NATIONAL VETERINARY INSTITUTE

WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2016

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Introduction

The health status of wildlife in Sweden is monitored through SVA's wildlife disease surveillance program. This annual report summarizes the work and results from the program, highlighting wildlife disease events of significance in 2016.

Uppsala, May 2017

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Summary

The health situation of Swedish wildlife

Source: SVA annual report 2016, SVA Wildlife section 2016.

Monitoring the disease situation among wild animals is mainly done by post-mortem examinations and ancillary tests on found dead wildlife and targeted collections of wildlife samples. The latter is usually done within various research projects. Reporting of disease and mortality in wildlife by the public and other government agencies also contributes to the monitoring program. The focus of the disease surveillance is a One Health approach, with special attention on infectious diseases that can be transmitted between wildlife, to or from domestic animals, or to humans.

In 2016, 1 525 carcasses or parts of wild animals were examined at SVA. Of these, 441 were large carnivores, where many samples are received from compulsory sampling of licensed hunting of wolf and brown bear. There were 149 cases of reportable diseases, notified to the Board of Agriculture and the OIE. A high number of cases of salmonellosis in passerine birds was noted in 2016, and a widespread outbreak of rabbit hemorrhagic disease resulted in an increase in the total number of cases, compared to 2015. Within a current research project at SVA, the presence of the new type of virus that causes rabbit hemorrhagic disease (RHDV type 2) is being investigated. This virus, first detected in 2010, has spread throughout Europe. The first known Swedish cases were found in 2013 within a retrospective study. However, it was not until 2016 that a widespread outbreak occurred and resulted in extensive mortality among both wild and domestic rabbits all the way up to Gävleborg county. The number of reported cases of skin lesions in moose declined sharply in 2016 compared to 2015, when SVA received samples or reports from approximately 150 cases. Bird flu type H5N8 spread throughout Northern Europe in 2016, and the first Swedish cases were diagnosed at SVA in the fall of 2016. White-tailed eagles and other birds of prey appear to have been more affected during this outbreak compared with the avian influenza outbreak from H5N1-type virus in 2006. In general, the wildlife health situation for Swedish wildlife is good, as there are few endemic infectious diseases, and only rare disease outbreaks that, so far, do not threaten wildlife populations.

Wildlife disease surveillance in Sweden

The Government's directive specifies that the veterinary expert authority SVA shall do a comprehensive assessment and analysis of the status of infectious diseases as well as the state of health in general of domestic and wild animals in Sweden. SVA is the only Swedish veterinary laboratory systematically working on disease surveillance of wild animals. The work is mainly based on the pathological examination of wildlife found dead, or samples from sick and euthanized wildlife, with the addition of samples collected from hunted game, for the monitoring of certain infectious agents. SVA also collaborates with other research groups and projects involved in wildlife studies, to obtain a more complete picture of disease issues in wildlife. Here we report the main activities and results of interest concerning wildlife disease monitoring during 2015.

Systematic Wildlife Disease Surveillance has been performed since the 1940s at SVA. The main component consists of general disease surveillance (fallen wildlife monitoring), supplemented with targeted monitoring and investigative efforts. The present Wildlife Disease Surveillance Programme (Viltsjukdomsövervakningsprogrammet) is possible through funding from the State Wildlife Fund (generated from Swedish hunting license fees) as well as funding from the government and the Environmental Protection Agency.

The Wildlife Disease Council (Viltsjukdomsrådet) is a group of experts and officials from the Environmental Protection Agency and SVA responsible for exchanging information on wildlife surveillance, wildlife management and wildlife disease surveillance and jointly discussing appropriate Active disease surveillance activities on wildlife in Sweden. In 2015, the Council consisted of Klas Allander, and Ola Inghe from the EPA and Dolores Gavier-Widén, Torsten Mörner, and Erik Ågren, with Henrik Uhlhorn as a secretary, from SVA. VSR held two meetings in 2015.

The Hunters Association's Game sampler's organization (Jägareförbundets Viltprovtagare) is a voluntary network of hunters within the Swedish Association for Hunting and Wildlife Management (Svenska Jägareförbundet, SJF). The network is active in all 21 counties of Sweden and assists in reporting disease and mortality events in wildlife, assists with the collection of wildlife tissue samples from hunted game species and aids the public through submission of fallen wildlife for general disease monitoring.

DEFINITIONS

General disease surveillance involves diagnosing diseases by necropsies, histopathology and ancillary testing of found dead wildlife or euthanized sick wildlife.

Targeted disease surveillance involves targeted sampling and examination of sick or healthy wildlife to investigate specific diseases or disease agents. Most often, these investigations are initiated by results found through general disease surveillance, or when information about emerging diseases or ongoing outbreaks are reported within Sweden or in neighboring countries.

Staff at SVA working with wildlife diseases

The wildlife section is part of the Department of Pathology and Wildlife Diseases. The wildlife section work is focused on pathology of wildlife and the majority of employees are veterinary pathologists. We collaborate with the other specialized laboratories and veterinary experts throughout SVA regarding analyses of infectious agents (e.g. bacteria, viruses, parasites) and chemical substances, and with specialists in epidemiology, to diagnose, study and report on the status of wildlife diseases.

