers had varying educational backgrounds and experience.

The stables had been assessed previously in Study II (Viksten *et al.* (2016)) and were re-assessed here using the same HWAP protocol. The stables were divided into two groups by first pairing up those of approximately the same type (e.g. riding school) and number of horses. The stables in each pair were then allocated randomly to one of two groups of 11 and 10 stables, respectively. Stable managers in the respective groups were provided with the assessment outcomes and one of two types of feedback within a month of assessment. The high feedback group (HF) received the results plus specific information and support regarding the outcomes, background information on the assessment measures and details of possible improvements whereas the low feedback group (LF) only received the assessment results (Table 10).

Table 10. *The content of the feedback that the two groups received after the first assessment.*

Group	**HF (10 stables)**	**LF (11 stables)**
Content of feedback	Information document with welfare background of assessment measures Microsoft Office Excel sheet (computer file and a paper copy) with results from assessments per individual horse, an average for each measure for the stable and the average value of all participating stables (anonymous) in the study (benchmark) Paper copies of completed HWAP scoring sheets for each horse Support telephone call regarding results and feedback just after receiving the data and again 3 weeks later Examples of specific solutions in relation to those measures where the average was below benchmark	Microsoft Office Excel sheet (computer file and a paper copy) with results from assessments per individual horse

The second assessment was conducted in the same way as the first. Horses that were assessed in only one of the two assessments, and measures where no welfare problems were observed during either assessment, were excluded from analysis. Similarly, measures such as housing or paddock size, ceiling height etc. were excluded since such resources did not change between assessments.

The stable managers' formal education was divided into three categories: none, basic and advanced (Table 16). Basic included: single courses on horse management (e.g. on feeding regimes), basic level courses for riding instructors (e.g. from the Swedish Equestrian Federation or Icelandic Horse Federation), and trainer education (level A-C or equivalent). Advanced level included university level education (BSc or MSc) in animal husbandry or other subjects associated with horse management.

3.5.2 Data management and statistics

All HWAP results (scores) were converted so that the scoring system for all measures used a 0-2 scale where 0 meant least negative impact on welfare (closest to ideal state) and 2 meant the most severe impact on welfare (farthest from ideal state). This meant that results from measures originally scored 0 or 1 were altered so that 0 remained 0 and score 1 was altered to 2. This was done to harmonize the scoring to a binary system of 0-2. The measure BCS, which was originally on a five point scale with half-points in between (Carroll & Huntington, 1988; Wright *et al.*, 1998) was altered so that 3 was scored as 0

(closest to ideal state), 2 and 4 were scored as 1, and 1 and 5 were scored as 2. Averages for each measure were calculated for every stable (all horses in the same stable). The score conversion also enabled the calculation of an average overall score for each stable (all measures included). These stable overall (SO) scores were analysed using a paired t-test (for normally distributed data) and a Wilcoxon signed rank test (for non-normally distributed data) to determine if significant changes had occurred between assessments. A Ryan-Joiner test was used to determine normality of the score distribution.

The averages of those measures which detected welfare problems (measures with an average above 0; i.e. occurrence of a welfare problem in the first assessment) were summed in each stable. These stable welfare issue (SWI) scores for the first and second assessment, as well as for the HF and LF groups, were then analysed using a paired t-test and a Wilcoxon signed rank test as per above.

All analyses were run at 5 % significance level using the computer statistics package Minitab® (version 16.1.0., Minitab Ltd. UK).

4 Summary of results

This chapter contains a summary of the main findings of the studies included in this thesis. For full details, see Papers I-IV.

4.1 Study I

The results show that 66 % (31/47) of the measures incorporated in the HWAP had over 85 % repeatability across two assessments carried out several days apart (Table 11 and marked measures in Table 12). The time needed to carry out the actual assessment was 10-15 minutes per horse for AB measures, and the subsequent inclusion of all RB and MB measures meant that a stable of up to 56 horses could be assessed in one working day (less than or equal to eight hours). The assessment caused little disturbance to management routines.

Significant differences (poor agreement in results) between the first and second assessment were seen in BCS, distance to adjacent feeding point, height of concentrate troughs (in Stable 2), cleanliness of drinkers, sum of RH and T, open fresh air inlets, lameness, paddock surface quality, mould, skin condition and equipment chafing (Table 12). The distributions of scores for measures scored on an ordinal scale were negatively skewed, i.e. one score was dominant in results, in either one or both assessments (score distribution in Table 12).

Table 11. *Measures with 100 % agreement between assessments that were considered reliable and excluded from analysis.*

Measure	**Score distribution or mean (± SD)**	
	Assessment 1	**Assessment 2**
Roughage height	Stable 1: 0.0 (±0.0) Stable 2: 0.0 (±0.0)	Stable 1: 0.0 (±0.0) Stable 2: 0.0 (±0.0)
Estimated time with roughage available	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Water available in stable	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0

Measure	Score distribution or mean (± SD)	
	Assessment 1	**Assessment 2**
Water available in paddock	Stable 1: 0 = 14 1 = 0 Stable 2: 0 = 21 1 = 0	Stable 1: 0 = 14 1 = 0 Stable 2: 0 = 21 1 = 0
Noise	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Thermal discomfort: sweating or shivering	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Paddock size	Stable 1: Horse 953 (± 257) Group 4671 (± 3277) Stable 2: Horse 227 (± 253) Group 849 (± 292)	Stable 1: Horse 953 (± 257) Group 4671 (± 3277) Stable 2: Horse 227 (± 253) Group 849 (± 292)
Time in paddock	Stable 1: 7.0 (± 0.0) Stable 2: 5.5 (± 1.7)	Stable 1: 7.0 (± 0.0) Stable 2: 5.5 (± 1.7)
Pasture access	Stable 1: 7.0 (± 0.0) Stable 2: 7.0 (± 0.0)	Stable 1: 7.0 (± 0.0) Stable 2: 7.0 (± 0.0)
Hoof condition	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Farrier intervals	Stable 1: 6-7 Stable 2: 6-7	Stable 1: 6-7 Stable 2: 6-7
Collisions or slipping when moving to and from paddock	Stable 1: 0 = 14 1 = 0 2 = 0 Stable 2: 0 = 21 1 = 0 2 = 0	Stable 1: 0 = 14 1 = 0 2 = 0 Stable 2: 0 = 21 1 = 0 2 = 0
Roughage fed without water	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0

Measure	Score distribution or mean (± SD)	
	Assessment 1	**Assessment 2**
Concentrates fed without roughage or before roughage	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Coughing	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Hampered breathing	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Nasal discharge	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 20 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 20 1 = 0
Condensation	Stable 1: 0 = 15 1 = 0 2 = 0 Stable 2: 0 = 22 1 = 0 2 = 0	Stable 1: 0 = 15 1 = 0 2 = 0 Stable 2: 0 = 22 1 = 0 2 = 0
Mane and tail	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0
Possibility of social contact	Stable 1: 0 = 15 1 = 0 2 = 0 Stable 2: 0 = 21 1 = 1 2 = 0	Stable 1: 0 = 15 1 = 0 2 = 0 Stable 2: 0 = 21 1 = 1 2 = 0

Measure	**Score distribution or mean (± SD)**	
	Assessment 1	**Assessment 2**
Horses per paddock	Stable 1: 5.6 (± 2.2) Stable 2: 4.0 (± 0.7)	Stable 1: 5.6 (± 2.2) Stable 2: 4.0 (± 0.7)
Occurrence of undesirable behaviours	Stable 1: 0 = 13 1 = 2 Stable 2: 0 = 19 1 = 1	Stable 1: 0 = 13 1 = 2 Stable 2: 0 = 19 1 = 1
Enrichments	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0
Visual horizon	Stable 1: 0 = 0 1 = 7 2 = 8 3 = 14 4 = 12 Stable 2: 0 = 0 1 = 7 2 = 8 3 = 14 4 = 12	Stable 1: 0 = 0 1 = 7 2 = 8 3 = 14 4 = 12 Stable 2: 0 = 0 1 = 7 2 = 8 3 = 14 4 = 12

Table 12. *Comparison of results between assessments (within individual horses). Measures derived from the stable management (i.e. not measured by assessor) are marked*. Measures where Kendall's tau could not be calculated due to skewed scoring or lack of some scores are marked **. Means are presented with standard deviation (SD) within brackets where applicable along with coefficient of variance (CV). N/a for kappa means identical scores between assessments. Measures that were considered reliable (over 85 % percentage agreement and or high kappa agreement) are marked with ***.*

