NATURAL GRAZING VERSUS SEASONAL GRAZING

Wouter Helmer, Stichting Ark

Nature development involves creating opportunities for natural processes to take their course. Natural grazing by large herbivores is one of the most important processes for the formation of landscape. However, many nature development projects use farm animals which graze only during the summer months. Does this really make any difference? Yes, it does, according to Wouter Helmer. Here he tells why.

Until the mid-1980s Dutch nature conservation was mainly directed at conserving existing nature. This meant that nature values were usually linked to some form of agriculture, such as hay pastures, reed and willow culture, heathland, poor grassland, arable land with special weeds and pasture which was farmed extensively. Any grazing of nature areas was done by flocks of sheep or farm cattle, as a continuation of traditional management methods. Stewardship and reserve areas were created to encourage the protection of nature values on agricultural land. The farmers within these areas could obtain payment for conserving or improving existing nature values, or for the voluntary sale of their land to a nature conservation organisation. In almost all cases seasonal grazing was practised, as it had been in the past.

Misunderstandings about natural grazing

Our increasing knowledge of the way natural systems function reveals that grazing is more than simply a means of conserving existing nature values. In fact natural grazing appears to be a key process in ecosystem development. The first experiments started about 15 years ago. Horses and cattle were returned to their natural role in the ecosystem. These experiments have been a great success and more sites will soon be given over to natural grazing by horses and cattle.

This activity did not go unnoticed by farming organisations. For the first time they saw horses and cattle which were not part of the agricultural process grazing in nature areas. The farmers wanted to know whether farm animals could be used to the same effect. This reaction is naturally understandable, especially if farmland has been bought up to make way for nature development and farm animals are replaced by other horses and cattle. For many farmers grazing of cattle in nature areas is a lucrative business. Because of the hardship suffered by many farmers in the Netherlands the discussion took on a political dimension. At first, many politicians saw the expansion of nature development areas as the perfect opportunity to create a new source of income for farmers as managers of these new nature areas.

Natural grazing versus seasonal grazing

To clarify the issue, the differences between natural grazing and farm management, including their ecological effects, are listed below. The information is partly based on experience gained in the Netherlands from fifty grazing projects in river and stream valleys over the past ten years.

1. Natural grazing is based on the principle of year-round grazing and the natural phenomenon that the land is only able to sustain as many animals as can find sufficient food in times of food scarcity, especially in late winter. This means in practice that in summer there is a surplus of food. There is a profusion of flowers and seeds, the patches of scrub that develop provide cover and food, and trees and bushes are allowed to grow higher. This means that ultimately a varied landscape is created which provides a habitat for thousands of plants and animal species.

Under seasonal grazing the number of animals relates to the amount of food available in the summer. In practice this means that livestock density in the summer is 10 to 30 times higher than for natural grazing. Plants hardly have the chance to flower and cannot spread through seed dispersal. There is little

Under natural grazing, essential knowledge about the site (location of water and sources of food, swimming routes to areas of refuge in the event of high water) is passed on from generation to generation.

It is far more appealing for the public to see a herd of feral animals comprising male and female, young and old herbivores together, rather than seasonal grazing involving one species, one sex and one age group.

food for insects and seed-eating birds. Plants cannot grow tall enough to provide winter shelter for the animals. Young trees and bushes get eaten up. In short: the explosion of growth which takes place under natural grazing is largely absent.

2. Under natural grazing the animals feed in winter on the extra summer growth. They also eat twigs and strip the bark from trees and bushes. This means that in winter they greatly influence the structure of the vegetation, most importantly the shrubs and young trees. This creates a type of **natural mosaic**, with a gradual progression from grassland to shrub and woodland. It is precisely this diversity that provides a wealth of wildlife. In contrast, seasonal grazing leads to more clearly defined areas of grassland contrasting with woodland because the grass is cropped short, while the woodland becomes thicker because it is not thinned out by winter feeding.

3. Most of nature benefits from grazing by different species of herbivores, which individually and cumulatively create a varied structure of vegetation. Each species has its own territory, its own food preferences and grazing intensity. Cattle can clear an opening through rough areas making them accessible for horses. This in turn opens the way for geese and rabbits. Together they create a **colourful diversity** of grazing patterns. Land managed by farmers is usually grazed by only one species of herbivore.

