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Content

Summary

The present risk assessment estimates the risk related to importing live boars or boar semen from Norway to Iceland. It is assumed that the boars would be imported from nucleus herds, and the semen would be imported from Norsvin's artificial insemination centre (AIC). The imported commodities (boars or semen) would either be imported directly to Icelandic herds, or to a quarantine herd (Hrisey), from which the imported boars or offspring born at Hrisey, would be transferred to Icelandic herds. Semen may be imported either fresh or frozen.

The following diseases/pathogens are taken into consideration, as requested by Svínaræktarfélag Íslands: PMWS, PRRS, Leptospirosis, *Salmonella*, Swine influensa, *Mycoplasma hyopneumoniae* (Porcine enzootic pneumonia), *Actinobacillus pleuropneumoniae*.

The assessment is based on the OIE guidelines for import risk analysis, and the first step was to assess whether the diseases/agents of interest are hazards or not. The conclusion is:

- PRRS and Swine influenza are not hazards because there is convincing evidence that they are absent from the Norwegian swine population and the probability of introducing these diseases into Norway through importation is negligible.
- PMWS, *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae* are not hazards because these diseases are found in the Icelandic swine population, the health status concerning these diseases is not better than in the Norwegian swine population, and they are not subject to any official control programme.
- Leptospirosis and *Salmonella* spp. are both hazards because they are subject to an official control programme, although the health situations in Norway and Iceland are very similar.

The probability of introducing *Leptospira* spp. or *Salmonella* spp. through semen to Icelandic swine herds is negligible, both for fresh and frozen semen, and both when used in quarantined sows and directly into the Icelandic herds.

The probability of introducing *Leptospira* spp. through live boars to Icelandic swine herds is considered very low for *L. interrogans* Bratislava, and negligible for *L. interrogans* Pomona or other strains. This probability becomes negligible for all strains if the boars are quarantined and treated with dihydrostreptomycin. If *L. interrogans* Bratislava is introduced, the consequences are expected to be mild to insignificant.

The probability of introducing *Salmonella* spp. through live boars to Icelandic swine herds is considered very low. If *Salmonella* spp. is introduced, the consequences are expected to be mild.

Conclusion:

Of the seven diseases considered in this import risk assessment, only *Salmonella* spp. and *Leptospira* spp. are considered hazards.

When live boars are imported, these two hazards represent a very low risk. The risk of introducing *Salmonella* spp. decreases when the boars are quarantined and tested for *Salmonella* spp. The risk of introducing *Leptospira spp.* would become negligible if the boars were quarantined and treated with dihydrostreptomycin.

When semen is imported, both to the quarantine or directly to Icelandic herds, the risk of introducing *Salmonella* spp. and *Leptospira* spp. is negligible, both for fresh and frozen semen.

Abbreviations

AD	Aujeszkys' disease
AI	Artificial Insemination
AIC	Artificial Insemination Centre
AQIS	Australian Quarantine and Inspection Service
DD	Pure-bred Duroc
KLF	Norwegian Independent Meat and Poultry Association
LL	Pure-bred Landrace
LD	Crossbred Landrace-Duroc
HH	Pure-bred Hampshire
KOORIMP	The Norwegian Farmers Advisory Council for the Prevention of Transmittable Import related Animal Diseases
NOK	National surveillance and control programmes for terrestrial and aquatic animals in Norway
PCR	Polymerase chain reaction
PCV	Porcine circovirus
PMWS	Post-weaning multi-systemic wasting syndrome
PRCV	Porcine respiratory coronavirus
PRRS	Porcine reproductive and respiratory syndrome
PRRSV	Porcine reproductive and respiratory syndrome virus
SPF	Specific Pathogen Free
TGE	Transmissible gastroenteritis
YY	Pure-bred Yorkshire

Introduction

Background

The National Veterinary Institute was asked by Ingvi Stefánsson, on behalf of Svínaræktarfélag Íslands (SFI), on 3 January 2008 to evaluate and compare the following alternatives for importing swine genetic material from Norway to Iceland:

- Import of animals (boars) from Norway directly to Icelandic herds
- Import of fresh semen from Norway directly to Icelandic herds
- Import of frozen semen from Norway directly to Icelandic herds
- Import of animals (boars) from Norway to quarantine herd (Hrisey) and then, after a quarantine period transfer the imported boars from Hrisey to Icelandic herds
- Import of fresh semen from Norway to Hrisey, use the semen to inseminate sows at Hrisey and transfer the offspring born at Hrisey to Icelandic herds.
- Import of frozen semen from Norway to Hrisey, use the semen to inseminate sows at Hrisey and transfer the offspring born at Hrisey to Icelandic herds.

The following diseases/pathogens were asked to be taken into consideration:

- PMWS (not OIE listed)
- PRRS (OIE listed, swine)
- Leptospirosis (OIE listed, multiple species)
- *Salmonella* (not OIE listed)
- Swine influenza (not OIE listed)
- *Mycoplasma hyopneumoniae* (enzootic pneumonia) (not OIE listed)
- *Actinobacillus pleuropneumoniae* (not OIE listed)

The report was to be delivered 4 February 2008 for use by a working group of experts ordered by the Icelandic congress, as well as by the Agricultural committee of the congress. A preliminary report was finalized on 11 February 2008 and sent to a list of stakeholders in Iceland and Norway (see Annex 4) and also posted on the internet for review and comments. The deadline for comments was 6 weeks later on 25 March 2008. The comments have been incorporated in the present report and a summary of the comments and responses are shown in Annex 4.

Method

The assessment is based on the OIE methodology for import risk analysis (OIE 2007) and its associated handbook (Murray *et al.* 2004). Due to the time constraints, emphasis was put on hazard identification, release assessment, the comparison between live swine and semen, and the effects of quarantine, which were understood as the main elements of interest in the request by Svínaræktarfélag Íslands.

Hazard identification

The hazard identification involves identifying the pathogenic agents which could potentially produce adverse consequences associated with the importation of live swine or semen from Norway.

To be identified as a hazard, the pathogenic agent must (Murray *et al.* 2004):

1. be potentially transmitted by the commodity imported (live swine or semen), AND

2. be present in the exporting country (Norway), AND

3. if present in the importing country (Iceland), either

    a) there are documented free zones or zones of low prevalence in the importing country

b) the pathogenic agent is subject to an official control programme in the importing country

c) there is a more virulent strain in the exporting country

to ensure that import measures are not more trade restrictive than those applied within the country (Murray *et al.* 2004).

The presence of each agent of interest in Norway was estimated from their known occurrence in Norway, the ability of the surveillance in place to detect the agent, and the probability that the agent might be introduced into the country. We thus combined a risk assessment approach to classical surveillance, to improve the quality of the estimate. A presentation of the Norwegian swine industry, imports, and health and control measures in place are presented to give a general understanding of the health situation. The potential presence of each agent in the commodity imported (live swine or semen) was based on literature.

The presence of each agent in Iceland and the expected measures that are in place was based on information provided by Dr. Konrad Konradsson, Icelandic Food and Veterinary Authority (January 2008).

For agents identified as hazards, a risk assessment was undertaken, involving the next steps.

Release assessment

The release assessment describes the biological pathways necessary for an importation activity to introduce ("release") the agent into the country, past the quarantine station, and the probability that this will occur. If the release assessment demonstrates that there is no significant risk at this stage, the risk assessment process will conclude.

In the present assessment we have considered the pathway depicted in Figure 1. The import of infection into the Icelandic swine population requires that ALL the following events occur for the same import:

1. The exporting herd is infected, AND
2. The infection is not detected at the time of export, AND
3. The material imported (individual boars, or semen doses) are infected/contaminated, AND
4. The infection in the imported boars or semen is not detected during the export procedures, AND
5. The infected boars or semen infect the quarantine station, AND
6. The pathogen enters the country.

When importing directly to the Icelandic herd, step 5 disappears.