Measure	**Score distribution, mean (± SD)[CV]**		**% agreement between assessments**	**95%; CI**	**Cohen's kappa (SE)**	**Kappa agreement**	**Kendall's tau**	**Paired t-test**
	Assessment 1	**Assessment 2**						
BCS	Stable 1: 1 = 0 2 = 0 3 = 1 4 = 11 5 = 3 Stable 2: 1 = 0 2 = 0 3 = 18 4 = 2 5 = 0	Stable 1: 1 = 0 2 = 0 3 = 4 4 = 11 5 = 0 Stable 2: 1 = 0 2 = 1 3 = 18 4 = 1 5 = 0	76.5	58.8; 89.3	0.56 (0.14)	Moderate	0.9	n/a
Distance to adjacent feeding point***	Stable 1: 0 = 6 1 = 9 Stable 2: 0 = 11 1 = 11	Stable 1: 0 = 7 1 = 8 Stable 2: 0 = 12 1 = 10	83.3	67.2; 93.6	0.67 (0.17)	Substantial	n/a	n/a
Height of concentrate trough	Stable 1: 0.6 (± 0.1) Stable 2: 0.9 (± 0.0) Both stables: 0.8 (± 0.2) [19.9 %]	Stable 1: 0.6 (± 0.2) Stable 2: 0.9 (± 0.0) Both stables: 0.8 (± 0.2) [20.2 %]	n/a	n/a	n/a	n/a	n/a	Stable 1: P > 0.05 Stable 2: P < 0.01
Height of drinker in stable	Stable 1: 0.7 (± 0.2) Stable 2: 1.1 (± 0.1) Both stables: 0.9 (± 0.2) [26.0 %]	Stable 1: 0.7 (± 0.2) Stable 2: 1.1 (± 0.0) Both stables: 0.9 (± 0.2) [21.9 %]	n/a	n/a	n/a	n/a	n/a	Stable 1: P > 0.05 Stable 2: P > 0.05

Measure	Score distribution, mean (± SD)[CV]		% agreement between assessments	95%; CI	Cohen's kappa (SE)	Kappa agreement	Kendall's tau	Paired t-test
	Assessment 1	Assessment 2						
Drinker function stable (automatic only)***	Stable 1: 0 = 10 1 = 0 Stable 2: 0 = 21 1 = 1	Stable 1: 0 = 15 1 = 0 Stable 2: 0 = 22 1 = 0	96.6	82.2; 99.9	n/a	n/a	n/a	n/a
Drinker flow (automatic only)***	Stable 1: 0 = 10 1 = 0 Stable 2: 0 = 22 1 = 0	Stable 1: 0 = 10 1 = 0 Stable 2: 0 = 22 1 = 0	96.6	82.2; 99.9	n/a	n/a	n/a	n/a
Cleanliness of drinker in stable	Stable 1: 0 = 3 1 = 12 2 = 0 Stable 2: 0 = 1 1 = 19 2 = 2	Stable 1: 0 = 1 1 = 9 2 = 5 Stable 2: 0 = 6 1 = 15 2 = 1	58.3	40.8; 74.5	0.05 (0.11)	Slight	0.44	n/a
Cleanliness of drinker in paddock	Stable 1: 0 = 1 1 = 13 2 = 0 Stable 2: 0 = 0 1 = 7 2 = 14	Stable 1: 0 = 0 1 = 0 2 = 14 Stable 2: 0 = 0 1 = 0 2 = 21	41.2	24.7; 59.3	0 (0)	Less than chance	0.5	n/a
Housing size	Stable 1: 6.3 (± 2.1) Stable 2: 7.3 (± 1.6) Both stables: 7.4 (± 2.0) [27.2 %]	Stable 1: 7.0 (± 2.3) Stable 2: 7.4 (± 1.6) Both stables: 7.8 (± 2.0) [27.2 %]	n/a	n/a	n/a	n/a	n/a	Stable 1: P > 0.05 Stable 2: P > 0.05

Measure	Score distribution, mean (± SD)[CV]		% agreement between assessments	95%; CI	Cohen's kappa (SE)	Kappa agreement	Kendall's tau	Paired t-test
	Assessment 1	Assessment 2						
Sum of RH and T in stable	Stable 1: 0 = 0 1 = 15 Stable 2: 0 = 0 1 = 22	Stable 1: 0 = 3 1 = 12 Stable 2: 0 = 22 1 = 0	58.3	40.8; 74.5	n/a	n/a	n/a	n/a
Fresh air inlet	Stable 1: 0 = 0 1 = 0 2 = 15 Stable 2: 0 = 1 1 = 21 2 = 0	Stable 1: 0 = 0 1 = 0 2 = 15 Stable 2: 0 = 1 1 = 10 2 = 11	69.4	51.9; 83.7	0.4 (0.15)	Fair	0.79	n/a
Time in training	Stable 1: 11.7 (± 7.9) Stable 2: 14.8 (± 4.1)	Stable 1: 10.8 (± 5.3) Stable 2: 14.8 (± 4.1)	n/a	n/a	n/a	n/a	n/a	*
Housing type***	Stable 1: 0 = 0 1 = 4 2 = 11 Stable 2: 0 = 0 1 = 12 2 = 10	Stable 1: 0 = 0 1 = 6 2 = 9 Stable 2: 0 = 0 1 = 13 2 = 9	86.1	70.5; 95.3	0.72 (0.16)	Substantial	**	n/a
Ceiling height	Stable 1: 2.9 (± 0.1) Stable 2: 6.3 (± 1.8) Both stables: 5.0 (± 2.2) [44.2 %]	Stable 1: 2.9 (± 0.1) Stable 2: 6.1 (± 1.8) Both stables: 4.9 (± 2.2) [44.3 %]	n/a	n/a	n/a	n/a	n/a	Stable 1: P > 0.05 Stable 2: P > 0.05

Measure	Score distribution, mean (± SD)[CV]		% agreement between assessments	95%; CI	Cohen's kappa (SE)	Kappa agreement	Kendall's tau	Paired t-test
	Assessment 1	Assessment 2						
Lameness	Stable 1: 0 = 10 1 = 5 2 = 0 Stable 2: 0 = 18 1 = 3 2 = 0	Stable 1: 0 = 13 1 = 2 2 = 0 Stable 2: 0 = 20 1 = 2 2 = 0	78.1	60.0; 90.7	0.11 (0.16)	Slight	**	n/a
Wounds***	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 16 1 = 6 2 = 0	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 17 1 = 5 2 = 0	91.4	76.9; 98.2	0.17 (4.0)	Slight	**	n/a
Paddock surface	Stable 1: 0 = 0 1 = 9 2 = 5 Stable 2: 0 = 19 1 = 0 2 = 2	Stable 1: 0 = 0 1 = 0 2 = 14 Stable 2: 0 = 21 1 = 0 2 = 0	67.7	49.5; 82.6	0.46 (0.11)	Moderate	0.89	n/a
Ocular discharge***	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 19 1 = 0 2 = 1	Stable 1: 0 = 12 1 = 2 2 = 0 Stable 2: 0 = 18 1 = 2 2 = 0	88.9	73.9; 96.9	0.29 (0.12)	Fair	0.64	n/a

Measure	Score distribution, mean (± SD)[CV]		% agreement between assessments	95%; CI	Cohen's kappa (SE)	Kappa agreement	Kendall's tau	Paired t-test
	Assessment 1	Assessment 2						
Mould	Stable 1: 0 = 11 1 = 4 2 = 0 Stable 2: 0 = 12 1 = 10 2 = 0	Stable 1: 0 = 12 1 = 4 2 = 4 Stable 2: 0 = 10 1 = 12 2 = 0	75	57.8; 87.9	0.54 (0.14)	Moderate	0.8	n/a
Skin condition	Stable 1: 0 = 14 1 = 1 Stable 2: 0 = 13 1 = 7	Stable 1: 0 = 13 1 = 2 Stable 2: 0 = 14 1 = 6	69.7	51.3; 84.4	0.18 (0.17)	Slight	**	n/a
Coat condition***	Stable 1: 0 = 15 1 = 0 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0	97.1	84.7;99.9	0 (0)	Slight	**	n/a
Equipment chafing	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0	Stable 1: 0 = 14 1 = 1 2 = 0 Stable 2: 0 = 20 1 = 0 2 = 0	79.4	62.1; 91.3	-0.1 (0.15)	Slight	0.44	n/a
Rug cleanliness***	Stable 1: 0 = 12 1 = 0 Stable 2: 0 = 21 1 = 0	Stable 1: 0 = 10 1 = 2 Stable 2: 0 = 21 1 = 0	93.8	79.2; 99.2	0 (0)	Slight	**	n/a

4.2 Study II

The protocols differed regarding the mix of measures: the HWAP contained 20 AB (35.7 %), 28 RB (50.0 %) and 8 MB (14.3 %) measures whereas the OP had 4 AB (8.9 %), 21 RB (46.7 %) and 16 MB (35.6 %) measures as well as 4 measures (8.9 %) that did not fall under either category (Table 13).