4. It is also important that the **social structure** of the herd is intact, as this herd behaviour also contributes to preserving the diversity of vegetation. This includes for instance creation of latrines, the sand baths particularly favoured by stallions and bulls, the splitting up of groups and the isolation of mothers and their young.

Land managed by farmers usually only contains animals of the same sex and age, usually young animals. Older animals are not wanted, because the quality of meat declines as the animal gets older. This is in spite of the fact that older, experienced animals play a key role in natural herds during migration and in the transfer of information.

5. De-domestication of horses and cattle is an essential process to enable these animals to once again take up their **natural role** in the ecosystem. This process is not able to evolve under farm management. Under seasonal grazing the animals do not develop a knowledge of the terrain, which is passed on from generation to generation, and would include for instance water and food sources and swimming routes to high ground in times of flood.

6. Wild grazers build up **fat stores** in the autumn in order to be able to survive the winter months. By the end of the winter they have used up these resources and may have lost as much as a quarter of the their body weight. This is also the period when weak animals run the greatest risk of mortality. This natural cycle, which also compels the animals to eat bark and twigs in the winter, does not rhyme with the principles of animal husbandry.

7. The sight of a herd of wild horses or cattle grazing, with male and female, young and old animals together is much more **appealing to the public** than a group of cattle of one species, sex and age put out to pasture. A natural herd is also usually much more active. The landscape created by natural grazing, with flowering grassland, shrubs and small groups of trees is more attractive than a clearly delineated agricultural landscape. Natural grazing would increase public support for nature development plans in the Netherlands.

8. We find species like the common agrimony, xanthium, common avens, burs, which attach themselves to the grazers' coats in the autumn for **seed dispersal**, all occurring in areas where there is year-round grazing. Seasonal grazing limits this dispersal mechanism.

9. Because of the high density of cattle during summer grazing, there is a high concentration of dung deposition and trampling of the soil in this period. This is precisely the season when these activities can do the most damage to wildlife and the soil and thus constitutes an assault on the very basis of the food chain.

10. Farm livestock is usually ill-equipped to survive in natural conditions. These animals usually reach maturity too early, cannot bear young without human help, have udders that are too large, produce too much milk which can cause mastitis and are not resistant to extreme weather conditions. Domestication can also lead to changes

in coat colour, which makes the animals more vulnerable to predators.

Conclusion

Natural grazing and seasonal grazing differ greatly in their aims, character and their effects on the landscape. If the purpose is not to preserve the agricultural landscape, but to develop a comprehensive ecosystem, then seasonal grazing is in no way a substitute for natural grazing. The explosion of life, the thousands of plant and animal species that occur under natural year-round grazing is largely absent under seasonal grazing.

Farmers can only meet the requirements of nature development if they are prepared to work with small numbers of specially selected horse and cattle breeds, which graze all year round without extra feeding. In addition the animals must be allowed to lose up to a quarter of their body weight in late winter. The 'harvesting of animals' would have to be in keeping with the natural selection which occurs in natural herds.

In practice this means that there is hardly any income to be gained from this activity. This situation could be improved by the granting of stewardship subsidies. But the subsidy would be better spent if it was jointly granted to nature management organisations. This would give a better guarantee of sustainability and ensure that the manager has trained staff to help make the transition from agricultural production to an acceptance of more natural processes. It goes without saying that nature organisations must continue to attract managers with appropriate ecological training and create enough opportunities for them to put this into practice.

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Reference:

Natuurlijke begrazing,Hoog Keppel, Stichting Ark 1999. Available from Stichting Ark, Postbus 21, 6997 ZG Hoog Keppel, the Netherlands.

NATURAL GRAZING, SOCIAL STRUCTURE AND HEREDITY

Willem Overmars, W. Helmer, R. Meissner and G. Kurstjens; Stichting Ark

Natural grazing is one of the essential elements of an ecosystem. It is a vital process for thousands of plants and animals. Grazing also helps to form the landscape. In order for large herbivores to fulfil their potential a natural, social structure in the herd is essential.

Horses and cattle are social animals which only really come into their own in larger groups where they can form natural group relationships. Their herd behaviour varies from species to species. Horses behave in a completely different way to cattle. It is important to respect the social order in contacts with these herds and deal with them in small social groups.

Although these animals have been domesticated for thousands of years, we still know surprisingly little about them.