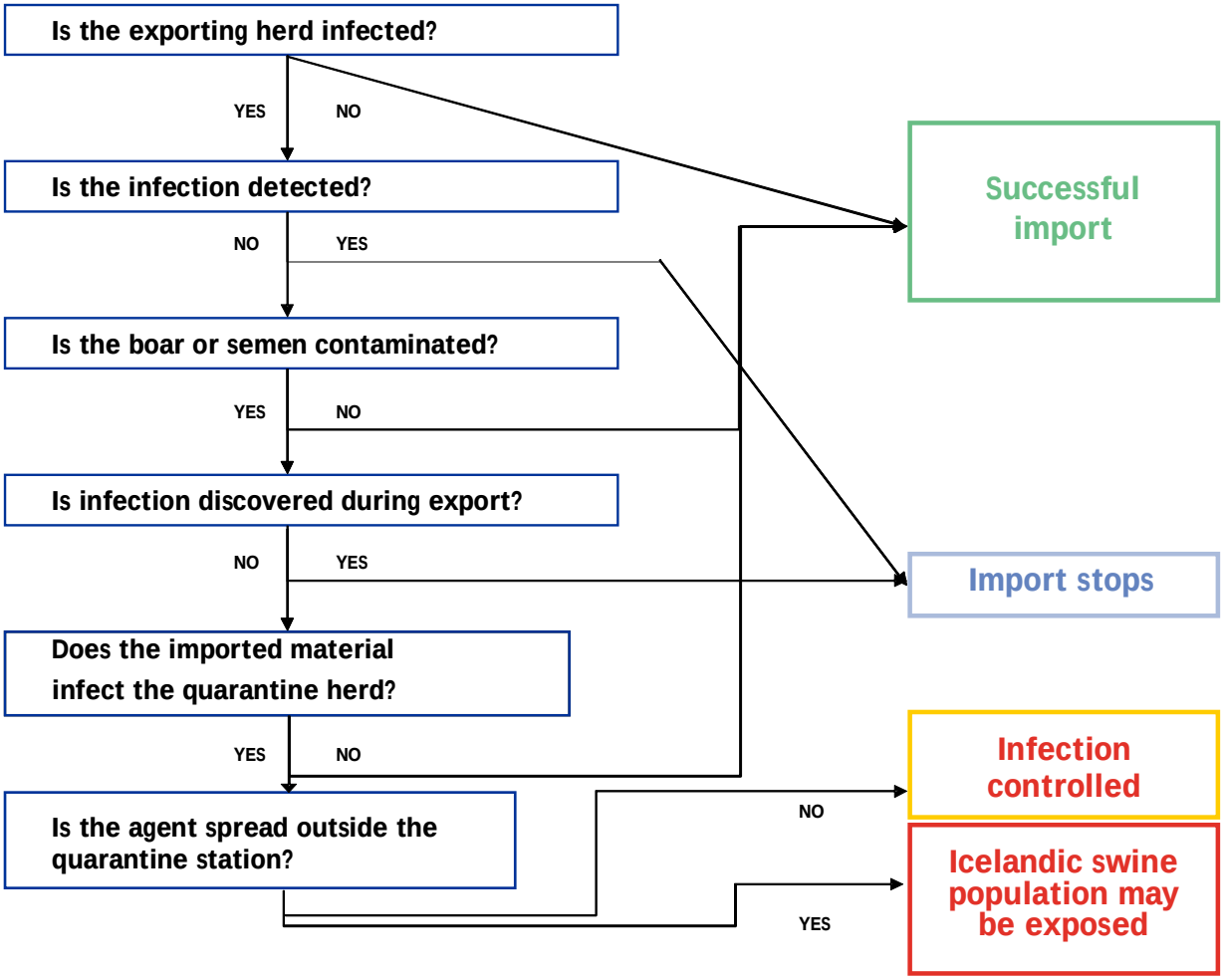

Figure 1. Event tree used for the release assessment.

The probability of the different events occurring was estimated based on:

- Biological factors: Susceptibility of swine to the hazard, expected intra-herd prevalence, transmission ways, infectivity, stability of the hazard, outcome of infection, impact of vaccination, testing, treatment in quarantine, and of testing and treatment of semen.
- Country factors: incidence and/or prevalence of the disease in Norway and in the exporting herds or semen station, historical experience, quality of the surveillance in place, including the capacity to detect the disease with the available diagnostic methods used, risk of importing the agents into Norway, measures in place at the specific exporting herds or semen station, import measures in Iceland.
- Commodity factors: ease of contamination of live boars or semen, production method for semen, effect of freezing, quantity of animals or semen to be imported.

Exposure assessment

The exposure assessment considers whether the Icelandic swine population is exposed to the agent if the agent is released into the population. If the release pathway is semen, sows will be exposed. If the release pathways are infected boars or infected offsprings born at Hrisey, it depends on whether they shed the agent in the proximity of Icelandic swine.

Consequence assessment

In the consequence assessment, the possible health, economic, and environmental consequences of an exposure to the agent is assessed.

Regarding the health consequences in the swine population, the mode of transmission is considered, to assess the likelihood of establishment of the disease in the Icelandic swine population and its spread.

An assessment is made of the likelihood that the agent:

- is present in the importing country, and to what extent, so as to assess the level of susceptibility or the level of protection in the swine population in terms of immunity;
- is transmitted to recipient sows through the infected boars or imported semen;
- is spread to other animals within the swine establishment and;
- is spread beyond the initial establishment.

For semen, transmission of disease requires all following elements:

- the agent is present in semen;
- the agent resists storage and antibiotic treatment of semen (and freezing, if semen is frozen);
- the agent is able to cause infection through the veneral route;
- the remaining amount of agent is sufficient to cause infection.

The existing prevalence of the disease in Iceland is also taken into consideration to assess the impact of introducing the disease on Iceland's status quo.

Risk estimation

Finally, the risk estimation is based on the probability of introducing the disease as well as the magnitude of the consequences.

Terminology

The terminology used is the same as the one used by AQIS (2000).

Definition of terms used for probabilities

- *High* : Event would be expected to occur.
- *Moderate* : There is less than an even chance of the event occurring.
- *Low* : Event would be unlikely to occur.
- *Very Low* : Event would be very unlikely to occur.
- *Negligible* : Chance of event occurring is so small that it can be ignored in practical terms.

Definition of terms used for consequences

- Extreme: consequences associated with the establishment of diseases that would be expected to significantly harm economic performance and/or social well being at a national level. Their effect may continue for an extended period of time. Alternatively or in addition, they may cause serious, irreversible harm to the environment or constitute a serious threat to human health.
- Serious: consequences associated with the establishment of diseases that would have serious biological consequences (eg high mortality or high morbidity with significant pathological changes in affected animals) or social consequences. Such effects may be felt for a prolonged period and may not be amenable to prompt and effective control or eradication. These diseases would be expected to significantly harm economic performance at the level of a major national industry or the equivalent. Alternatively or in addition, they may cause serious harm to the environment or constitute a significant threat to human health.
- Medium: consequences associated with the establishment of diseases that have less pronounced biological consequences. These diseases may harm economic performance significantly at the level of an enterprise, region or industry sector, but they would not have a significant economic effect at the 'whole industry' level. These diseases may be amenable to control or eradication, albeit at a significant cost or their effects may be

temporary. They may affect the environment, but such harm would not be serious or may be reversible.

- Mild: consequences associated with the establishment of diseases that have mild biological consequences and may be amenable to control or eradication. Such diseases would be expected to harm economic performance at the enterprise or regional level but to have negligible significance at the industry level. Effects on the environment would be minor or, if more pronounced, would be temporary.
- Insignificant: consequences associated with the establishment of diseases that have no significant biological consequences, may be transient and/or that are readily amenable to control or eradication. The economic effects would be expected to be low to moderate at an individual enterprise level and insignificant at a regional level. Effects on the environment would be negligible.

Validity

The present assessment is valid as long as the assumptions made are valid. The risk assessment should be updated if:

- Relevant changes in the health situation occur, both in Iceland and Norway;
- Relevant changes in knowledge occur;
- Any other new relevant information is provided.

It is highly recommended that the present report is made available to stakeholders for comments during a period of minimum 6 weeks, and that relevant information is taken into consideration. Important stakeholders would be the international scientific community, particularly experts in swine diseases, the Norwegian and Icelandic swine industries, as well as governmental organs with specific knowledge about the swine health situations and impacts. Until this is done, the present report should be considered as a preliminary report.

The Norwegian swine industry

Structure

Norway has one breeding organization, Norsvin, and two slaughterhouse organizations, Nortura, the cooperative organization with about 73 % of the swine production, and KLF, the private slaughterhouse organization with local, independent slaughterhouse units and about 27 % of the total swine production.

About 1.5 million swine are slaughtered per year, and the total number of breeding sows (> 6 months) is about 80,000 distributed in 1,654 herds (1,412 mixed breeding-finishing herds and 242 breeding herds). There are 13 sow pools and 1,130 fattening herds.
Norway has 51 nucleus herds (40 Landrace, 10 Duroc and one Hampshire) and 85 multiplying herds, including 3 SPF herds. About 20,000 sows are sold from the nucleus or multiplying herds to conventional herds each year, and this constitutes about 98 % of the total number of sows sold per year in Norway. There is one AI centre in Norway, owned by Norsvin. About 90 % of the sows are served by AI with semen coming from boars at this station.

Health

All the laboratory tests and results mentioned in this report have been performed by the National Veterinary Institute in Norway or Denmark.

Health status concerning list A and list B diseases

The Norwegian swine population is free from all list A and most of the list B diseases. As shown in **Table 1**, most of these diseases have never been diagnosed in Norway.

Table 1. Diagnosis of list A and list B diseases in Norway.

Disease	Last time diagnosed in Norway
List A diseases	
Foot and mouth disease	1952
Classical swine fever	1963
African swine fever	Never
Vesicular stomatitis	Never
Swine vesicular disease	Never
Teschen disease	Never
Aujeszkys	Never
TGE	Never
Brucellosis	Never
List B diseases	
Swine influenza	Never
PRRS	Never
PRCV	Never
PED	Never
Leptospirosis	Never confirmed. Last suspected in 2002
Bovine tuberculosis	1986
Clostridium perfringens type C infection	Sporadically in one geographic area
Salmonellosis	Very low prevalence of *Salmonella* spp. in the surveillance programme. No clinical cases during the last 20 years
Trichinella spiralis infection	1994

National surveillance and control programmes for specific virus infections in swine herds in Norway

A national surveillance programme for specific virus infections in the Norwegian swine population has been ongoing since 1994 (Lium *et al.* 2004b, Kampen *et al.* 2007). The aim of the programme has been, through serological surveillance, to document that the Norwegian swine population is free from Aujeszky´s disease (AD), transmissible gastroenteritis (TGE), porcine respiratory coronavirus (PRCV), porcine reproductive and respiratory syndrome (PRRS), porcine epidemic diarrhoea (PED) and swine influenza (SI), and to contribute to the maintenance of this favourable situation.

All commercial swine herds are covered by the programme. All nucleus and multiplier herds (breeding herds) (140-180 herds) are tested annually. In addition, a random sample of the remaining swine population, farrowing herds, as well as integrated herds and finishing herds, are included in the annual sampling. The National Food Safety Authority is responsible for the implementation of the programme and for measures in case of positive reactions.

Between 458 and 1,112 herds have been tested annually, since the programme started. This constitutes 6 % to 14 % of the total number of swine herds in Norway in the actual years. The mean number of animals tested per herd per year has been on average 10.5 (range 4 to 20).