The sampling methods also differed: the HWAP examined each animal individually and measured all resources whereas the OP used a random sample of animals or resources or identified non-compliances based on a screening of the animals at group level or a general overview of resources.

Table 13. *Measures included in both the Official Protocol (OP) and the Horse Welfare Assessment Protocol (HWAP). Protocol structures in terms of mix of animal- (AB), resource- (RB) and management-based (MB) measures and total number of measures per welfare criterion are structured according to the principles and criteria used in the Welfare Quality® approach.*

		HWAP 56 measures in total			**OP** 45 measures in total		
Welfare Principles	**Welfare Criteria**	**AB** 20 (35.7 %)	**RB** 28 (50.0 %)	**MB** 8 (14.3 %)	**AB** 4 (8.9 %)	**RB** 21 (46.7 %)	**MB** 16 (35.6 %)
Good feeding	Absence of prolonged hunger	BCS	Amount of feed (roughage and concentrates) Access to pasture Height of feed Cleanliness of trough Undisturbed feeding	Estimated time with available roughage	BCS	Ability to eat naturally	Feeding regimes
		Total 7 measures			Total 3 measures		
	Absence of prolonged thirst		Water availability in stable and paddock Drinker flow Drinker function No of drinkers Type of drinker Water height Water cleanliness			Ability to drink naturally Water availability and quality	Daily inspection of function of automatic systems
		Total 7 measures			Total 3 measures		
Good housing	Comfort around resting	Chafing or wounds on hocks and protruding joints	Size of stall/box Noise level		Cleanliness of horses	Housing is of adequate size Noise levels acceptable Bedding quality and use	
		Total 3 measures			Total 4 measures		

		HWAP 56 measures in total			**OP** 45 measures in total		
Welfare Principles	**Welfare Criteria**	**AB** 20 (35.7 %)	**RB** 28 (50.0 %)	**MB** 8 (14.3 %)	**AB** 4 (8.9 %)	**RB** 21 (46.7 %)	**MB** 16 (35.6 %)
	Thermal comfort	Signs of thermal discomfort	Ventilation (RH and T) Fresh air inlet Shelter			Housing for all horses during cold season Air quality and climate Emergency ventilation Outdoor kept horses	
		Total 4 measures			Total 4 measures		
	Ease of movement		Housing type Ceiling height Paddock size	Time in training per day/week Time in paddock per day/week Yearly pasture/rest		Tie-up of horses Ceiling height Paddock quality (size)	Time spent in paddock Housing for breeding and foaling
		Total 6 measures			Total 5 measures		
Good health	Absence of injuries	Lameness Hoof condition Wounds Bumping into things or slipping when moving to paddock	Paddock surface Risk of injuries in housing/paddock	Farrier intervals	Hoof care routines	Housing design causes no risk of injury Housing floor surface Sufficient lighting in housing Paddock quality (surface)	Daily inspection by owner Harmful objects kept away from horses Procedures in case of fire and electrical failure
		Total 7 measures			Total 5 measures		

		HWAP 56 measures in total			OP 45 measures in total		
Welfare Principles	**Welfare Criteria**	**AB** 20 (35.7 %)	**RB** 28 (50.0 %)	**MB** 8 (14.3 %)	**AB** 4 (8.9 %)	**RB** 21 (46.7 %)	**MB** 16 (35.6 %)
	Absence of disease	Coughing Hampered breathing Ocular and Nasal discharge Skin and coat condition Mane and tail condition	Mould in stable Condensation	Roughage fed without water Order of feed types		Daylight inlets in housing Cleanliness of housing Cleanliness of bedding	Sick/injured horses are given adequate care Documentation of veterinary treatments Extra inspection of horses in need of it by owner Use of hormones Operations by veterinarian
		Total 11 measures			Total 8 measures		
	Absence of discomfort caused by use	Mouth health Equipment chafing Back palpation	Rug cleanliness			Equipment	No use of electrical equipment Breeding and foaling
		Total 4 measures			Total 3 measures		
Appropriate behaviour	Expression of social behaviour		Possibility for social interaction	Group size in paddock	Need for social contact fulfilled		
		Total 2 measures			Total 1 measure		
	Expression of other behaviours	Stereotypy Undesirable behaviour	Enrichments				Weaning routines
		Total 3 measures			Total 1 measure		
	Good human-animal relationship	Behaviour towards assessor					Suitability of staff
		Total 1 measure			Total 1 measure		

		HWAP 56 measures in total			OP 45 measures in total		
Welfare Principles	**Welfare Criteria**	**AB** 20 (35.7 %)	**RB** 28 (50.0 %)	**MB** 8 (14.3 %)	**AB** 4 (8.9 %)	**RB** 21 (46.7 %)	**MB** 16 (35.6 %)
	Positive emotional state		Possibilities for visual horizon				
		Total 1 measure			Total 0 measures		
					Other (4 measures, 8.9 %): ID papers, Horses kept for other intention than use as food, Valid permit and Other observed welfare issues		

Table 14. *Numbers of stables where welfare issues were detected in each protocol at measure and at criterion level. Measures with no detected issues by either protocol were excluded.*
** = measures absent from the protocol.*

Welfare Principles	**Welfare Criteria**	**Measure**		**Number of stables with welfare issues per measure**			**Number of stables with welfare issues per criterion**		
		HWAP	**OP**	**HWAP**	**Both protocols**	**OP**	**HWAP**	**Both protocols**	**OP**
Good feeding	Absence of prolonged hunger	BCS ≠ 3	BCS ≠ 3	26	22	22	26	22	22
		Feeding trough cleanliness	*	17	-	-			
		Undisturbed feeding	*	8	-	-			
		Time with available roughage	*	3	-	-			
		Feed without water	*	3	-	-			
		*	Ability to eat naturally	-	-	0			
	Absence of prolonged thirst	Water availability	*	3	-	-	18	2	2
		Drinker function	Automatic systems	7	2	2			
		Cleanliness of water and drinker	Water hygiene and quality	18	0	0			
		*	Ability to drink naturally	-	-	0			
Good housing	Comfort around resting	Bedding	Bedding	2	1	3	3	3	5
		Housing size	Housing size	1	1	5			
		*	Cleanliness of horses	-	-	1			
		Noise	Noise	3	3	3			
	Thermal comfort	*	All horses have a space in housing	-	-	0	15	4	5
		Ventilation	Ventilation	4	1	5			
		Fresh air inlets	Fresh air inlets	15	4	4			
		*	Fencing condition	*	-	1			

Welfare Principles	Welfare Criteria	Measure		Number of stables with welfare issues per measure			Number of stables with welfare issues per criterion		
		HWAP	OP	HWAP	Both protocols	OP	HWAP	Both protocols	OP
	Ease of movement	Paddock surface quality	Paddock surface quality	10	0	0	10	1	9
		Risk of injury in paddock and housing	Interior of housing	2	1	9			
Good health	Absence of injuries	Wounds	Wounds	10	0	0	10	0	0
		*	Chemical storage	-	-	0			
		Lameness	Lameness	3	0	0			
		Hoof condition	Hoof condition	1	0	0			
		Bumping into things or slipping between stable and paddock	*	2	-	-			
		Mould	Mould	7	1	1			
	Absence of disease	Condensation	Condensation	6	2	3	22	2	3
		Mane and tail condition	Mane and tail condition	3	0	0			
		Coat quality	Coat quality	13	0	1			
		Skin condition	*	21	-	-			
		Ocular discharge	*	22	-	-			
		Order of feed types	*	2	-	-			
		Cough	Cough	2	0	0			
	Absence of discomfort caused by use	Mouth health	*	23	-	-	23	1	1
		Equipment chafing	Equipment chafing	19	1	1			
		Back palpation	*	10	-	-			
		Rug cleanliness	Rug cleanliness	3	0	0			