Because they are domesticated their social order has been determined by humans, this is not the same as their natural one.

Supernumerary bulls and stallions are castrated or slaughtered. The females are kept together in large groups, with few, if any, males. This deprives the animals of the opportunity to create their own social order. The creation of this social order needs animals of both sexes and all ages. The processes of harem forming, rejection, the formation of groups of roaming males, etc. then begin to reappear. For both sexes an animal's position in the hierarchy is decided by combat between individuals. The Stichting Ark has been working on a limited scale in a few nature areas to gain experience of social herds. The most interesting site in this respect is the Beneen Geuldal in the province of Limburg. This is an area of 130 ha of highly varied terrain. It contains a large plateau, a stream valley, steep wooded slopes and secluded, isolated open spaces in the woodland. This landscape offers excellent opportunities for the animals to split into herds and form social groups.

Horses

A horse population is made up of a number of groups, each with its own composition and behaviour. The harem group usually includes a stallion and a number of mares, with one horse leading the group. This could be the stallion or one of the mares. Sometimes there is a second, subordinate stallion, the lieutenant, which can sometimes be the son of the dominant stallion, not rejected by the herd. The group remains together for many years. Occasionally a new mare is introduced to the group. The young stallions and mares born into the group are often rejected by the herd when they become sexually mature. This considerably reduces the risk of inbreeding. Harem groups live in habitats which overlap each other and are more or less stable in composition. In the Oostvaardersplassen the home ranges overlap to so much that it is difficult to distinguish the different harems.

Animals rejected from the various herds can get together and form temporary adolescent groups before they find a final place in a harem or stallion group. In this period young mares sometimes bear one or two foals. These groups are unstable and the animals are vulnerable to predation. We have seen confirmation of this in the Przewalski horses recently returned to the wild in Mongolia.

The stallion group is made up of stallions without their own harems. These are lively groups of animals in which the young stallions gain experience for their future role as leading stallion, although many of them never attain this position. Sometimes experienced stallions take

Galloway cattle in Blauwe Kamer under the Grebbeberg. Photo: Gerard Litjens.

over a harem group, or form a new one. Fights between stallions usually take place on spring when the mares are in season. Wounds caused by bites or kicks resulting from this male show of strength are however seldom serious and heal quickly. If there is enough space, the animals prefer to retreat.

Cattle

The social order for cattle is based on different principles from horses. A family group is primarily made up of related females. In other words, the young remain with their mothers and grandmothers.

Young bulls remain in the group for about three years. If there is a mature bull in the group when the cows come in season, the young bulls will not mate with them. A number of these small, related groups will come together form a herd. But the sub-groups within the herd are still recognisable because they graze or lie together when ruminating.

The family groups roam slowly around an area and so visit the home ranges of different bull groups. Cows that have reached maturity are covered by one of the bulls from the bull group. The bull then remains by the cow as long as she is in season. Other cows in season are covered by other bulls. The female members of the family remain together and are covered by different bulls so that inbreeding is avoided. A bull with a higher social ranking does cover relatively more cows, but by no means all.

The second group, the bull group, is smaller. They live in areas bordering each other which to some extent overlap. The sexually active bulls in a bull group mate with the females from a family group. Bull groups sometimes follow the family groups. This type of social order is a means of gene dispersal particular to cattle.

It may be that other forms of seasonal structure and herd composition occur in addition to the social structure described above. These aspects continue to be studied.

Influence of social herds on the landscape

The social structure determines the distribution of animals throughout an area and their consequent influence on the landscape. This can clearly be seen for instance during periods when there are young in the herd and mobility is limited. In Spring some areas will be heavily grazed and others not at all. When groups split up because of harem rivalry, for instance, removal of a group of adolescents or separation of a cow about to calf, grazing patterns will again change. The animals disperse over the whole area so that parts not visited by the large herd will now also be grazed. Other effects on the landscape resulting from social herds are the large latrines created by stallions and the churning up of the turf caused by fighting bulls or stallions.