All 80,000 blood samples tested between 1994 and 2007 were negative in all serological tests except for low-titer reactions for antibodies against type H_3N_2 of swine influenza in 2 of 19 swine from one multiplier herd in 1998. No clinical signs of swine influenza were observed in the herd, and all samples analysed in subsequent years have been negative for antibodies against H_3N_2.

None of the viral infections included in the surveillance programme have ever been diagnosed in Norwegian swine herds. A confirmed infection with any of these viruses (except PRCV) will initiate an attempt to eradicate the infection by "stamping out". A comprehensive epidemiologic investigation will be performed to find the source of the infection, and all other contact herds.

The results from the national surveillance programme performed since 1994 provide strong support for freedom from AD, TGE/PRCV, PED, PRRS, type H_1N_1 of swine influenza and most probably also swine influenza type H_3N_2 in the Norwegian swine population.

National surveillance and control programme for Salmonella *spp. in swine*

The aims of the *Salmonella* spp. surveillance programme with regard to swine are to provide reliable documentation of the prevalence of *Salmonella* spp. in the Norwegian swine population and to ensure that Norwegian pork and pork products are virtually free from *Salmonella* spp. (Lium & Hopp 2004, Lyngstad *et al.* 2007). The programme is based on bacteriological examination for *Salmonella* spp. The number of samples in different parts of the programs is estimated to be sufficient to detect at least one positive sample of *Salmonella* spp. with a confidence level of 95 % if the prevalence in the population is at least 0.1 %.

Faecal samples from swine in the elite and multiplier breeding herds have been tested annually since 1995. The annual prevalence of *Salmonella* spp. in these herds has ranged from 0 % to 0.6 % on a herd level, with one multiplier herd testing positive in 1995 (*S.* Agona) and another in 2002 (*S.* Typhimurium). Mesenteric lymph nodes from a total of 35,834 slaughtered swine (fatteners and sows) have been examined (1995-2006), and *Salmonella* spp. have been detected in 16 samples, which gives an overall observed prevalence of 0.06 %. From 0 to 4 lymph node samples have tested positive for *Salmonella* spp. each year, which gives an annual prevalence varying from 0 % to 0.15 %. None of the 33,753 swab samples from the surface of swine carcasses has proven positive. Of the *Salmonella* spp. isolates from live swine, 9 were *S.* Typhimurium and the remaining isolates were *S.* Agona, *S.* Bareilly, *S. diarizonae*, *S.* Infantis, *S.* Hadar, *S.* Hessarek and *S.* Saintpaul.
The occurrence of *Salmonella* spp. in Norwegian swine and pork is similar to what has been reported from Sweden, but it is very low compared to reports from other countries. It is important for Norway to maintain this favourable situation. When *Salmonella* spp. is found in live swine or lymph nodes, action is taken to eliminate the infection from the herd, to prevent transmission to other herds and to prevent contamination of food products. In addition, an investigation aiming at finding the source of the infection or contamination is initiated.

In conclusion the results from the surveillance programme during the years 1995 to 2006 confirm an extremely low prevalence of *Salmonella* spp. in Norwegian swine.

Serological surveillance for Leptospira interrogans

Norsvin and the Norwegian swine health service have, in cooperation with the National Veterinary Institute, performed an investigation to study the prevalence of antibodies against *L. interrogans* in boars selected for AI service, and in sows from randomly selected Norwegian herds (Lium *et al.* 2004a). The correlation between the serological status and the reproductive performance of the investigated sow herds was also studied.

Serological investigation of AI boars:
During 1995 to 2003, serological samples from all boars selected for use at Norsvin´s AI centre were analysed for antibodies against *L. interrogans*. The boars originated from approximately 80 elite breeding herds. Until June 2000 the analyses included testing against serovars Bratislava, Pomona, Grippotyphosa, Hardjo, Tarassovi and Ballum with 1,206 boars tested. From June 2000 to October 2003, the analyses were restricted to serovars Bratislava and Pomona with 1,182 boars tested. Among the 2,388 samples analyzed, 62 (2.6 %) were positive for serovar Bratislava. None was found positive for other serovars.

Serological investigation of sow herds:
Serological samples from 5 sows in each of 193 randomly selected herds included in the Norwegian surveillance and control programme for viral swine diseases in year 2002 were analysed for antibodies

against serovars Bratislava and Pomona. Among the 965 samples tested, 45 (4.7 %) were positive for antibodies against serovar Bratislava. The highest titre found was 1:400. The positive samples represented 40 different herds (20.7 % of the herds). Only five of the positive herds had two positive samples, and none had more than two positive. All samples were negative for antibodies against serovar Pomona. The herds sampled in this survey reflect the population of Norwegian swine farms in terms of geographical location and herd size. The prevalence of herds tested positive for serovar Bratislava varied between 12.7 % and 26.7 % in different parts of the country.

Results from the litter recording system were available from 73 negative and 18 positive herds. This investigation revealed no correlation between positive titres for antibodies against serovar Bratislava and the reproductive performance in the herds, however, the number of samples from each herd was limited.

The results from this investigation indicate that the prevalence of antibodies against serovar Bratislava in Norwegian swine is low, and lower than what is reported from other countries. Other serovars of *L. interrogans* than Bratislava seem to be of no significance in the Norwegian swine population.

Eradication programme for Mycoplasma hyopneumoniae in the Norwegian swine population

The Norwegian swine industry has since 1994 implemented a surveillance and control programme for *M. hyopneumoniae* (Lium & Baustad 2002). The aim of this programme has been to eradicate *M. hyopneumoniae* from all swine herds in Norway. The herds' health status has been proved by testing blood or colostrum samples for antibodies against *M. hyopneumoniae* by a monoclonal blocking ELISA (DAKO®, Denmark) which has very high sensitivity and specificity (Sørensen *et al.* 1993). Since the programme was initiated in 1994, more than 110,000 blood or colostrum samples from swine in more than 2,900 herds, including all herds with sows, have been tested. Herds testing positive have to perform an eradication programme. Per 31 December 2007 there were only 4 - 5 known positive herds in the country, and the infection most probably will be eradicated from all these herds in 2008. This means that the whole Norwegian swine population will be virtually free from *M. hyopneumoniae.*

Infections that do occur in Norwegian swine herds

Porcine circovirus type 2 (PCV2):
This virus is assumed to occur in almost all swine herds in Norway, but the associated disease PMWS is rare (3 cases by 2 april 2008). In 2003, PMWS was diagnosed in two farrowing herds in Norway (Brunborg *et al.* 2004). All swine in both herds (herd 1 and 2) were slaughtered in 2004, and the herds were restocked. The third and last case diagnosed in Norway was diagnosed on 14 February 2008 in a farrowing herd (herd 3, 180 sows).

These three herds are localized in different parts of Norway, and there has been no obvious connection between the herds. Sequence information of the PCV2 strains shows that the strains from herds 1 and 3 belong to genotype 1, which is considered as the most pathogenic by some scientific groups, and also found in the Icelandic herd affected by PMWS in 2006. The strain from herd 2 belongs to genotype 2, the most common strain found so far in Norway and considered less pathogenic.

In Norway PMWS is a list C disease, but so far, stamping out has been performed to attempt to eradicate it. Stamping out was carried out in herds 1 and 2 in 2004, and will most probably be completed in herd 3 in a few months.

In 2006-2007, The Norwegian Pig Health service and Norsvin, in cooperation with the National Veterinary Institute, performed an investigation to search for clinical, pathoanatomical and virological indications of PMWS in Norwegian nucleus herds (Moldal *et al.* 2008). Twenty-nine nucleus herds that had produced more than 100 litters in 2005 were included in the survey. Veterinarians in the Norwegian Pig Health Service visited the farms during May and June 2006. In each herd, five weaned piglets (5-11 weeks old) were selected for autopsy. Piglets in poor body condition and piglets having diarrhoea or dyspnoea were prioritised. In 2007, blood samples were collected from five healthy piglets (10-12 weeks old) in 23 of the 29 nucleus herds. Clinical examination and autopsies including histopathological and immunohistochemical investigations did not reveal evidence of PMWS in any of the 29 Norwegian nucleus herds investigated. Sequence information on the PCV2 strains found in nine of the herds indicates low pathogenicity, genotype 2.

***Actinobacillus pleuropneumoniae*:**
Serological surveys performed by the Norwegian swine health service indicate that one or more serotypes of *A. pleuropneumoniae* do occur in most of the swine herds in Norway, including the nucleus and

multiplier herds. Based on the serological results the most common serotypes are type 2, 6, 7, 8 and 10. Serotypes 6 and 8 have been most frequently associated with clinical outbreaks during the last 10 years.

Toxigenic *Pasteurella multocida* **(atrophic rhinitis):**
In the early 1990ies the Norwegian swine health service performed a survey with nasal swabbing of swine in the nucleus and multiplying herds indicating that this bacterium was present in about 40 % of the herds. There have been no or very moderate clinical signs of atrophic rhinitis in these herds.

Brachyspira hyodysenteriae **(swine dysentery):**
Swine dysentery occurs sporadically in conventional herds. Nucleus and multiplying herds, however, are free from this infection. If the infection is detected, the herd, an eradication programme is practiced. During 2006 and 2007 all nucleus and multiplying herds were tested by bacteriological examination of rectal swabs from 60 swine in each herd. Except for one herd that had clinical signs, all herds tested negative.

*Sarcoptes scabiei***:**
All nucleus and multiplier herds have to be free from this infection, and more than 98 % of herds selling piglets are free from mange.

Others:
Lawsonia intracellularis (porcine proliferative enteropathy), enterotoxic and enterotoxemic *Escherichia coli* (enteritis and edema disease), *Streptococcus* spp. (most common Group C), *Haemophilus parasuis* (Glässers disease), *Erysiphelothrix rhusiopathiae* (erysipelas), *Isospora suis* (coccidiosis) and *Ascaris suum* are all frequently found in Norwegian swine herds.