Welfare Principles	Welfare Criteria	Measure		Number of stables with welfare issues per measure			Number of stables with welfare issues per criterion		
		HWAP	OP	HWAP	Both protocols	OP	HWAP	Both protocols	OP
Appropriate behaviour	Expression of social behaviour	Social contact	Social contact	5	0	0	5	0	0
	Expression of other behaviour	Stereotypy	*	8	-	-	19	-	1
		Undesirable behaviour	*	6	-	-			
		Enrichment	*	19	-	-			
		*	Weaning routines	-	-	1			
	Good human-animal relationship	Behaviour towards assessor	*	21	-	-	21	-	*
	Positive emotional state	Visual horizon	*	3	-	-	3	-	*

The protocols included 21 measures that were considered similar enough by the assessor (e.g. lameness and water quality) to be directly comparable (Table 13) despite differences in assessment methodology. Detection of existing welfare issues differed between protocols; the HWAP identified more stables with welfare issues than the OP in 11 of the 12 welfare criteria and in 19 of the 21 common measures (Table 14). For some welfare measures (e.g. interior of housing, risk of injury, condensation and coat quality) the protocols identified different numbers of welfare issues (columns five and seven in Table 14) as well as different stables where welfare issues were detected (column six in Table 14). Depending on the stable the HWAP took between 3 h 20 min and 8 h 40 min to complete; this included 5-15 min per horse for AB measures, 1-2 h per stable for RB measures and around 1 h for interviewing the stable manager regarding routines. The OP took between 2 and 4 h including 10-15 min for checking documents (passports, etc.).

Four horses that showed aggressive behaviour (tried to kick or bite the assessor) were excluded from the study for safety reasons. Two horses had to be haltered by personnel during the physical assessment (one showed avoidance and the other was slightly aggressive). In 15 of the 26 stables (57.7 %) the lameness assessment was fully or partially excluded due to weather conditions and/or lack of personnel. Thus 362 of the 497 horses (68.8 %) were excluded from the lameness assessment.

4.3 Study III

The online questionnaire (Table 15) was answered by 625 horse owners of which 76 % (476/625) were recreational riders and 24 % (149/625) were professionals (working full-time with horses). Both groups had between 1-55 years experience and 92 % (575/625) were responsible for less than ten horses (professionals were responsible for 1-50 horses and recreational horse owners for 1-30 horses). Main uses of the horses (several responses possible) were all-round riding (a mix of show jumping, hacking and dressage) 61 % (359/588), dressage 45 % (265/588) and show jumping for 36 % (211/588) of respondents.

Table 15. *Questions and responses presented with the distribution of responses and percentage of responses for each question. In questions where the respondent could choose several options, the number of responses will exceed the number of respondents.*

Question and number of responses and respondents	**Answer (number of respondents indicating an option)**									
How many horses do you keep?	< 10	> 10								
625 respondents	575 (92.0%)	50 (8.0%)								
What sort of horse experience do you have?	Working on professional level, educated at least 2 years at university level.	Working on professional level, other formal education on horses.	Working on professional level, no formal education.	Recreational rider/driver with own responsibility over one or more horses.	Other horse background					
625 respondents	9 (1.4%)	88 (14.1%)	52 (8.3%)	318 (50.9%)	158 (25.3%)					
Professional	149 (23.8%)									
Recreational				476 (76.2%)						
How many years experience do you have?	Professionals 1 – 55			Recreational and others 1-55						
Which main area of usage applies to your horses? (choose one or more options)	Dressage	Eventing	Driving	Allround riding (mixed usage)	Show jumping	Riding school	Endurance	Working equitation	Academic riding	Western riding
588 respondents (1224 responses)	265 (45.1%)	44 (7.5%)	101 (17.2%)	359 (61.1%)	211 (35.9%)	25 (4.3%)	16 (2.7%)	27 (45.9%)	65 (11.1%)	49 (8.3%)
Did you previously have questions regarding horse welfare in your current stable within any of these areas? (choose one or more options)	Housing	Size of paddocks (enclosure)	Feeding regimes	Horse behaviour	Horse health	Horse equipment	Education for horse owners			
560 respondents (1942 responses)	322 (57.5%)	305 (54.5%)	347 (62.0%)	232 (41.4%)	255 (45.5%)	234 (41.8%)	158 (28.2%)			

Question and number of responses and respondents	**Answer (number of respondents indicating an option)**								
Indicate how various factors affect your decision making around the horses. Rank those using score 1-7 where 1 is most important.	Score	Economy	Horse health	Behavioural issues of the horse	Performance of the horse	Your own health and energy	External support for changes (federation etc.)	Injunction from official controls	
931 responses	1	140 (28.1%)	421 (83.2%)	355 (71.3%)	155 (30.9%)	125 (24.8%)	76 (15.4%)	136 (27.3%)	
	2	89 (17.7%)	41 (8.1%)	61 (12.2%)	96 (19.1%)	109 (21.6%)	76 (15.4%)	85 (17.1%)	
	3	99 (19.9%)	9 (1.8%)	28 (5.6%)	120 (23.9%)	113 (22.4%)	116 (23.5%)	81 (16.3%)	
	4	83 (16.7%)	3 (0.6%)	13 (2.6%)	68 (13.5%)	68 (13.5%)	91 (18.5%)	80 (16.1%)	
	5	48 (9.6%)	2 (0.4%)	6 (1.2%)	30 (6.0%)	46 (9.1%)	45 (9.1%)	32 (6.4%)	
	6	17 (3.4%)	5 (1.0%)	6 (1.2%)	17 (3.4%)	29 (5.8%)	44 (8.9%)	38 (7.6%)	
	7	22 (4.4%)	25 (4.9%)	29 (5.8%)	16 (3.2%)	14 (2.8%)	45 (9.1%)	47 (9.4%)	
	Average	2.9	1.5	1.77	2.68	2.89	3.54	3.18	
Where do you gather information and support for changes in your horse management today? (choose one or more options)	Discussion with other horse enthusiasts	On the Swedish Board of Agriculture's website	My own personal opinions	From the federation or a horse club	Consultant	Popular scientific horse magazines	Internet	Internet forums	Other
480 respondents (1753 responses)	389 (81.0%)	298 (62.1%)	303 (63.1%)	112 (23.3%)	16 (3.3%)	171 (35.6%)	191 (39.8%)	82 (17.1%)	75 (15.6%)
Which areas of horse welfare are you most interested in? (choose one or more options)	Housing	Horse behaviour	Horse health						
479 respondents (957 responses)	196 (40.9%)	313 (65.3%)	390 (81.4%)						
How would you like to receive results from a horse welfare assessment?	Computer file	Paper format	Other						
445 respondents	339 (76.2%)	83 (18.7%)	23 (5.1%)						
Would you appreciate background information for all measures used in assessments?	Yes	No							
451	436 (96.7%)	15 (3.3%)							
Would you like to see results for:	Each individual horse	Average for all horses in the stable	Both						
450 respondents	78 (17.3%)	28 (6.2%)	344 (76.4%)						

Question and number of responses and respondents	Answer (number of respondents indicating an option)			
Would you like a benchmark to enable comparison with other stables?	Yes	No		
448 respondents	406 (90.6%)	42 (9.4%)		
Would you like the feedback to contain (choose one or more options):	Good and bad general examples	Proposed improvements for your stable	Solely references to research	
439 respondents (743 responses)	206 (46.9%)	366 (83.4%)	126 (28.7%)	
Would you like a follow up feedback after receiving the results?	No	Yes, over the phone	Yes, with a visit from the assessor	
436	121 (27.8%)	129 (29.6%)	186 (42.7%)	
Would you like extensive information and advice on how to improve specific results?	Yes , but only in ”worst” areas	Yes, within all areas	No	
434	77 (17.7%)	282 (65.0%)	76 (17.5%)	
How important is it for you to discuss ideas with other horse entrepreneurs?	Not important	A little important	Important	Very important
432	9 (2.1%)	45 (10.4%)	195 (45.1%)	183 (42.4%)
Do you have such discussions today?	Yes	No		
433	394 (91.0%)	39 (9.0%)		

The main welfare areas where horse owners previously had questions were feeding regimes (347/560 respondents; 62.0 %), housing (322/560; 57.5 %), the size of paddocks (305/560; 54.5 %) and horse health (390/479; 81.4 %). The most important factors influencing decision making relating to the horses' management and care were horse health and behavioural issues (Figure 3). The least influential motivating factor was external support (e.g. advice, financial help) for changes (e.g. from a federation).