Heredity

To achieve a genetically healthy population a minimum of 50 reproductive animals divided equally between the sexes is generally thought to be necessary. This means that the population can then survive in the long term through the autonomous process called genetic drift without losing variation. Animals that reproduce monogamously, for instance the eland, require a population of 125-150 animals. Herd animals with a harem structure, such as horses or herbivores with a different type of polygamous sys-

Leadership battle between two Konik horse. Photo: Gerard Litjens.

tem of reproduction, such as cattle, deer and European bison require a population of at least 250 animals. A minimum area can be calculated for each species depending on social behaviour and the availability of food in the habitat. These can vary from 1,000 ha for horses, deer and cattle to 5,000 ha for eland and 7,500-10,000 ha for the European bison.

Migration between populations of successfully reproducing individuals plays an important part in maintaining sufficient genetic variation between a population of minimum size. The transfer of one non-family member per generation is adequate for this purpose. There are two reasons for this rule of thumb: the first is that this scale of migration sufficiently compensates for the loss of hereditary characteristics. The second is that it is not enough to affect specific positive gene combinations which have arisen within a population through natural selection. Genetic differentiation between populations as a reaction to local selective forces thus remains possible.

Table 1. Variation in blood lines, (founders) and size of population in 1993 in a number of Euro-Asian grazers, compared with the minimum number of blood lines.

Speces and location	number	number of founders	male	female
Koniks - Poland	ca. 1000	22	6	16
Koniks Stichting Ark	ca. 300	17	6	11
Koniks Oostvaardersplassen	ca. 370	9	4	5
European bison-world-wide	ca. 3000	12	?	?
Przewalski - world-wide	ca. 1500	13	5	8
Ideal population	*>500*	*50*	*25*	*25*

The effect of social structure on genetic variation

The system of reproduction plays a crucial role in the prevention of excessive inbreeding in the population. Monogamous and polygamous reproduction systems vary considerably in the extent to which inbreeding builds up, or can be reduced. The build-up of inbreeding depressions occurs more quickly in species with a harem structure than in monogamous species. In addition there is more inbreeding in larger harems than smaller harems because then only a few males participate in reproduction. On the other hand a polygamous species recovers more quickly from a spate of inbreeding because only a few new males are required to introduce fresh genes. There are of course natural mechanisms to prevent reproduction with close relatives. It has been established among the wild horses in America that the avoidance of inbreeding is based on a system of recognition of close relatives. Both sexes have a role to play here. Young mares tend to leave the herd they grow up in to avoid being covered by their fathers. Leading stallions allow young stallions to mate with their female offspring. This recognition mechanism has its limitations however: after eighteen months stallions do not seem to be able to distinguish their own female offspring from other mares.

Two harems keeping respectful distance from each other. Photo: Gerard Litjens.

Some degree of inbreeding is therefore a natural occurrence in herd animals and need not be a cause for concern. Only with Konik Horses should inbreeding be avoided at all costs because the genetic base is much smaller than is necessary for the preservation of an ideal genetically healthy population (see table 1). It also depends on whether the founders, from whom the population was built up, were themselves inbred or descend from a varied cross-natural population. The founders of the Konik horses descended from domestic horses mixed with the genes of the extinct Tarpan.

Grazing in the area around the major rivers: genetic research

The various nature reserves on the flood plains of the major rivers in the Netherlands do not yet meet the minimum size requirements for populations of grazers to survive independently as a genetic entity. When the large nature development projects along the Grensmaas (2500 ha) and Gelderse Poort (300 ha) are completed we will be nearer our aim of creating large connected natural areas for the benefit of wildlife. The situation will be further improved when there are links with the higher nature areas on poorer ground such as the Veluwe, Utrechtse Heuvelrug and the Maasduinen. In the flood plains along the major rivers the population is divided between about 40 sub-groups. There is regular inter-change between these groups and new sub-groups are formed from them.

We turn this situation of small groups to our advantage and maintain lineage records for each animal, using genetic

Unexpected high mortality at Oostvaardersplassen nature reserve

In 1999, Oostvaardersplassen nature reserve supported some 500 Heck cattle. But in that winter more than 70 animals died, 50 of which were bulls. This was so unexpected that it made the local papers and raised questions in Dutch Parliament. Such a large number of deaths in so short a time had never occurred before. People wondered whether it was the site managers that were to blame or whether it was a natural phenomenon in a nature reserve where human intervention is kept to a minimum. The State Secretary believes the latter is the case. Still, this high mortality has taught us a thing or two.