Health requirements, health control and biosecurity in nucleus and multiplier herds (breeding herds)

The swine industry (Norsvin and the slaughterhouse organisations) have worked out special requirements for health, biosecurity and hygiene in the breeding herds. The breeding herds have to be free from all notifiable diseases (list A and list B diseases). In addition they shall be free from *Mycoplasma hyopneumoniae* (enzootic pneumonia), *Brachyspira hyodysenteriae* (swine dysentery), *Sarcoptes scabieii* (mange), and clinical symptoms of atrophic rhinitis.

These herds have quarterly inspections by an approved veterinarian. Based on clinical inspection of the animals in the herd, health recordings in the herd, disease recording from the meat inspection, results from laboratory examinations and result from the national and mycoplasma surveillance programmes, he signs a health certificate, which among others contains freedom from mycoplasma.

All nucleus herds are "closed". That means that they are not allowed to bring in swine from other herds. They are, however, allowed to use AI with semen approved by the National Food Safety Authority and Norsvin. Multiplier herds are allowed to buy replacement gilts from a single approved nucleus herd. Breeding herds shall have an approved biosecurity system to prevent spread of infection by visitors or in connection with transport of swine in or out of the herds.

Health monitoring and biosecurity at Norsvins test stations and AI centre

The AIC Norsvin's conforms to OIE guidelines on porcine semen – see Annex 1.
The detailed measures applied to boars of different origins are illustrated in Figure 2.

LL and DD boars come from the nucleus herds to Norsvin's test stations for boars. Selected boars from the test stations undergo a 6-weeks quarantine before they go to the AI centre. Before they are sent to the quarantine, they are tested for AD, CSF and brucellosis. LD boars come directly from the nucleus herds to the quarantine. Before they are sent to the quarantine, they are tested for AD, CSF and brucellosis. After at least 3 weeks in the quarantine they are tested for AD, brucellosis and PRRS. During quarantine all boars are treated with the antibiotic dihydrostreptomycin (DHS) two times with an interval of 14 days. In addition they are vaccinated against porcine parvovirus and erysipelas two times with three weeks interval.

YY and HH boars come from separate quarantine herds, one for Yorkshire and one for Hampshire. Selected boars from these herds are sent to 18 weeks quarantine before they go to the AI centre. After 9 weeks they are tested for AD, CSF, brucellosis and PRRS, and after 15 weeks they are tested for AD, brucellosis and PRRS. During the stay in the quarantine all boars are treated with the antibiotic dihydrostreptomycin

(DHS) two times with an interval of 14 days, and they are vaccinated against porcine parvovirus and erysipelas two times with three weeks interval.

Boars staying at the AI centre are tested for AD, CSF, PRRS and brucellosis with 12 months interval. The same testing regime is carried out for boars that are sent from the AI centre to slaughter.

To reduce the risk for spread of bacteria, included *Leptospira* spp, through AI, an antibacterial component (Tri-X-cell) containing tylosin, amoxicillin and gentamycin, is added to the semen.

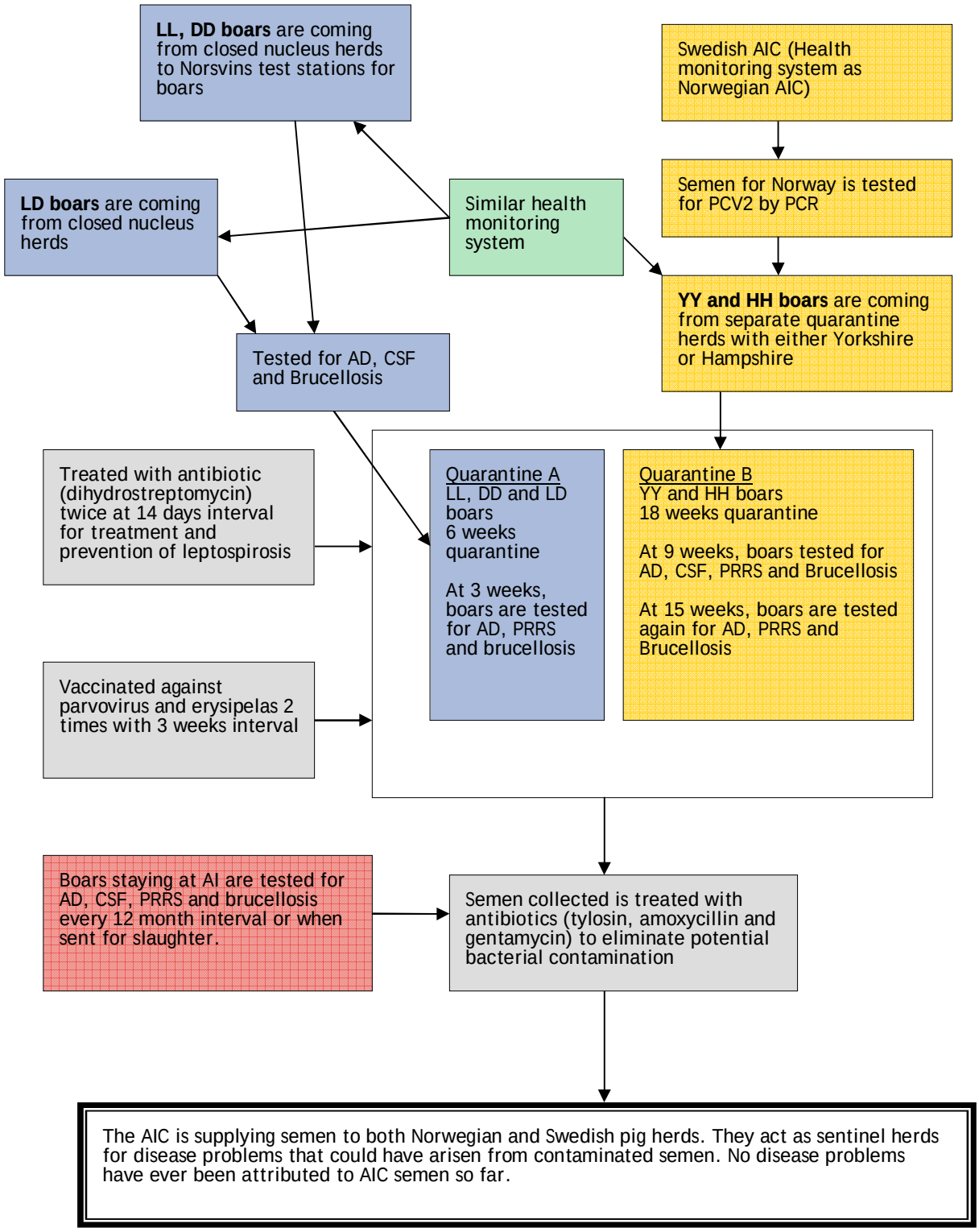

Figure 2. Flow chart on biosecurity measures to ensure that the semen collected at AIC is pathogen free.

Importation of live swine and boar semen

The importation of live swine and boar semen into Norway is limited (see Table 2 and Table 3) and strictly regulated (see Annexes 2 and 3).

Table 2. The imports of live swine to Norway during the last 10 years.

Year	Number of swine	Exporting country	Importer
1997	30	Sweden (SPF swine)	Knive Gård SPF herd
1998	8 (minipigs)	Denmark (SPF research institution)	Norwegian School of Veterinary Science (for research purposes, euthanasied afterwards)
1999	3 (minipigs)	Denmark (SPF research institution)	Norwegian School of Veterinary Science (for research purposes, euthanasied afterwards)
2000	No import recorded		
2001	No import recorded		
2002	No import recorded		
2003	8 (minipigs?)	Denmark (SPF research institution)?	Norwegian School of Veterinary Science (for research purposes, euthanasied afterwards)?
2004	No import recorded		
2005	49 Hampshire	Finland SPF	Scanpig (SPF) isolation multiplier
2006	1 (minipig)	Germany	Private person

Table 3. The imports of boar semen to Norway (number of doses).

Year	Number of doses			
	To Norsvin (YY) - origin		To Scanpig (HH) - origin	
1998	64	England		
1999	194	England/Finland		
2000	90	Finland		
2001	58	Finland		
2002	112	Finland		
2003	220	Finland		
2004	200	Finland		
2005	230	Finland	164	Sweden
2006	58	Finland	112	Sweden
2007	320	Sweden	198	Sweden

For many years until 2006, YY-semen was imported from Finland to Norsvin's quarantine multiplier herd for Yorkshire. Since 2007, the YY-semen is imported from Sweden. Since 2005, HH-semen is imported from Sweden to Scanpigs quarantine multiplier herd for Hampshire.

The AI centres in Finland and Sweden have principally implemented a similar quarantine and control regime as described for Norsvin's test stations and AI centre. All ejaculates intended for export to Norway are tested for PCV2 by a PCR developed at the National Veterinary Institute in Sweden (SVA).

The quarantine multiplier herds receiving imported boar semen for Yorkshire and Hampshire respectively are comprised by the same health requirements, health control and biosecurity instructions as described for nucleus and multiplier herds.

KOORIMP (The Norwegian Farmers Advisory Council for the Prevention of Transmittable Import related Animal Diseases) has worked out special requirements for biosecurity and testing in these herds.

The Icelandic swine industry

This information was kindly provided by Dr. Konráð Konráðsson, Icelandic Food and Veterinary Authority, after request in January 2008.