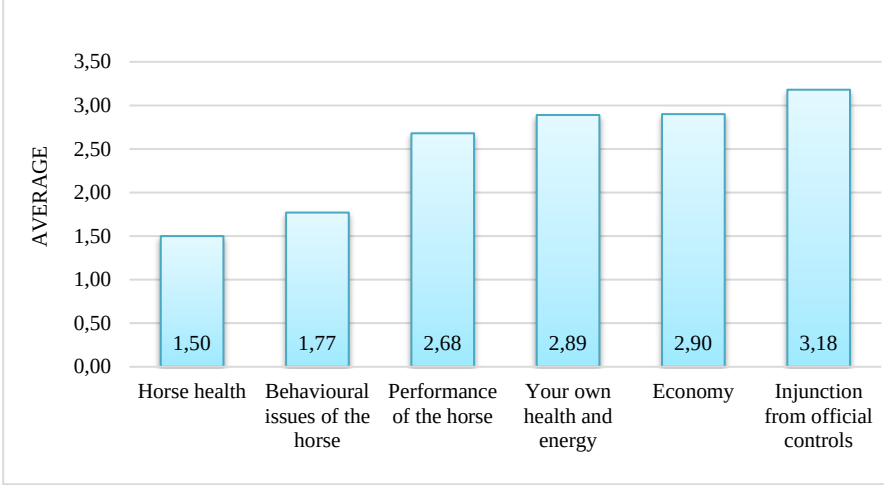

Figure 3. Motivating factors behind decision making for horse owners presented as an average of the scores each factor received in the question where factors were ranked from 1-7 (1 being the most important factor).

Sources of information that were used as a basis for alterations in management are depicted in Figure 4. Eighty seven percent (378/432) of respondents stated it was "important" or "very important" to discuss ideas with other horse owners and 91 % (394/432) were currently doing this.

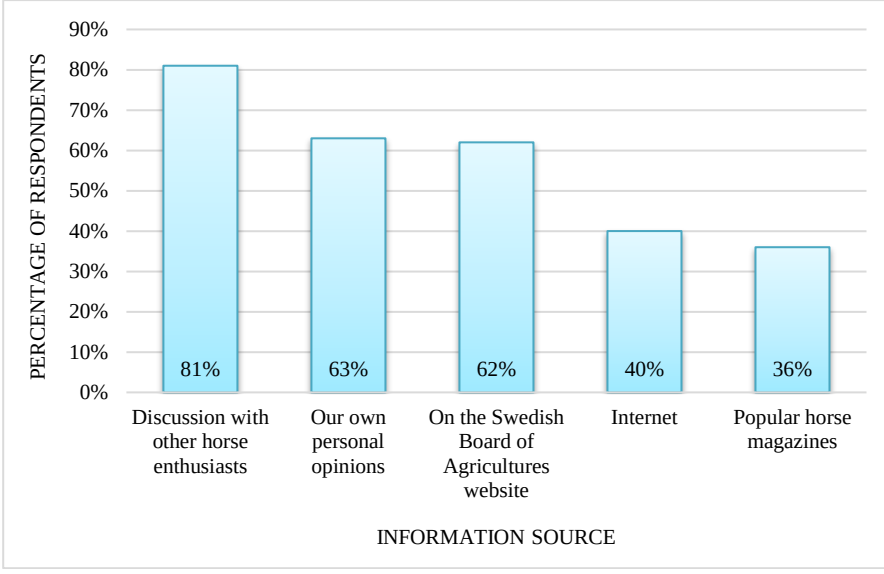

Figure 4. Information sources for support in decision making around horse management. Presented as percentage of 480 respondents (several response options possible).

When asked about the form of feedback 76 % (339/445) of horse owners indicated that they wanted the results of assessments on computer file, 97 % (436/451) said, it should contain background information on all measures used in the assessment and 77 % (344/450) wanted results for individual horses as well as on group level.

Ninety one percent (406/448) of horse owners wanted a benchmark or average score so that they could compare their results to that of other horse owners, 83 % (366/439) wanted improvement suggestions specifically targeted at their stable and 47 % (206/439) wanted the feedback to contain good and bad examples as comparators. Forty three percent (186/436) of horse owners would like the assessor to revisit as part of a follow up whilst 29 % (129/436) preferred a phone call and 28 % (121/436) declined any post-assessment follow up.

4.4 Study IV

Eighty four of the 449 horses used in the first assessment did not participate in the second assessment because they were no longer available (ill, dead, re-homed, sold etc.). This yielded a study total of 365 horses.

Analyses of stable overall (SO) scores showed no significant differences. On the other hand, significant differences in individual measures between

assessments were found in both feedback groups; (6 in the high feedback (HF) group, 5 in the low feedback (LF) group); four of these measures coincided in both groups (Table 17). The HF group showed significant improvement in water trough cleanliness, equipment chafing and number of open fresh air inlets but also significant deterioration in water drinker function, ocular discharge and the sum of RH and T. The LF group improved significantly in feeding- and water trough cleanliness and in equipment chafing but deteriorated significantly in mane and tail condition and in the sum of RH and T.

The stable welfare issue (SWI) scores were significantly improved between assessments in both the HF and the LF group. There were significant decreases between assessments in SWI median scores for both the HF (10 stables, $W = 5.0$, $P = 0.025$) and the LF (11 stables, $W = 0.0$, $P = 0.004$) groups. Eight stables improved (SWI average closer to 0) and 2 deteriorated (average further from 0) in the HF group whereas all LF stables improved (Table 16).

Table 16. *Increases and decreases in welfare scores between assessments presented as number of measures per stable and group. Stable managers' education and years of experience of keeping and working with horses are also shown. Trend in welfare measures indicates if the stable had more measures of improved (+) or deteriorated welfare (-).*

Group	Stable number	Stable managers education and years of experience	SWI score		Significant changes between assessments	Measures indicating improved welfare at 2nd assessment	Measures indicating deteriorated welfare at 2nd assessment	Trend in welfare measures
			First assessment	Second assessment				
HF	7	Basic, 25 years	7.1	6.5		6	11	-
	9	Basic, 20 years	3.4	3.9		2	6	-
	10	None, 15 years	4.4	2.5		3	4	-
	11	Basic, 30 years	16.9	10.3		12	3	+
	14	Basic, 20 years	10.4	6.8		10	7	+
	16	Basic, 30 years	12.5	9.7		12	3	+
	22	Basic, 30 years	15.1	11.7		11	5	+
	23	Advanced, 40 years	11.8	12.8		5	10	-
	24	Basic, 30 years	8.4	5.3		7	3	+
	26	Basic, unknown	3.2	2.6		3	11	-
	Sum of group		93.3	72.0	$P < 0.05$	71	63	
LF	1	Basic, 30 years	16.0	11.5		14	5	+
	6	Basic, 20 years	5.6	4.8		3	4	-
	12	Basic, 31 years	6.3	3.2		9	7	+
	13	Advanced, 7 years	11.3	9.0		6	4	+
	15	Advanced, 20 years	4.5	4.0		3	1	+
	17	None, 40 years	10.9	10.7		5	10	-
	18	None, 20 years	11.7	11.5		11	10	+
	19	Advanced, 15 years	13.2	7.9		10	3	+
	20	Unknown	17.7	14.6		5	7	-
	21	Basic, 20 years	10.0	9.4		6	8	-
	25	None, 30 years	6.0	4.8		5	3	+
	Sum of group		113.3	91.3	$P < 0.05$	65	62	

There were also several non-significant changes in individual measures suggesting both improved and deteriorated welfare; five (50 %) stables improved and five (50 %) deteriorated in HF whilst seven (64 %) improved and four (36 %) deteriorated in LF (Table 20). For some measures more SO scores improved than deteriorated (e.g. water cleanliness, mouth health and equipment chafing): 17 (60.7 %) in the HF group and 16 (57 %) in the LF group. However, for other measures (e.g. BCS and ocular discharge) more stables deteriorated than improved; 10 (35.7 %) in HF and 9 (32 %) in LF, respectively.