The cause of these deaths, as it turned out, was that rumen fermentation had suddenly stopped after a diet that had been high in fibres. The rumen plays a major part in regulating the animal's body temperature. When it stops working the animal may die from hypothermia, which is exactly what had happened. There were a number of reasons for all this. The crucial point was that the older bulls, which were low in the social hierarchy, had been unable to move to better sites to feed. In the past, they been banished from the herd, and had each found a new territory where they had built new, solitary lives. They had managed quite well on their own, but in the wet and severe winter of 1998/1999 food soon became scarce for many of these solitary bulls. This was made worse by the temporary closure of a section of the Oostvaardersplassen nature reserve, where the bulls could otherwise have grazed, because site managers were digging pools for amphibians. On the whole, food availability in the reserve was adequate for the number of animals it supported. It is remarkable then that so many of these older, solitary bulls fell victim to food scarcity and hardly any cows, dominant bulls, younger cattle, Konik horses or red deer.

We now know that neither supplementary feeding nor culling would have been the answer. Such measures would only have caused great social unrest in the herds. Moreover, supplementary feeding might not only have resulted in fights - in which case the hay would not have gone to the animals that needed it most - it would also have artificially raised the area's carrying capacity. As a consequence more calves would have been born earlier in the season, that is, December or January, a highly undesirable consequence.

In the years ahead, dozens of animals in the nature reserve will die, and not only bulls. This is only natural as the lifespan of the cattle, Konik horses and red deer is 15 to 25 years and the herds number hundreds of animals each. And did not the State Secretary say that management was to aim for the most natural nature in which the death of an animal is a fact of life? Only where animals should suffer unnecessarily should it be killed by the site manager.

For more recent figures, please go to: http://www.minlnv.nl/grazers/

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testing to confirm parentage. DNA samples are taken from the hair follicles of each animal. This study is still underway and the results have yet to be assessed. This will enable us to collect a large amount of useful data: we can assess the amount of inbreeding in relation to fertility and health both at individual level and for each blood line, and at population level we can look at the percentage of heterozygosity per year class. This serves as a guideline for the genetic variation in the population. This genetic information can be correlated with other data, for example on late sexual maturity in female animals, or how much fat reserves an animal builds up.

Consequences for nature management
In building up a herd of horses or cattle the maximum number of healthy founders has to be used (see table 1) in order to start as wide a gene pool as possible. If there is one large herd, like those in the Oostvaardersplassen or the Lauwersmeer, then the exchange of one couple (male and female) per 15 years with other grazing herds is sufficient if that couple can breed effectively.

On the floodplains of the major rivers it is necessary to work with a large number of small harems and breeding groups. We start with as many bloodlines as possible. Risks are optimally distributed by building up a population at a number of different locations under the influence of various forces for selection. The risk of total extermination as the result of a disaster is lower than it would be for one large population. Because of the limited size of the herd the numbers do have to be controlled and too much inbreeding avoided. If too much inbreeding is revealed by deviant behaviour, build or health, intervention to prevent the animals from reproducing is then necessary.

Horse populations are controlled by removing young mares and stallions from the herd when they reach sexual maturity, between 1 and 2 years old. New harems are formed with the young mares.
The young stallions form stallion groups within the same nature area, or are removed to a separate site. When herds are removed or formed it is preferable to maintain the existing composition of harem groups as much as possible. By populating new sites with harem groups which include experienced leaders many teething problems can be avoided. Replacement of the dominant stallions or leading mares disrupts the group.

In the case of cattle the family groups are kept intact as far as possible and removed in their entirety to graze new nature areas. Sometimes numbers are regulated by removing bulls to form bull groups and the regular capture or exchange of dominant bulls. If the site is large enough more bulls can remain with a family group.

Conclusion

To fully exploit the role of large herbivores in nature areas , it is desirable to aim for a social structure in the herd which is as naturally as possible. We believe that this strategy, developed over a number of years, allows us to treat our herds in an ethical manner. We take the view that animals allowed to live in a natural way experience less stress, and this has also been our experience in practice. It also enables us to comply with legislation under the Animal Health and Welfare Act of the Netherlands. In conclusion we would like to make it clear that in our studies in the Netherlands we have not included the influence of predation. However, as far as possible we have included knowledge and experience gained from large projects abroad. The Stichting Ark will soon be able to gain experience with herds subject to predation when a herd of Konik's horses are introduced into a large reserve in Latvia, inhabited by wolves.