Structure

Iceland has about 20 herds with a total number of about 4,000 sows. Most of the herds are conventional herds with sows and finishing swine. Of about 20 herds, 3 of them are pure sow herds, 5 of them are pure finishing herds (i.e. weaning swine are fattened for slaughter) and the rest of them are conventional herds. None of the herds are true breeding herds (no nucleus breeders). Imported sows or swine from Norway are transported into the herds after a certain quarantine period. In the year 2006 (numbers for 2007 are not yet available) about 75,000 slaughter swine were produced in Iceland.

Health

The health situation of swine in Iceland is good concerning infectious diseases, and it is very similar to the swine health situation in Norway. Concerning the diseases of interest for the present risk assessment, the following information is of importance:

PRRS is a notifiable, list B disease and has never been diagnosed in Iceland. There have never been positive serological tests for antibodies against PRRS virus in Iceland.

Swine influenza is a notifiable, list B disease, and has never been diagnosed in Iceland. There have been few sporadic positive tests for antibodies against SIV (H_1N_1 and H_3N_2), but follow-up testing of herds or animals in quarantine has always been negative.

Porcine circovirus (PCV) is common in Icelandic swine and in the year 2001 antibodies against PCV2 were found in 6 of 7 herds examined. PMWS has been diagnosed in two herds, one in January 2006 and another in November 2007. The DNA sequence of the PCV2 isolated from swine in the first Icelandic herd with PMWS was very similar to the PCV2 isolated from the first case of PMWS in Norway. PMWS is not listed in the Icelandic legislation, but affected herds are restricted in movement of live swine or semen to other herds.

Leptospirosis is a notifiable, list B disease. This disease has never been diagnosed in swine herds in Iceland, but a serological screening in 2004 revealed that about 4 % of the tested swine, and about 50 % of the herds tested, had antibodies against *L.* Bratislava (titer 1:100). Same herds were negative for antibodies against *L.* Pomona. Other serotypes were not tested. These results are very similar to what was found in a similar screening of Norwegian herds.

Salmonella is a notifiable, list B disease, and Iceland is performing a comprehensive surveillance programme.
About 25 % of the swine carcasses are tested for *Salmonella* spp. by swabbing. The prevalence of Salmonella in swine carcasses is very low (<1%).
Sampling is also performed for meat juice test (cut-off S/P ratio 0.1) where every herd is tested for antibodies against *Salmonella* spp. Based on the serological results and calculation of a *Salmonella* index, the herds are divided into three categories. Since autumn 2006, all herds have been graded as group one.
In 2007 *S.* Infantis was diagnosed in faecal samples from one out of 13 herds.
Salmonella is not considered a problem in Icelandic swine production, but *Salmonella* spp. can be detected in routine tests.

Mycoplasma hyopneumoniae is a list C disease and it is common in most of the swine herds in Iceland. Many herds are vaccinating against *M. hyopneumoniae*.

Actinobacillus pleuropneumoniae is very common in Icelandic swine herds, and antibodies against one or more serotypes of *A. pleuropneumoninae* are common in almost all herds. Clinical signs caused by infection with *A. pleuropneumoniae* are seen only sporadically in some few herds. Serotypes 2, 6, 7, 8 and 12 of *A. pleuropneumoniae* are the main serotypes that have been tested for and identified.

Surveillance and control programmes

In 2007, a surveillance programme for AD, PRRS (EU and US type), TGE, PRCV and SI (H_1N_1, and H_3N_2) was started. Two times a year, blood samples from 15 finishing swine from 8 herds were tested for antibodies against the agents listed above. All samples were negative in all tests. Previous tests have sporadically shown some few low positive titres for SI, but there have been no clinical signs of SI, and following up testing has always been negative.

All Icelandic swine herds are planned to be yearly tested for *Salmonella* spp. by bacteriological examination of faeces sampled in the herds (started in 2007), by examination of meat juice from slaughtered swine with a serological test for antibodies against *Salmonella* spp. (started in 2006) and by examination of swabs from carcasses at slaughter (started in 2006) with a rapid test for *Salmonella* spp. – Tecra test. In 2007, 10 swabs out of 1,930 were positive for *Salmonella* spp. with the Tecra Test.

Importation of live swine and boar semen

Since 1994 Iceland has imported about 800 swine from Norway. In 1997 there was one import of 25 swine from Finland. Imported swine are kept in quarantine for at least 8 weeks. During the stay in the quarantine they are tested for antibodies against AD, PRRS, SI, TGE, PRCV and *Salmonella* spp. Faecal samples are also tested for *Salmonella* spp. and parasites. If all swine are negative in all tests and they are clinically normal, they are moved to conventional herds.

If imported swine are positive for an agent or a disease that is already diagnosed in the local swine breed it is usually not considered as a hazard.

Semen has been imported three times from Norway, since 2001. Only sows in the quarantine have been inseminated. After farrowing, weaning and routine testing in the quarantine, swine were transported to the Icelandic herds. Each time semen has been imported, approx. 25 sows have been inseminated.

When semen is imported, blood samples are taken from the sows before and after insemination for comparison.

Hazard identification

This part identifies if the diseases or agents of concern are hazards, that means they could potentially produce adverse consequences to Iceland, when importing live boars or semen from Norway.

PMWS

Although the etiology of PMWS is still uncertain and is believed to be multifactorial, the associated virus, PCV2, can potentially be imported with live animals and semen.

In Norway, PMWS is a list C disease and has been diagnosed in a total of three herds by 2 april 2008, two farrowing herds in 2003 and one farrowing herd in Febuary 2008. None of them were multiplying herds. Stamping out was performed in the first two herds in 2004 and is planned to be undertaken within a few months for the third herd. These three herds are localized in different parts of Norway, and there has been no obvious connection between the herds. Sequence information of the PCV2 strains shows that the strains from herds 1 and 3 belong to genotype 1, which is considered as most pathogenic by some scientific groups, and also found in in the Icelandic herd diagnosed with PMWS in 2006. The strain from

herd 2 belongs to genotype 2, the most common strain found in Norway and considered less pathogenic. The origin of these strains and the reason for the outbreaks are unknown. There has been an intensified surveillance in nucleus herds, without PMWS being identified. Semen imported from Sweden is tested for PCV2 and only negative semen is allowed imported.

In Iceland, PMWS has been diagnosed in two herds, in 2006 and 2007. There are no documented free zones or zones of low prevalence, and PMWS or PCV2 are not subject to an official control programme. PCV2 is common in both Iceland and Norway and there's no indication that the Norwegian strains are more virulent than the Icelandic strains.
Conclusion: PMWS is not a hazard.

PRRS

PRRS can potentially be imported with live animals and semen.

In Norway, PRRS has never been diagnosed despite national surveillance since 1995. It is a notifiable list B disease subject to an official control strategy. The surveillance includes the annual sampling of all breeding herds, 240 mixed herds, 60 finishing herds and 20 wild boars herds[1]. In addition, all boars used for AI are tested during the quarantine period, as well as annually. The test used is the best available, as it detects the most predominant European and American types of PRRSV and is considered the golden standard for detection of antibodies to PRRSV (HerdCheck ® 2XR PRRS ELISA, IDEXX Laboratories). In the case of dubious or positive reactions, the samples are retested with blocking ELISA and immune-peroxidase tests (IPT) at the Danish Veterinary Institute. When first introduced, PRRSV has a great capability to establish itself and spread in the swine population, and would therefore be detected by the existing surveillance. Therefore, the probability that PRRS is present but undetected in Norway is negligible.

The semen imported from Sweden comes from stations with the same biosecurity measures as Norsvin's AI station and goes to the Hampshire and Yorkshire quarantine multiplier herds. Norway has strict requirements to protect against PRRS when importing live swine or semen (See Annexes 2 and 3). Therefore, it is highly unlikely that PRRS can enter the Norwegian swine population.
Conclusion: PRRS is not a hazard.

Leptospirosis

Leptospirosis can potentially be imported with live animals and semen.

In Norway, leptospirosis has never been diagnosed. It is a notifiable list B disease subject to an official control strategy. It was suspected to be the causative factor in one herd with reproductive problems in 1991 and one in 2002, and control measures were applied. However, the diagnosis was never confirmed. The causative agent, *Leptospira* spp., is divided in subgroups where the subgroup *Leptospira interrogans,* particularly the subtypes Bratislava and Pomona, seem to be most important in Europe. Only antibodies against *L. interrogans* Bratislava have been identified in Norway, in 2,6 % of boars intended for use in AI, 4,7 % of tested sows, and 20.7 % of the herds. There was no significant correlation between serology and reproductive performance. However, unreported leptospirosis could still occur in Norway since antibodies against *L. interrogans* Bratislava is present in a small fraction of the animals. Treatment with dihydrostreptomycin is however systematically given to boars before entering the AIC.

In Iceland, the situation is very similar to Norway. Leptospirosis is a notifiable, list B disease. It has never been diagnosed, but a serological screening in 2004 revealed that about 4 % of the tested swine, and about 50 % of the herds tested, had antibodies against *L. interrogans* Bratislava, but none against *L. interrogans* Pomona. Thus the disease might be present in Iceland. There are no documented free zones or zones of low prevalence. When compared to Norway, the strain in Iceland is not less virulent than the strain found in Norway. In Iceland the disease is subject to an official control programme.
Conclusion: Leptospirosis is a hazard.

[1] http://www.mattilsynet.no/mattilsynet/multimedia/archive/00009/Overv_knings_og_kontr_9330a.pdf

Salmonella spp.

Salmonella spp. can potentially be imported with live animals, and semen if contaminated during collection.

In Norway, *Salmonella* spp. is present, but at very low prevalence. It is a notifiable list B disease subject to an official control strategy. The 16 positive isolates found in the 35,834 lymph nodes and 33,753 swab samples from swine examined in 1995-2006 have been *S.* Typhimurium (9 isolates), *S.* Agona, *S.* Bareilly, *S. diarizonae*, *S.* Infantis, *S.* Hadar, *S.* Hessarek and *S.* Saintpaul.