Table 17. *Differences per measure between assessments in the high feedback (HF) and low feedback (LF) group presented as the change in welfare issues (number of stables with issues in assessment one - number of stables with issues in assessment two). * = measures that differed significantly (P < 0.05) between assessments.*

Measures	**Difference between assessments (change in number of stables)**	
	HF	**LF**
BCS	- 5	- 3
Concentrates trough cleanliness	5	8*
Undisturbed feeding	- 1	2
Estimated time with available roughage	1	1
Drinker function	- 6	- 3
Water cleanliness	7*	5*
Noise	- 1	1
Sum of RH and T	- 5*	- 7*
Open fresh air inlet	4*	3
Lameness	1	0
Hoof condition	- 1	0
Wounds	1	- 2
Bumping into things or slipping when moving to paddock	0	- 1
Paddock surface quality	1	0
Coughing	1	0
Ocular discharge	- 8*	- 6
Nasal discharge	0	- 1
Skin condition	0	3
Coat condition	1	2
Mane and tail condition	- 5	- 6*
Mould in stable	0	2
Condensation	1	3
Roughage without water	2	0
Mouth health	4	3
Equipment chafing	8*	5*
Back palpation	1	2
Rug cleanliness	1	0
Stereotypy	0	- 1
Undesirable behaviour	- 2	1
Enrichments	- 2	0
Behaviour towards assessor	3	1
Possibilities for visual horizon	2	2

5 Discussion

The studies in this thesis have focused on the development of a horse welfare assessment protocol (HWAP) (Paper I), comparing HWAP to the official protocol (OP) used in Swedish official controls (Paper II), investigating horse owners motivational factors and information sources (Paper III) and testing if feedback from horse welfare assessment had any effect on the actual horse welfare (Paper IV).

This chapter discusses the findings in these studies from a wider perspective and presents ideas for future studies. The theory of planned behaviour is used to structure the discussion and help to explain underlying factors that affect implementation of research results and systematic horse welfare assessments (Figure 2) (Ajzen, 1985). This theory explains human behaviour through an individual's *intention* to perform the behaviour, i.e. motivational factors (Ajzen, 1985; Ajzen, 1991). This intention is in turn dependent on a person's *attitude* towards the behaviour (influenced by previous experiences), on *subjective norms*, (e.g. social pressure to perform the behaviour), and also on *perceived behavioural control* (e.g. the persons confidence that he/she can perform the behaviour) (Ajzen, 1985).

5.1 Attitude: assessing horse welfare

An individual's positive or negative evaluation of performing a certain behaviour can be referred to as their attitude towards the behaviour (Ajzen, 1985). A horse owner's behaviour and choice of managerial regime is crucial to determining the horses' welfare status. The education and knowledge level of a horse owner does not guarantee that implementation of the knowledge occurs, thereby ensuring a high level of welfare (Visser & Van Wijk-Jansen, 2012; Viksten *et al.*, submitted-b). Hence, horse owners might know better than their current behaviour and managerial regimes show, but they might not alter their behaviour to increase welfare. The theory of planned behaviour can be used to put horse welfare assessments and horse owners' behaviour into a wider context, as previously discussed by Hemsworth (2012); Hemsworth *et al.* (2015).

5.1.1 Influencing owners' behaviour via HWAP

When developing and applying a protocol for assessment of horse welfare the aim is to assess the actual welfare status in a feasible, valid and repeatable manner. The protocol also indirectly measures the horse owner's behaviour and managerial regimes since this is reflected in the actual welfare status of the horses (Hemsworth *et al.*, 2015; Viksten *et al.*, submitted-b). If an assessment is

followed by feedback of results it has the potential to clarify the aims (improving horse welfare), change the attitude and positively influence the horse owner's behaviour. However, a number of requirements need to be fulfilled for this to happen. Assessing and supplying feedback needs to be conducted in a transparent way that increases horse owners' and "consumers" (e.g. riders at riding schools) knowledge and awareness of welfare (Blokhuis *et al.*, 2013). The results in this thesis strongly suggest this requires an assessment of each individual horse using a mix of measures and an interview with the horse owner (or where applicable: the stable manager) to gather information on managerial and husbandry regimes and other required information about the horses and their housing.

The choice of measures and their relevance to welfare must be easily understood by horse owners in order for them to trust the results. Measures also need to be feasible, repeatable and scientifically validated. The results in study I show that 66 % (31 out of 47) of the measures incorporated in the HWAP had over 85 % repeatability (conducted by one assessor) and that the assessment can be conducted in a way acceptable to horse owners and managers. The study also shows that although measures are validated and reliable (e.g. BCS from Carroll and Huntington (1988)) repeatability might be low due to a real change in conditions. The measures with lower repeatability are still considered relevant, but must be placed in the wider context of other potentially influential variables (e.g. season, use of the horse, feeding regime) and thereby require regular monitoring.

The benefits of regular monitoring and using scientifically sound measures need to be further explained to horse owners. By explaining and ensuring an understanding of the assessments and underlying reasons for monitoring welfare, attitudes can most probably be affected to facilitate behaviour towards improved horse welfare.

5.1.2 Comparing HWAP to the OP

Study II compared two protocols designed for different purposes; the HWAP which aims to assess the horses' actual welfare status through the use of mainly AB measures, and the OP which assesses compliance with legislation mainly through RB measures. Both protocols can identify possible risk factors to horse welfare. Although RB and MB measures are undoubtedly relevant for the protection of the horses' welfare, their relation with actual welfare status is not always clearly understood and may vary between individual horses. A combination of AB, RB and MB measures can help identify possible risk factors even before horses show detectable signs of compromised welfare. This combined approach can thereby prevent the development of welfare problems,

but might be hard to grasp for the horse owners due to the complex interactions of measures.

The different protocols resulted in differences in the number and type of welfare issues detected under the various welfare criteria as well as the numbers of stables where such issues were detected (Table 14). There were also differences in how welfare issues and risk factors were picked up when comparing measuring on group- or individual level. The OP uses a methodology of assessing animals or resources that "stand out" from normal whilst the HWAP assesses all animals. By not assessing all animals some welfare issues were missed which is in accordance to previous studies (Lundmark *et al.*, 2015). If issues are missed in one assessment and picked up by another, this might affect horse owners' attitude towards assessments in general, deeming them as unreliable.

The need for guidance for the assessor during the actual assessment (i.e. in the protocol) became clear in Study II. The study also showed that although Sweden has legislation specific for horses, the specific wording of the legislation are sometimes vague (e.g. able to drink "naturally") and sometimes quite strict (e.g. minimum housing size in cm). The lack of explanations as to how the used measures actually affect welfare, which could be done with good and bad examples in the feedback to horse owners, hampers understanding of their meaning and importance for horse welfare. This in turn affects owners' attitude towards assessors and controls and thereby reduces the chances to realise behavioural change. There is also a risk that an assessor's personality or attitude does not "match" that of the horse owner which makes knowledge transfer around horse welfare very difficult and possibly hampering future welfare assessments.

5.2 Intentions and subjective norms: what do horse owners want?

An individual's *intention* to perform a certain behaviour can be described as the motivational factors that influence a behaviour (Ajzen, 1985; Ajzen, 1991). The intentions may change over time and are influenced by experiences and *subjective norms*, e.g. social pressure to perform the behaviour (Ajzen, 1985).

5.2.1 Decision making and information retrieval

In order to explore horse owners' intentions and subjective norms Study III included a questionnaire and the results yielded useful information on the decision making of horse owners concerning horse welfare. The respondents clearly considered horse health and behaviour as the two most important

motivational factors influencing their decision making on management and welfare. Factors like the respondents' own health, the economy and official injunctions were considered less important. This suggests that many horse owners regard their horses as individuals with an intrinsic value and not just with an instrumental value for a specific purpose or for making a profit.

External support from various bodies, e.g. federations, was considered the least important factor underpinning the decision-making process. Support from federations is probably more important for professional stables and riding schools (who are usually members) in order to ensure a high quality level of service for customers, to be allowed to arrange competitions, for insurance purposes and to gain access to advisory services (Svenska Ridsportförbundet, 2016).

Although non-compliance with legislation discovered during official controls may lead to seizure of horses and fines for the horse owners, such injunctions were not regarded as particularly important by the horse owner. This might be due to the fact that most respondents in the questionnaire do not need official permits to run a stable. This is a requirement for professional stables and stables with more than 10 horses (Djurskyddslagen, SFS 1988:534). Inspections at stables that do not require permits would only be conducted if there were complaints. This may well explain the owners' views on non-compliance. It may also reflect a lack of well-founded information about welfare legislation and its potential benefits.

Study III shows that exchange of information and experiences with other horse owners and horse enthusiasts is the most common way of gathering knowledge. This practise runs the risk that scientific evidence is ignored and that the use of misleading information and related risk factors may be increased (Leckie, 2001).