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HEALTH RISKS BETWEEN LARGE HERBIVORES, FARM ANIMALS AND MAN

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When animals whose health status is uncertain wander about in a densely populated area they pose a health risk to other animals. That this is a real risk was borne out by the role feral pigs played in the recent outbreaks of Classical and African Swine Fever. Pathogens are easily transmitted when feral pigs, free range and intensively produced pigs come into contact. The same is true in cattle. When non-vaccinated cattle get infected with the Foot-and-Mouth Disease virus the disease may easily spread. The consequences are disastrous both for farm animals and for animals in the wild.

Other animals may also be carriers of pathogens: rabbits (Johne's Disease), badgers (Tuberculosis) and ducks (Influenza), for instance. Spores of Anthrax can be found in the soil. Species-specific forms of Salmonellosis and Brucellosis are found in all animal species. Generally, certain pathogens are more common in certain groups of animals which are then referred to as the core group. This means that the susceptibility for certain pathogens differs from one species to another, but the risk of infection between species and sectors remains.

The risk of infection

Classical and African Swine Fever, Foot-and-Mouth disease are highly infectious diseases which easily cross national boundaries. At the other end of the scale are the less infectious diseases, which are easier to contain, such as Colibacillosis, Pasteurellosis or the non-infectious afflictions caused by nutrient deficiencies or an excess of toxic intake, traumata and neonatal mortality. In between and/or next to it, we find the zoonotic diseases, which can be transmitted to humans, such as BSE, Rabies, Anthrax, Tuberculosis (TBC), Brucellosis, Leptospirosis and the trade-related diseases Infectious Bovine Rhinotracheitis (IBR), Bovine Virus Diarrhea (BVD), and Johne's disease (see table).

With all these diseases, we need a good health monitoring programme which can give us a clear picture of the risk of infection that large herbivores pose to livestock and vice versa, and help us to control such infections. The problem however lies with diagnostics. It is not always easy to identify a disease on the basis of physical observation. The visible clinical symptoms in an animal may indicate a variety of afflictions. Laboratory testing is also necessary to identify the presence or absence of certain pathogens (see box). Managers of large nature areas such as the Oostvaardersplassen, Imbosch and Slikken van Flakkee work according to a health monitoring protocol under the guidance of local veterinarians.

Health monitoring protocol

Both clinical examinations and laboratory testing should follow a protocol. A protocol gives guidelines on sample size, to establish the start situation (the nought measurement) and to safeguard uniformity over time. A protocol also enhances uniformity in sampling and examination methods, providing answers to questions such as: should the animals be caught in a corral, stunned from a distance, culled or should fresh cadavers be sampled, what species should be sampled and what selection criteria are to be applied (at random, age, sex, condition). Monitoring results can be given a follow-up in the shape of evaluations or further examination.

For legal, rather than veterinary reaons, carcasses of cattle and horses may no longer be left in the Oostvaardersplassen and Veluwezoom (Highland cattle). This does not count for red deer and roe deer.

There are a number of bottlenecks in monitoring the health of large herbivore herds in managed nature reserves. These include the risk of IBR infections, the role of barriers or distances to surrounding farms, the presence of cadavers in the field and a lack of adequate physiological homeostasis in the animals. We discuss each of these bottlenecks and how it relates to the risk of infection briefly, below.

The risk of IBR infections

IBR is a fairly common disease which rarely produces symptoms in populations of large herbivores in managed nature reserves. The disease is a fact of life here and tends to be harmless. The general policy is to keep interventions to a minimum. For farm animals things are different. Cows with IBR may give less milk or meat and reproduction may be affected. Obviously this has consequences for their market value, which is why a vaccination programme was set up in 1998 to eliminate the disease and give the farms a disease free status. Extending this programme would not only raise practical problems, culling infected animals would meet with a great deal of resistance from nature site managers. Since not much is known about the character and extent of the risk of infection between farm animals and large herbivores the Ministry of Agriculture, Nature Management and Fisheries has decided to have a risk analysis carried out to see how infection would affect population dynamics.

Cadavers in nature reserves

On this issue, too, nature management and livestock farming are diametrically opposed. The cadavers of large herbivores left out in the field are tackled by wild boars first and then by birds and insects. Regardless of the benefits to the biotope, in terms of naturalness and nutrient balance, this practice is anathema on farms where cadavers must be disposed of as soon as possible and destroyed under the Dry Rendering Act.