In Iceland, *Salmonella* spp. in general is also present at low prevalence. There are no documented free zones or zones of low prevalence. When compared to Norway, there are no indications that the strains from Iceland are less virulent than the strains in Norway. In Iceland the disease is subject to an official control programme as it is a notifiable, list B disease.
Conclusion: *Salmonella* **spp. is a hazard.**

Swine influenza

Swine influenza can potentially be imported with live animals, but not semen.

In Norway, swine influenza has never been diagnosed. It is a notifiable list B disease subject to an official control strategy. It is included in the national surveillance and control programme for specific virus infections in swine since 1997, and a total of 47,710 samples were tested in 1997-2006. All breeding herds as a random sample of remaining herds, are tested annually with relatively more samples from areas considered at higher risk. Antibodies against H_1N_1 and H_3N_2 are tested by the hemagglutination inhibition test, according to the OIE procedure. It is a highly contagious disease, which would be expected to spread rapidly if it was introduced. The probability that swine influenza is present in Norway without being detected is therefore negligible.

Imports of live swine to Norway are rare and subjected to strict prevention measures (See Annexes 2 and 3). Imported swine must come from a closed herd and are isolated 30 days before export. Once in Norway they are quarantined two months. They are examined for swine influenza both in the exporting country and in Norway. The probability that swine influenza is imported into Norway is therefore negligible.
Conclusion: Swine influenza is not a hazard.

Mycoplasma hyopneumoniae (Porcine Enzootic Pneumonia)

Mycoplasma hyopneumoniae can potentially be imported with live animals, but not semen.

In Norway, *M. hyopneumoniae* is close to being eradicated, but a few herds still have the infection.

In Iceland, *M. hyopneumoniae* is common in most of the swine herds. There are no documented free zones or zones of low prevalence. When compared to Norway, there are no indications that the strains in Iceland are less virulent than those in Norway. In Iceland, the disease is not subject to an official control programme.
Conclusion: *Mycoplasma hyopneumoniae* **is not a hazard.**

Actinobacillus pleuropneumoniae

Actinobacillus pleuropneumoniae can potentially be imported with live animals, but not semen.

In Iceland, clinical signs caused by infection with *A. pleuropneumoniae* are seen only sporadically in some few herds, but antibodies against one or more serotypes of *A. pleuropneumoninae* are common in almost all herds. There are no documented free zones or zones of low prevalence. When compared to Norway, there are no indications that the strains in Iceland are less virulent than those in Norway. In Iceland, the disease is not subject to an official control programme.
Conclusion: *Actinobacillus pleuropneumoniae* **is not a hazard.**

Summary:

- PRRS and Swine influenza are not hazards because there is convincing evidence that they are absent from the Norwegian swine population and the probability of introducing these diseases into Norway through importation is negligible.
- PMWS, *Mycoplasma hyopneumoniae* and *Actinobacillus pleuropneumoniae* are not hazards because the health status concerning these diseases in the Icelandic swine population are not better than in the Norwegian swine population, and they are not subject to an official control programme in Iceland.
- Leptospirosis and *Salmonella* spp. are both hazards because they are subject to an official control programme in Iceland. The health situations, however, are very similar in Norway and Iceland.

Risk assessment

The present chapter assesses the risk of importing Leptospirosis and *Salmonella* spp. through live boars or boar semen, from Norway to Iceland. It is assumed that the live boars are imported from a nucleus herd, and the semen is imported from Norsvin's AIC.

Leptospirosis

Release assessment

The introduction of Leptospirosis into the Icelandic population requires that a number of steps all occur, as described in the event tree, page 10. The probability of each of these necessary steps is evaluated, assuming that the precedent steps have occurred. A table grouping the conclusions, as well as main reasons for this conclusion, is shown for live boars, then semen. The overall conclusion is given below the table in each case.

The genus *Leptospira* is divided in subgroups and many subtypes, and the subgroup *Leptospira interrogans* with the subtypes Bratislava and Pomona seems to be most important in Europe. Although the Norwegian swine population has a low prevalence of positive serology to *L. interrogans* Bratislava (2.6 % of the 2,388 boars selected for AIC and tested in 1995-2003), there have never been any confirmed cases of Leptospirosis, and only two suspicions, suggesting a very low prevalence of the agent. Other strains have never been detected despite several years of active surveillance. The absence of confirmed cases of Leptospirosis suggests the prevalence of the most virulent strains among these, particularly Pomona, is negligible.

Serological testing with the MAT (Micro Agglutination test) is the most common method for diagnosing leptospirosis, but the method has severe limitations in the diagnosis of chronically or subclinically infected swine, as usually is the situation in swine infected with serovar Bratislava. Infected swine may have MAT-titers below the accepted minimum significant titer of 1:100. This test should be used on herd basis and not individually.

Live boars

Table 4. Likelihood of each step for the probability of release of Leptospirosis by import of live boars.

Live boars	Likelihood	Comments
Exporting herd infected	Very low (Bratislava) Negligible (Pomona)	Prevalence of serologically positive boars is low (Bratislava) or very low/negligible (Pomona) in Norway. It's a notifiable disease and only two suspected (1991 and 2002), but no confirmed clinical cases have been reported.
Infection is undetected	High (Moderate/ low if the herd is tested)	No ongoing surveillance. Hard to detect because *L. interrogans* Bratislava, which is the most probable agent in Norway, very often causes mild to subclinical infections, especially in indoor productions as is the case in Norway.
Infected boar selected for export	Moderate	2.6 % boars found positive in Norway, within herd prevalence up to 22 % reported (Chappel *et al.* 1998).
Infected boar undetected during export	High (Moderate with testing)	No pre-export testing. If testing is requested, it is by serology (MAT), which has low sensitivity on individual swine.
Infected boar undetected during quarantine (if any)	High (Moderate with testing)	Testing of boar is not usually done. Clinical manifestation of the disease is absent.
Infected boar released to swine herds in Iceland	High (Very low if treated)	No treatment of boars during quarantine is described.

Conclusion: The overall probability of release of the Leptospirosis agent through live boars is very low for *L. interrogans* Bratislava, and negligible for *L. interrogans* Pomona or other strains. The overall probability of release of *L. interrogans* Bratislava is reduced to negligible if testing and treatment of the boars is introduced during quarantine.

Semen

Table 5. Likelihood of each step for the probability of release of Leptospirosis by import of semen (fresh or frozen).

Semen	Likelihood	Comments
AIC is infected	Negligible	Prevalence is very low in Norway. All boars are treated twice with antibiotic (dihydrostreptomycin) with 14 days interval during quarantine.
Infection is undetected	High	No ongoing surveillance.
Semen is infected	Negligible	Treated with broad spectrum antimicrobial (Tylosin, amoxicillin and gentamycin).
Infected semen undetected during export	High	No testing.
Infected semen causes infection in the sow	Moderate	About 50 % of the Icelandic herds are already serologically positive for *L. interrogans* Bratislava.
Infected sow undetected during quarantine (if any)	High	No testing, few or no signs.

Conclusion: The overall probability of release of the Leptospirosis agent through semen is negligible for all strains of *L. interrogans*, both in semen used fresh and frozen, and both when used in quarantined sows and directly into the Icelandic herds.

Exposure Assessment

The release assessment has shown that the release of *Leptospira* spp. into Iceland was possible only through live boars. Therefore, the exposure assessment is only considered for live boars.

Transmission of *Leptospira* spp. may be horizontal or vertical. The infection is thought to be introduced into susceptible animals via the mucus membranes of the eye, mouth, nose or vagina. Following the period of leptospiraemia, *Leptospira* spp. localize and multiply in the renal tubes, and they are voided in the urine for up to two years. The introduction of *Leptospira* spp. into a herd can occur through the introduction of carrier boars and gilts, and swine to swine transmission via urine is common.

Conclusion: The probability is high that the Icelandic swine population is exposed to *Leptospira* spp. if infected boars are released into the population.

Consequence assessment

The previous steps have shown that the Icelandic swine population may be exposed to *L. interrogans* Bratislava through the introduction of live boars from Norway. The present chapter discusses its possible consequences.

Abortions occurring 2-4 weeks before term are the most common manifestation of leptospirosis in swine, especially for Pomona. Piglets produced at term may be dead or weak and may die soon after birth. General infertility, return to oestrus, may be the only indication of infection with Bratislava. Differential diagnoses include brucellosis, parvovirus, PCV2 and SMEDI (stillbirth, mummification, embryonic death, and infertility). Suboptimal fertility may be a consequence in sows infected with serovar Bratislava at the time of breeding or in early gestation.

However, based on experience from the diagnostic laboratories in Norway, the Bratislava strains found in the Norwegian swine population do not seem to be a significant cause of infertility in Norwegian swine herds.

Since the Icelandic herd is largely based on imports from Norway, it is most likely that the strains found in that population are the same as in Norway. Since leptospirosis causes no problem in Iceland, it is most likely that the introduced strains will not cause any additional harm to the fertility in sows.

Human health risk: Carrier swine present a serious health risk to piggery and abattoir staff and transport drivers. Human infection can cause prolonged and severe symptoms similar to those of 'flu', together with ongoing fatigue and joint soreness, and may involve severe complications such as kidney failure. However, Bratislava is very seldom associated with disease in human beings.

As the leptospirosis situation of Iceland is similar to Norway, an infected boar entering the swine population will not have much impact on the *status quo* of Iceland.

Conclusion: The consequences would be mild to insignificant, if the Icelandic herd was exposed to *L. interrogans* Bratislava through imported boars.