Horse owners' behaviour is known to affect horse welfare (Hemsworth *et al.*, 2015) and owners often differ in regards to welfare improvement, information gathering, attitude and knowledge levels (Visser & Van Wijk-Jansen, 2012). Even though scientifically based feedback from welfare assessments can be adapted to match owners' preferences, there is no guarantee that this will result in positive changes in management and improved horse welfare.

The social culture in stables and clusters of owners is probably very influential with regard to how scientific and valid the information is that is exchanged between horse owners. Studies have also shown that visiting professionals such as veterinarians might influence the knowledge levels in horse owners (Visser & Van Wijk-Jansen, 2012). This may cause large local variances in absence or presence of welfare issues depending on the local professionals.

Subjective norms can be changed and self-taught horse owners can be educated through courses (e.g. stable schools led by a researcher or teacher) and feedback from welfare assessments. This approach has been tested on animal owners within the farm-industry with successful outcomes (Vaarst *et al.*, 2007). There is clearly great potential for effective knowledge transfer and a clearly communicated emphasis on the benefits of welfare improvement for the horses and their owners (Main *et al.*, 2014). The feedback needs to be accessible, correct, understandable and concise so that all owners, regardless of their level of background knowledge and education, can understand welfare concerns and take appropriate informed decisions (Leckie, 2001). The most challenging aspect will be to reach out to recreational horse owners and to realise effective implementation of the feedback and the related welfare improvements.

5.3 Intentions and perceived behavioural control: do horse owners see improvements?

An individual's previous performance affects his or her perceived ease or difficulty of performing a particular behaviour. This is referred to as *perceived behavioural control* and affects if an individual is likely to perform a certain behaviour (Ajzen, 1985).

5.3.1 Official welfare assessments

As seen in Study II, The Swedish official system for horse welfare assessments uses mainly RB measures, provides quite little feedback and gives hardly any advice to horse owners. This may affect the perceived behavioural control of owners, which in turn affects their intentions. The risk is of course that an assessment that the horse owner does not understand or accepts hampers changes in behaviour (e.g. management regimes) that could have improved horse welfare. If the feedback was instead complimented by personalised advice, education of horse owners (e.g. through stable schools) and self-assessment schemes, meaningful improvements would be more likely.

5.3.2 Does feedback have an effect?

The findings in Study IV revealed some significant improvements between assessments in SWI scores regardless of the type of feedback the stable received. Changes in both groups suggest that the assessment, regardless of feedback, might have worked to raise awareness and generate welfare improvements. This finding is in line with those from other research areas such as health care and psychology (Ajzen, 1985; Jansen *et al.*, 2010), where it was also found that there might be an effect independent of the feedback. Collectively those studies

suggested that many other factors can affect implementation of advice and behavioural change regardless of the amount of support and information given. A system that aims to increase welfare will very likely require the provision of feedback capable of addressing the characteristics and requirements of individual animal owners rather than just supplying general information aimed at all animal owners (Jansen *et al.*, 2010; Visser & Van Wijk-Jansen, 2012).

The significant improvements observed in both feedback groups in Study IV involved features that could easily be improved without large financial investment or large structural and managerial changes, e.g. better trough cleanliness and opening more (existing) air inlets. The routines used for trough cleaning are easily altered and our results suggest that the stable managers became aware of the issues after the first assessment and took steps to improve the welfare of their horses.

Clearly, non-managerial changes can occur between assessments which are independent of the type of feedback. For example, seasonal changes may have affected the welfare outcomes, as the stables were first assessed in winter and early spring, received feedback and were then re-assessed about six months later in the late autumn.

Addressing welfare issues such as insufficient ventilation systems requires necessary funds, locating and hiring a suitable contractor, applying for permits and timing the effort when horses are either moved to another facility or on summer pasture. This may explain why stables in Study IV had not corrected their malfunctioning ventilation systems or paddock surfaces during the six months between assessments. Another possible reason for the lack of remedial action in some measures may have been that the managers did not believe in the results or the importance of the assessment or individual measure. However, although the education levels of staff were associated with the occurrence of injuries and other welfare issues in previous studies (Lönnell *et al.*, 2012) the findings in Study IV suggest that the managers' education and experience were not related to the implementation of improvements arising from the feedback, or the improvement of welfare scores.

The feedback provided in Study IV was not particularly successful in altering behaviour of the stable managers, despite voluntary participation and perceived high motivation levels. The reason behind the inconclusive results might simply be that six months was an insufficient time period to see significant changes, but may also indicate more complex underlying issues. It is also recognised that explaining the complexity of how different welfare measures correlate to one another is difficult and that alternative ways of delivering feedback might be a solution, e.g. through meetings, lectures and stable schools. The results of Study IV highlight that many factors affect the implementation of knowledge. The

results revealed hidden welfare issues even in these “nice” stables which may indicate a lack of knowledge in stable managers and horse owners about how to assess and improve horse welfare on an everyday basis.

The participating stables supplied very useful feedback on the assessments and information that they received in the study. Their feedback also revealed attitudes towards horse welfare that were quite concerning. These included a reluctance to trust in published research, denial of existing welfare issues, putting performance of horses above welfare and a lack of interest in even looking at results from assessments (Viksten et al. unpublished results). This highlights the need for a clear, concise feedback system and support to horse owners so that they will change their attitude and behaviour and be more open to constructive criticism.

5.4 Concluding remarks

The results from the studies included in this thesis indicate that there are welfare issues even in stables with experienced and well-educated personnel. The developed assessment protocol, HWAP, discovered these issues and shows potential as a feasible welfare assessment tool in systematic horse welfare assessments. The HWAP also demonstrated in Study II that using more AB measures and assessing each individual animal is superior to using mainly RB measures and assessing on group level when it comes to detecting actual welfare issues. When inquiring into what horse owners want from welfare assessments in Study III, the need for knowledge and possibly advisory services in horse welfare became clear. Many owners wanted feedback to enable comparison to results of other stables, a type of benchmarking, which is facilitated when a stable is awarded an overall welfare score with different ratings (see the WQ® approach (Veissier *et al.*, 2011)). This sort of benchmarking would open possibilities for stables to market themselves regarding horse welfare which encourages good horse welfare and may lead to increased business opportunities. Considering the results from the studies, one conclusion is that there might be a need for systematic horse welfare monitoring in Sweden, apart from the existing official controls. This system would need to include a holistic approach with several important parts: assessment using a mix of valid, repeatable and feasible measures, interpretation of results, providing horse owners with feedback and possibly a certification system.

Successful implementation of evidence-based research outcomes in human healthcare routines (Rycroft-Malone & Bucknall, 2010; Seers *et al.*, 2012) and in quality assurance programmes in the livestock industry (Edge & Barnett, 2009) suggest that strategies such as stable schools, educational programmes,

dissemination of best practices for management etc. could be applicable to the horse industry. Furthermore, provision of feedback with suggested changes and information on welfare should be tailored to the personality type of the person receiving feedback in order to improve managerial regimes (Jansen *et al.*, 2010). Factors such as their trust in external information, attitude towards the outside world, the social context and their ethical viewpoint on animal welfare (Heleski & Anthony, 2012) also affect how animal owners perceive the information (Jansen *et al.*, 2010). Therefore, implementation strategies need to cater for different kinds of horse owners (and stable managers) (Visser & Van Wijk-Jansen, 2012). Motivational factors must also be identified (Viksten *et al.*, submitted-a) because they are unlikely to be identical to those in the food-animal production sector where for instance pressure from interest groups and consumer awareness are more obvious (Blokhuis *et al.*, 2010b).

The studies in this thesis indicate that there are many variables around measures and how they interact with each other that need to be accounted for in interpretations of results. This is a challenge when formulating feedback to horse owners and might require new ways of delivering feedback as discussed in Study IV. Another possible difficulty in the interpretation of results is that horses are often individually managed although they reside in the same housing. This requires assessment of all individual horses, as concluded in Study II, which is more time consuming and may hamper stable-level feedback. Individual management is possibly unique to horses and might not occur in other farm animals assessed with protocols developed in the WQ® system.

Protocols will require regular updating as research and knowledge in all areas of horse welfare changes. As was seen in Study I and II there are requirements for further research within several welfare areas, not least in behavioural measures feasible for on-farm assessments in different housing systems.