A rotting cadaver may be a source of infection. It carries the pathogens of the disease that killed the animal but also the pathogens that naturally develop in cadavers such as Clostridium botulinum, a bacteria causing botulism. Inside the cadaver Clostridium botulinum produces very potential toxins. Ingestion of these toxin is highly dangerous and mostly fatal for both other animals (water birds) and man. Pigs are generally not susceptible to Clostridia bacteria.

In 1996 the site managers of the Oostvaardersplassen and the Slikken van Flakkee were granted exemption from the Dry Rendering Act to safeguard the interests of nature. This exemption was subject to stringent conditions including veterinary supervision. Farmers, however, lodged objections against this decision, primarily on legal rather than veterinary, grounds, which led to the exemptions being withdrawn in 1997. Now cadavers are either destroyed or, if fresh, taken to the Animal Health Service for examination. As this has done nothing to resolve the opposition between nature managers and livestock producers further

IBR infection in Heck cattle in the Oostvaardersplassen: the animals themselves are not bothered by it.

research into the risks of leaving cadavers in the field in nature areas is needed.

The distance to surrounding farms

Nature areas lie scattered all over the Netherlands. Sometimes they are virtually rubbing shoulders with farmland or residential areas. That is why it is important to study the effects of distance, natural barriers and borders on infection or spreading of pathogens. The FMD virus, for instance, may be spread over large distances by moisture droplets in the air. Animals such as raptors, crows, foxes, deer, mice or insects also play a part in the spread of pathogens. It is important to find out how woodland margins, banks and dikes influence patterns of transmission. A model study should be made to explore various factors, parameters and possible measures for intervention.

Health

In general cattle adapt easily to their surroundings. Dairy cows for instance have been able to double or even triple their milk production in a matter of decades. It can therefore safely be assumed that cattle will adapt to more natural surroundings without any problems. Well-adapted implies homeostasis, meaning that the animals have an ideal physiological and microbiological resistance, good vitality, and are well able to cope with temporary imbalances in nutrient and environmental conditions. Infection with various native diseases may enhance the resistance of a population, thus acting as a positive ecological influence rather than a threat.

Adaptation will not be a problem except in isolated or insufficiently large nature areas where, in time, structural nutrient deficiencies or toxicity from pollutants may develop. In such cases intervention is necessary. More research is needed to find out how this should be incorporated in the health monitoring protocol.

Infectious diseases and susceptible species, including humans

	Cattle	Red deer	Roe deer	Horses	feral pigs	Humans
Notifiable diseases						
foot-and-Mouth Disease (FMD)	+	+	+		+	
Rinderpest	+	+	+		+	
Anthrax	+	+	+	+	+	+
Rabies	+	+	+	+	+	+
Mad Cow Disease (BSE)	+					+
Classical Swine Fever (CSF)					+	
African Swine Fever (ASF)					+	
Swine Vesicular Disease (SVD)					+	
Glanders				+		+
Monitoring and prevention diseases						
Brucellosis (species-specific)	+	+	+	+	+	+
Tuberculosis	+	+	+	+	+	+
Enzootic bovine leukosis (EBL)	+					
Aujeszky's Disease	+	+	+	+	+	
Bovine influenza (BR)	+	+	+			
Bovine virus diarrhoea (BVD)	+	+	+		+	
Johne's Disease	+	+	+			
Leptospirosis	+	+	+	+	+	+
Local diseases						
Botulism	+	+	+	+	+	+
salmonellosis	+	+	+	+	+	+
Pasteurellosis	+	+	+	+	+	
Colibacillosis	+	+	+	+	+	
Influenza				+	+	+
Rhinopneumonia				+		
Contagious inflammation of the uterus (CEM)				+		
Strangles				+		

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Conclusions

In principle large herbivores and farm animals are subject to the same legal provisions. However exemptions in the interest of nature should be possible. Particularly with respect to the Registration and Identification scheme, the control of IBR, the removal of cadavers, certain standards for husbandry care and transport. Exemptions should however be based on scientific grounds. All (potential) risks should be listed, monitored and minimised. Scenarios and contingency plans should be drawn up for the outbreak of diseases in nature areas and calamity schemes for floods, draughts and accidents involving visitors. Finally, the incorporation of nature development objectives into EU veterinary regulations should also be improved.

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