Risk estimation

Conclusion: The probability of introducing *Leptospira* spp.into Iceland through live boars is considered very low for *L. interrogans* Bratislava, and negligible for *L. interrogans* Pomona or other strains. The probability is negligible for all strains if the boars are quarantined and treated with dihydrostreptomycin. The probability of introducing *Leptospira* spp. into Iceland through semen is negligible for all strains. If *L. interrogans* Bratislava is introduced, the consequences are expected to be mild to insignificant.

Salmonella spp.

Release assessment

Live boars

Table 6. Likelihood of each step for the probability of release of *Salmonella* spp. by import of live boars.

Live boars	Likelihood	Comments
Exporting herd infected	Very low	Prevalence is very low in Norway. It is a notifiable disease and no clinical cases have been reported. Ongoing national surveillance and control programme.
Infection is undetected	High	Surveillance is once a year. Within herd prevalence is very low < 1 %. Clinical cases not observed in positive herds.
Infected boar selected for export	Very low	Within herd prevalence is very low < 1 % (Christensen *et al.* 2002).
Infected boar undetected during export	Moderate	Pre-export testing of the exporting herd is requested by Iceland. Pooled faecal samples.
Infected boar undetected during quarantine (if any)	Low	Moderate sensitivity of faecal test. No clinical signs. Both serology and bacteriology.
Infected boar released to swine herds in Iceland	High	No effective treatment during quarantine.

Conclusion: The overall probability of release of *Salmonella* spp. into Iceland through live boars is very low as the prevalence is very low in Norwegian nucleus herds and testing provides additional protection. Serology and faecal test during quarantine reduces the probability further, but not enough to consider it negligible.

Semen

Table 7. Likelihood of each step for the probability of release of *Salmonella* spp. by import of semen (fresh or frozen).

Semen	Likelihood	Comments
AIC is infected	Very low	Prevalence is very low in Norway. It's a notifiable disease and no clinical cases have been reported. Ongoing national surveillance and control programme.
Infection is undetected	High	No ongoing surveillance.
Semen is infected	Negligible	Treated with broad spectrum antimicrobial (Tylosin, amoxicillin and gentamycin).
Infected semen undetected during export	High	No testing.
Infected semen causes infection in the sow	Negligible	*Salmonella* spp. is an enteric pathogen.
Infected sow undetected during quarantine (if any)	High	No testing, few or no signs.

Conclusion: The overall probability of release of *Salmonella* spp. into Iceland through semen is negligible, for both fresh and frozen semen, and both when used in quarantined sows and directly into the Icelandic herds.

Exposure Assessment

The release assessment has shown that release of *Salmonella* spp. into Iceland was possible only through live boars. Therefore, the exposure assessment is only considered for live boars.

Transmission of *Salmonella* spp. is horizontal. An infected boar released into the Icelandic herds may shed *Salmonella* spp. through defecation into the environment and other swine sharing the same living space could be exposed through the oral faecal route.

Conclusion: The probability is high that the Icelandic swine population is exposed to *Salmonella* spp. if infected boars are released into the population.

Consequence assessment

The previous steps have shown that the Icelandic swine population may be exposed to *Salmonella* spp. through the introduction of live boars from Norway. The present chapter discusses its possible consequences.

A number of studies have reproduced experimental infection by the oral route and during acute disease swine will shed up to 10^6 *S.* Choleraesuis (Smith & Jones 1967) or 10^7 *S.* Typhimurium (Gutzmann *et al.* 1976) g^{-1} faeces. Generally high doses have to be used and disease is frequently difficult to reproduce.

In a broad perspective, clinical swine salmonellosis can be separated into two syndromes, one involving S. Typhimurium which is associated with enterocolitis, while the other involves S. Choleraesuis and is usually associated with septicaemia. Intensively reared weaned swine are most often affected by *Salmonella* spp. infection. In general, *S.* Typhimurium tends to cause enterocolitis in young swine from six to twelve weeks of age. Disease from this serovar is rare in adult animals. The initial sign of infection is often watery, yellow diarrhoea. Infected swine are inappetent, febrile and lethargic. Mortality is usually low. However, morbidity can be high within a few days after infection (Wilcock & Schwartz 1992).

In the present risk assessment, however, it must be taken into consideration that even though *S.* Typhimurium is the most common *Salmonella* isolated from swine in Norway, there have not been any reports of any clinical disease in swine. The most common serotype isolated from swine in Norway is *S.* Typhimurium and the reservoar seems to be small birds (sparrows).

As the Icelandic herd is largely based on imports from Norway, it is most likely that the strains found in that population might be similar. Since *Salmonella* spp. causes no clinical problem in Icelandic swine, it is most likely that the introduced strains will not cause any additional harm. Therefore, the consequences, in terms of economic, human health and the environment would not be significantly changed. The most serious consequences of identifying *Salmonella* spp. (including *S.* Typhimurium) in swine are the associated probability that pork and pork products may be contaminated by *Salmonella* spp. , and the associated cost of the control measures in place.

Conclusion: The consequences would be mild if the Icelandic herd was exposed to *Salmonella* spp. through imported boars.

Risk estimation

Conclusion: The probability of introduction of *Salmonella* spp. through live boars is considered very low. Serology and faecal testing during quarantine provides additional protection. The probability of introduction of *Salmonella* spp. through semen is considered negligible.

If *Salmonella* spp. is introduced, the consequences are expected to be mild.

Conclusion

Of the seven diseases considered in this import risk assessment, only *Salmonella* spp. and *Leptospira* spp. are considered hazards.
When live boars are imported, these two hazards represent a very low risk. The risk of introducing *Salmonella* spp. decreases when the boars are quarantined and tested for *Salmonella* spp. The risk of introducing *Leptospira* spp. would become negligible if the boars were quarantined and treated with dihydrostreptomycin.

When semen is imported, both to the quarantine or directly to Icelandic herds, the risk of introducing *Salmonella* spp. and *Leptospira* spp. is assessed to be negligible, both for fresh and frozen semen (Table 8).

Table 8. Risk of introducing selected diseases from Norway to Iceland – a comparison of various import methods.

	Method of Transfer					
	Direct			Via quarantine		
	Live boars	Fresh semen	Frozen semen	Live boars	Fresh semen	Frozen semen
PRRS	Not considered a hazard					
PMWS	Not considered a hazard					
Leptospirosis	Very low	Negligible		Very low	Negligible	
Salmonella spp.	Very low	Negligible		Very low	Negligible	
Swine influensa	Not considered a hazard					
Mycoplasma hyopneumoniae	Not considered a hazard					
Actinobacillus pleuropneumoniae	Not considered a hazard					

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Annexes

Annex 1. OIE guidelines for porcine semen

Article 3.2.2.1.

Conditions applicable to artificial insemination centres

1. The centre should be officially approved by the *Veterinary Authority*.
2. The centre should be under the direct supervision and sanitary control of an *Official Veterinarian*.
3. The centre should be under the overall supervision of the *Veterinary Authority*, which is responsible for routine visits to check the health and welfare of animals, and the procedures and prescribed records at the centre at least every 6 months.
4. Only swine associated with semen production should be permitted to enter the centre. Other species of livestock may exceptionally be resident on the centre, provided that they are kept physically apart from the swine.
5. Swine on the centre should be adequately isolated from farm livestock on adjacent land or buildings for instance by natural or artificial means.
6. The entry of visitors should be strictly controlled. Personnel at a centre should be technically competent and observe high standards of personal hygiene to preclude the introduction of pathogenic organisms. Protective clothing and footwear for use only on the centre should be provided.
7. Individual semen containers and storage rooms should be capable of being disinfected.

Article 3.2.2.2.

Conditions applicable to the introduction of boars

1. Boars should only enter an *artificial insemination centre* if they fulfil the requirements laid down by the *Veterinary Authority*.
2. The semen from boars with genetic defects or associated with genetic defects in near relatives may not be eligible for export.
3. Boars must be clinically healthy and physiologically normal and must pass pre-entry tests within the 30 days prior to entry into isolation at an *artificial insemination centre*. The prescribed diseases and tests are listed in point 3.2.2.3.2. of Article 3.2.2.3.
4. Boars must remain in isolation at an *artificial insemination centre* for a period of at least 30 days before being retested to meet the standards listed in Article 3.2.2.3. Boars may only enter the stud on the successful completion of these tests and must be clinically healthy.

Article 3.2.2.3.

Testing programme for boars

1. Definitions

   Prescribed tests cover a minimal range of diseases from which all boars on an *artificial insemination centre* must be free.

   Routine tests are tests applied at regular intervals to confirm the continued freedom from disease of the stud.

2. Prescribed tests
   a. Bovine tuberculosis

      Boars to give negative results to intradermal tuberculin tests with mammalian tuberculin in accordance with the *Terrestrial Manual*.

   b. [1.] Brucellosis (B. abortus, B. suis)

      Boars to give negative results to serological tests in accordance with the *Terrestrial Manual*.

3. Routine tests
   a. [1.] Swine vesicular disease

Boars to give negative results to a serum-neutralisation test in accordance with the *Terrestrial Manual* (see also Articles 2.6.5.9. and 2.6.5.10. of this *Terrestrial Code*).

Routine tests to be applied at least every 12 months.

b. [1.] African swine fever

Boars to give negative results to enzyme-linked immunoabsorbent assay and indirect immunofluorescent tests in accordance with the *Terrestrial Manual* (see also Articles 2.6.6.10. and 2.6.6.11. of this *Terrestrial Code*).

Routine tests to be applied at least every 6 months.

c. [1.] Enterovirus encephalomyelitis (ex Teschen disease)

Boars to meet certification standards in Articles 2.6.3.9. or 2.6.3.10. of this *Terrestrial Code*.

Routine tests to be applied at least every 12 months.

Claims of country freedom from some viral and bacterial infections of swine may be given consideration providing such claims are backed by serological survey data and epidemiological investigation.