5.4.1 Improving official controls

The Swedish legislation on horse welfare needs to be updated and harmonised with contemporary research. Its content needs clarification and specification so that the risk of misunderstandings and misinterpretations is minimised. The assessors that conduct the official controls should be supplied with the best tools (i.e. protocols) available which will require constant updates with scientifically evaluated measures. Study II showed that although similar measures are used in both the HWAP and the OP, results differ. Since horses are often individually managed, group level assessment, like in the OP, can overlook welfare issues (Lundmark *et al.*, 2015). Therefore an updated assessment should include all individual animals. Even though this will take more time, outcomes will reflect the actual welfare of the whole group, and not just a few individuals.

5.4.2 A note on risk factors

One conclusion from the studies in this thesis is that the interpretation and analyses of results from welfare assessments pose several challenges. One is finding the causal factor and giving proper advice, another is how to explain to the horse owner, in a clear and easily understood way, how measures relate to each other.

Risk factors are commonly identified in welfare assessments and owners are often encouraged to address them in order to prevent more serious issues occurring. One challenge with risk factors is that they can be difficult to explain to horse owners. Especially if the risk factors have not (yet) caused any concerns or injuries. The actual risk that these factors have can also be hard to estimate: something causing welfare issues in one stable might not cause them in another stable due to managerial regimes. An example of this is seen in Study I with poor paddock surface quality which is a risk factor to skin and hoof disorders. Welfare issues were however absent in both participating stables due to preventative measures (e.g. regular farriery intervals) and management regimes. The number of variables around a risk factor might make it difficult for the assessor to motivate changes and to assess all stables equally. To get around this issue the causal effects and managerial regimes need to be identified and guidance for the assessor provided when interpreting assessment results.

5.4.3 Personal reflections on horse welfare assessments

Horse owners' behaviour is affected by their previous experiences of assessments, as explained in the theory of planned behaviour (Ajzen, 1985). Horse welfare assessments might feel intimidating to horse owners, despite voluntary participation, and make them nervous, defensive and insecure about what to expect. Therefore it is suitable that an assessor has training not only in the actual horse assessment, but also in communicating with people in a pedagogical way. Because, even though the quality and accuracy of the assessment itself is important, the studies in this thesis have also shown that in order to improve actual horse welfare, we need to focus on the horse owner.

5.5 Limitations of the studies

The stables were participating voluntarily and it is possible that only those stables agreed to be involved that were realising a high level of welfare, which might be a selection bias. Having high standards in regard to welfare may result in skewed outcomes, which was the case in Study I. The sample size in Study I was quite small which somewhat hampered the statistical analysis.

The availability of only one assessor excluded testing for inter-observer repeatability in the studies in this thesis and is a potential source of error in regards to the assessor possibly remembering previous results from assessments. This risk was however reduced by blinding the assessor to previous results (not accessing them or analysing them) between assessments.

There was also only one assessor to conduct both protocols in Study II so they were conducted sequentially, starting with the more detailed (HWAP) in the morning (to enable measurement of RH and T whilst horses were indoors). This am/pm time difference may have affected some outcomes, e.g. the cleanliness of troughs and risk of injury depend on presence of horses and management regimes. Secondly, both protocols were conducted on the same day by the same assessor so memory of issues detected earlier in the day may have introduced some bias into the second assessment.

In order to evaluate if the HWAP is valid for monitoring changes over long periods, a longer study is required with several repeated assessments.

Not all horses present at the stables were used in all measures or even in both assessments for Studies I, II and IV since some were excluded due to illness, being away at training, being sold (not present at stable anymore) or euthanized between assessments due to injuries unrelated to the study. This reflects the challenges with doing repeated assessments in the field: the sample population is rarely constant.

It is recognised that the questionnaire in Study III was accessed online on a free choice basis so there could have been an under- or over-representation of specific types of respondents. For example, it may have mainly attracted those horse owners specifically interested in horse welfare.

The relatively small sample size in Study III means that results might not be representative of all horse owners in Sweden.

6 Ideas for further research

- Future studies of horse welfare should include further development and testing of new measures, particularly in the areas of usage of horses (e.g. conflict behaviours during training) and its effects on welfare, how to assess if paddock sizes are sufficient to encourage natural behaviours and feasible behavioural assessments (e.g. to determine HAR) suitable for all housing conditions.
- Future studies should include the automatization of as many measures as possible and the possibility to make applicable measures quantifiable or continuous (e.g. RH and T). By measuring automatically, more data can be gathered with minimum effort from the horse owners and if it is combined with computerised alarms (e.g. when exceeding a golden standard value or set threshold) it could promote increased welfare and prevent welfare issues.
- The horse pain face scale should be included in HWAP (Gleerup *et al.*, 2015) to assess the presence of pain in different situations (e.g. at training or just generally in the stable). Absence of pain is prerequisite for good horse welfare and any signs of it should be taken seriously and treated, regardless the age and area of usage of the horse.
- The HWAP will need further intra- and inter-repeatability testing with a group of trained assessors in order to determine if the scoring and previously non-validated measures are reliable and repeatable enough to be used in a systematic horse welfare assessment system. The protocol is a living document and should be updated regularly with new scientifically tested measures to improve its ability to accurately assess horse welfare.
- Feedback systems for horse welfare assessments with the goal to disseminate and implement research results should be further developed through a longer study where support and advice is given on a regular basis to participating stables. The feedback should be adapted to each horse owner's personality traits and wishes regarding feedback format. This will give the best possible conditions for altering horse owners' behaviour and thereby improving actual horse welfare.
- A systematic horse welfare monitoring system based on HWAP should be developed and implemented in Sweden. This system should include welfare certification in line with the WQ® system and advisory services for horse owners as well as assessors. This would complement current systems and contribute towards increased horse welfare and possibly other benefits for the horse industry.
- International standards for assessing horse welfare should be developed to encourage international collaborations and comparisons or research results.

7 Populärvetenskaplig sammanfattning

Hästvälfärd är ett mångfacetterat koncept som omfattar både mentala och fysiska aspekter. I den här avhandlingen används ett helhetsperspektiv till att bedöma hästvälfärd med Welfare Quality's® (WQ®) principer och kriterier som utgångspunkt. Målet med avhandlingen var att utveckla ett bedömningsprotokoll för hästvälfärd i linje med WQ® och att utveckla ett system för att återkoppla resultaten från bedömningarna till hästägarna.

I den första studien genomfördes en omfattande litteraturstudie av befintliga mätmetoder av hästvälfärd vilket resulterade i en lång lista med potentiella mätmetoder att inkludera i protokollet. Efter ett flertal diskussioner med nationella och internationella experter inom relevanta områden kortades listan med mätmetoder ned och sammanfattades i ett bedömningsprotokoll för hästvälfärd: horse welfare assessment protocol (HWAP). I en pilotstudie påvisades det att protokollet utgör en stabil grund för att övervaka hästvälfärd, har hög repeterbarhet och är praktisk tillämpbart under fältförhållanden.

Den andra studien jämförde en uppdaterad version av HWAP med det offentliga protokoll (OP) som används vid offentlig svensk djurskyddskontroll. Resultaten indikerade att den högre detaljrikedomen och större antalet djurbaserade mått i HWAP möjliggjorde en mer utförlig bedömning av de individuella djurens faktiska välfärd än OP.

Den tredje studien använde ett frågeformulär för att undersöka svenska hästägares beslutsfattning kring hästvälfärd och vilka preferenser de hade gällande återkoppling från välfärdsbedömningar. Resultaten påvisade ett behov av systematisk välfärdsbedömning som kan förse hästägare med solid kunskap och vetenskapligt grundade råd inom olika områden. Resultaten från studien och feedback från de stall som deltog i studierna i avhandlingen användes till att utveckla en databas där hästägare kan få tillgång till sina resultat från välfärdsbedömningar online.

Den fjärde och sista studien utvärderade hur olika mängder feedback från bedömningar (med HWAP) påverkade faktiska ändringar i hästvälfärden. Resultaten visade att ett sexmånadersintervall mellan bedömningar troligtvis är otillräckligt för att betydande förändringar ska synas. Studien indikerade att utbildningsnivån hos den som är huvudansvarig för hästarna (t.ex. stallchefen) inte verkar ha något samband med förändringar i den faktiska hästvälfärden efter feedback.

Avhandlingen utgör en stabil grund för att bedöma hästvälfärd och att förse hästägare med återkoppling från bedömningar. Den ger också en inblick i det komplicerade ämnet med att förändra hästägares beteenden, vilket mäts indirekt genom hästvälfärdsbedömningar.

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