Article 3.2.2.4.

Optional tests and requirements

Artificial insemination centres may be required by the *Veterinary Authority* to include in their veterinary prophylactic programmes a number of other diseases, either through vaccination or by requiring negative results to serological tests.

Additionally, some *importing countries* may require assurances of freedom from a disease (for example: classical swine fever, Aujeszky's disease) based on negative serology or other biological tests. The range of infections to be covered is extensive and beyond the capacity of *artificial insemination centres* to support totally. Thus, only optional tests remain to be applied and interpreted by bilateral agreement when importation of semen is being considered.

Where a disease is covered by a Chapter in this *Terrestrial Code*, the testing requirements of the Chapter should be followed.

Records of the progeny of a donor boar should be maintained as far as possible to determine that he is not associated with any genetic defect. The records of the boar should indicate his fertility. The semen must be obtained from a boar with a normal libido.

Article 3.2.2.5.

Conditions applicable to diluents

Whenever milk, egg yolk or any other animal protein is used in preparing the semen diluent, the product must be free of pathogens or sterilised; milk heat-treated at 92°C for 3-5 minutes, eggs from SPF flocks when available. The inclusion of penicillin, streptomycin, polymixin etc. is permitted, provided that this is declared in the *international veterinary certificate*.

Article 3.2.2.6.

Conditions applicable to the packing and storage of semen

Semen for export should be stored separately in fresh liquid nitrogen in sterilised flasks for at least 28 days.

The examination of ejaculates, and the dilution and freezing of semen must be carried out in a laboratory maintaining the hygienic standards set by the *Veterinary Authority*. The pre-sperm fraction should not be included in material to be stored. Only semen of a health standard equivalent to that produced in an *artificial insemination centre* should be handled.

Semen straws or pellets shall be code marked in line with national standards.

Containers must be sealed before export and accompanied by an *international veterinary certificate* listing the contents.

1. In countries where the diseases marked with an asterisk have not occurred and where country freedom is claimed in accordance with the criteria set out in the relative chapter of this *Terrestrial Code*, the pre-entry/post-entry and routine tests may be dispensed with.

Annex 2. Requirements for import of live swine to Norway

RA = Requirements by the Norwegian authorities
RI = Requirements or recommendations by the Norwegian pig industry

Conditions/agents	In the exporting country	In a Norwegian isolate
Exporting herd closed for at least 1 year	RI	
Animals borne in the herd	RI	
Isolation in Norway, 2 months		RA
Isolation 30 days in exporting herd	RA	
Official status or documentation of freedom of:		
Foot and mouth disease	RA	
Teschen Disease	RA	
Classical swine fever	RA	RA
Swine vesicular disease	RA	RA
Brucellosis	RA	RA
Aujeszky`s disease	RA	RA
Salmonella spp.	RA/ only IR for Finland and Sweden	RA
Transmissible gastroenteritis	RI	RA
Swine influenza	RI	RA
Porcine reproductive and respiratory syndrome (EU and US)	RI	RA
Porcine respiratory coronavirus	RI	RA
Tuberculosis	RI	RA
Leptospirosis	RI	RA
Actinibacillus pleuropneumoniae type 5	RI	RI
Treatment against parasites	RI	RI

Annex 3. Requirements from the swine industry for import of boar semen to Norway

All imports and uses of boar semen shall be approved by KOORIMP.

KOORIMP may approve that boar semen from countries that are free from PRRS may be imported and used without quarantine of the recipient sows.

Boar semen shall be imported only from AIC where all animals are documented free from, and not vaccinated against PRRS. All animals shall be serologically negative for antibodies against PRRS.

If fresh boar semen is imported from a country where pigs are infected with PRRS, the recipient sows shall be quarantined. Blood samples taken after at least 4 weeks in isolate shall be tested for PRRS with a negative result before the recipient animals can be free from quarantine.

If frozen boar semen is imported from countries where pigs are infected with PRRS, semen from each ejaculate shall be used on at least 4 sentinel sows in a Norwegian isolate. Blood samples taken after at least 4 weeks in isolate shall be tested for PRRS with a negative result before the semen can be free for use in Norwegian herds.

It may also be decided to use PCR to detect PRRSV directly in the semen before the semen can be used. If frozen semen is imported the boars may be tested serologically for antibodies against PRRSV before and after the collection of semen.

Annex 4. Peer review

The preliminary report of 11 February 2008 was published on the internet and sent specifically to following persons for comments:

In Iceland, by Ingvi Stefánsson, on behalf of Svínaræktarfélag Íslands :

- Chief Veterinary Officer, Halldór Runólfsson
- Veterinary of Swine Disease, Konráð Konráðsson
- Ministry of Fisheries and Agriculture, Einar K. Guðfinnsson
- Veterinary counsel, 4 members, Chairman, Páll Stefánsson, Eggert Gunnarsson, Auður Lilja Arnþórsdóttir, Gunnar Þorkelsson
- Committee of fisheries and agriculture of the Parliament (Alþingi), 7 members
- The breeding counsel of SFÍ, 7 members

In Norway, by Bjørn Lium, on behalf of the authors:

- Peer Ola Hofmo, Norsvin
- Ingrid Melkild, Norwegian Livestockindustry's Biosecurity Unit (Koorimp)
- Mona Gjestvang og Anne Jørgensen, Norwegian Pig Health Service

The deadline for comments was 25 March, giving a six weeks opportunity to read and comment on the report.

Comments were received from Konráð Konráðsson and Peer Ola Hofmo. Their comments, as well as our response, are summarized below.

Konráð Konráðsson, Icelandic Food and Veterinary Authority:

- A few suggestions about formulations related to the Icelandic health situation.
  Response: All were included in the text.
- Correction related to the new case of PMWS, diagnosed on 14 February 2008.
  Response: Included in the text.
- Additional information about the prevalence of *Salmonella* in Iceland.
  Response: included in the text.
- Question whether we should include in the report that PMWS in Iceland might have entered Iceland through imported swine from Norway, and whether PMWS would have been considered a hazard if the report had been written before 2006. Konráð Konráðsson also suggested that if PMWS has been imported from Norway, then all herds might finally get PMWS since herds add new animals only through import from Norway. The choice of including this aspect in the report, including the probability of this scenario occurring, was left to the authors.
  Response: The hazard identification focuses on the present situation, and therefore does not address how PMWS first came to Iceland. It considers the national or regional status, and not the status of each herd. If it had been performed before 2006 but after 2003, when Norway had its first case, Iceland would have been considered as free from PMWS, and PMWS would have been considered a hazard to Iceland when importing Norwegian swine. In that case, the probability of introducing PMWS from importing Norwegian swines would have been addressed when performing the release assessment. However, it is not addressed in the present report because we follow the OIE guidelines and PMWS is not considered a hazard in 2008. Therefore, the next step (release assessment) is not addressed. This is stated now more clearly in final conclusion and Table 8.

Peer Ola Hofmo, Norsvin:

- Comment related to PCV2 investigation in Norway. The report states that blood samples were collected from 23 of the 29 nucleus herds.
  Response: This statement is true for 2007, as stated in the report. Since then, new herds have been sampled, and some herds have been tested from organs sampled in 2006.
- Comment related to Leptospirosis. Peer Ola Hofmo considers that Leptospirosis should not be considered a hazard, and suggests it would have been better to distinguish between Pomona and Bratislava.
  Response: We indeed considered the option of separating Pomona and Bratislava before the hazard identification. However, because the OIE Terrestrial Animal Health Code (2007) lists Leptospirosis as a list B disease, independent of serovars, we therefore considered all potential agents as causing one disease at this step. However, the distinction between serovars was done when considering the

prevalence of agents and their consequences. If we had distinguished between Pomona and Bratislava, Pomona would not have been considered a hazard since extensive investigations have shown that it's absent in Norway. However, Bratislava would have been considered a hazard since although it's present in both the importing and the exporting countries, it is subject to an official control programme in the importing country (see Methods, option 3.b)). Although Bratislava has lower pathogenicity than Pomona, it is considered as an important reproductive pathogen in pigs[2].

[2] http://www.daff.gov.au/__data/assets/pdf_file/0006/43089/leptoreviewfinal.pdf

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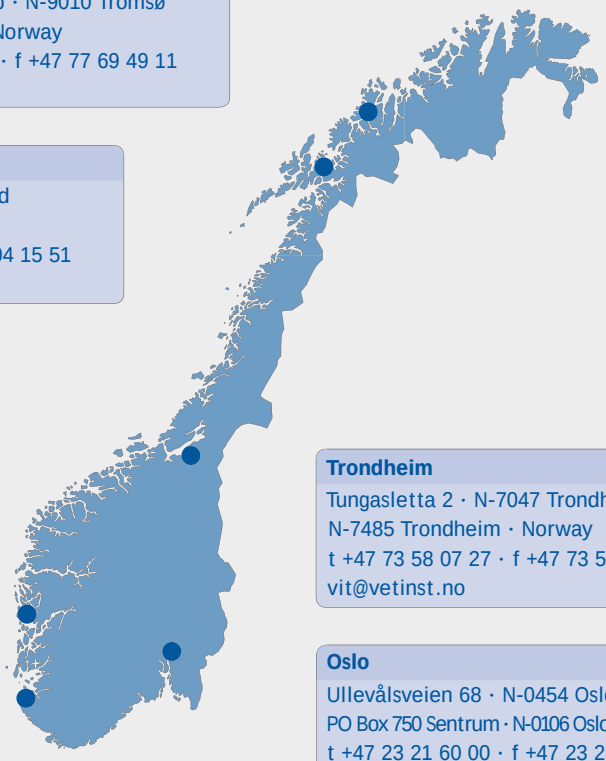

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