Wildlife section 2016

Erik Ågren, head of section, Veterinary officer, Dipl. ECVP, DipECZM (WPH)
Caroline Bröjer, Veterinary officer, MSc, PhD, DipECZM (Wildlife population health)
Gete Hestvik, Veterinary officer
Jonas Malmsten, Veterinary officer, PhD, DipECZM (Wildlife population health)
Aleksija Neimanis, Veterinary officer, BSc, MSc, Dipl ACVP, MVetSci.
Henrik Uhlhorn, Veterinary officer, PhD
Karin Olofsson, Veterinary officer
Holly Cedervind, Veterinary officer
Tomas Meijer, researcher, PhD.
Ewa Backman and Carina Bohlin, Secretaries at the wildlife section.

The four large carnivores

Tomas Meijer, Erik Ågren.

Other staff at SVA working with wildlife

Necropsy assistants Hans Kanbjer, Johan Karevik, Lars Hammarsten.
Necropsy technicians Marit Liljefors, Sandra Karevik.
Dolores Gavier-Widén, PhD, head of Department.
Histological laboratory technicians
Torsten Mörner, State veterinarian of wildlife diseases, PhD, Associate Professor, Department of Epidemiology and Disease Control. OIE National Focal point for wildlife diseases.

Wildlife section staff 2016. From left: Gete Hestvik, Carina Bohlin, Henrik Uhlhorn, Tomas Meijer, Ewa Backman, Aleksija Neimanis, Jonas Malmsten, Caroline Bröjer, Erik Ågren. Missing in photo: Karin Olofsson and Holly Cedervind, new employees 2016. Photo: SVA

Wildlife disease surveillance 2016

NUMBER OF CASES RECEIVED, CARCASSES OR PARTS OF WILD ANIMALS IN 2016

Of the 1 704 cases where type of species was established, 1 161 were mammals,542 were birds and 1 was an amphibian. Cases are grouped according to species, in descending numbers, in tables 1-3 below.

Mammals	Number
Brown bear	264
Moose	153
Lynx	122
Otter	93
European brown hare	76
Rabbit	75
Red fox	75
Roe deer	65
Bat	57
Wolf	44
Wild boar	25
Wolverine	24
Hedgehog	20
Porpoise	10
Mountain hare	9
Badger	8
Red deer	8
Squirrel	6
Fallow deer	5
Marten	4
Dolphin	2
Grey seal	2
Hare (sp. not noted)	2
Ferret	2
Vole	2
Water vole	2
Field vole	2
Beaver	1
Deer (sp. not noted)	1
Muskox	1
Raccoon	1
Total, Mammals	**1 161**

Amphibians	Number
Frog	1

Number	Birds
114	White-tailed eagle
29	Ural owl
28	Rock pigeon
24	Bullfinch
22	Mallard
19	Golden Eagle
17	Great Horned Owl, Buzzard, Starling
16	Jackdaw
15	Kestrel
13	Tawny owl
12	Goshawk, Eurasian sparrowhawk
12	Eurasian sparrowhawk
11	Greenfinch
10	Mute Swan, Rook, Magpie
8	Blue tit, Great grey owl, Peregrine falcon, Waxwing
7	Blackbird
6	Herring gull, Eurasian siskin, Northern Hawk Owl
5	Herring gull, common Redpoll, Great spotted Woodpecker
3	Osprey, Greylag Goose, Long-eared owl, Crow, Partridge, Wood pigeon, Black-headed gull, Tufted duck
4	Unspecified bird sp.
2	Fieldfare, Chaffinch, Dove, Rough-legged buzzard, Black-backed gull, Short-eared owl, Tengmalm's owl
1	Honey buzzard, Common eider, Falcon, Pheasant, Ptarmigan, Grey-headed woodpecker, Green woodpecker, Yellow Bunting, Heron, Common linnet, Hazel grouse, Goldeneye, Eurasian hobby, Willow warbler, Robin, Guillemot, Pygmy owl, Grosbeak, Cormorant, Whooper swan, Capercaillie, Swift, Barnacle goose, White-winged gull, Montagu's Harrier, Lesser Whitethroat
542	**Birds, total**

Number of wildlife species examined at SVA in 2016.

Wildlife diseases in focus 2016

CWD

***Chronic wasting disease* is a prion disease only affecting cervids. The disease has been known in North America for about 50 years. In April 2016 CWD was found for the first time ever in Europe, in a wild reindeer in southern Norway.**

Prions are proteins with abnormal structural conformation that makes them very resistant to denaturation. Prions are also infective, as they cause normal prion-proteins to convert into the abnormal prion form. This leads to accumulation of prions in the body, particularly in the brain where plaques of prions cause brain tissue damage. Over time, brain lesions lead to signs of mental deterioration and death from emaciation (wasting).

Surveillance of CWD in Norway was intensified after the discovery of a positive case in a wild reindeer in April. Then in May and June, two cases of CWD were found in moose. After a risk analysis by the Norwegian scientific committee for food security (VKM report 2016:26), increased monitoring of CWD in deer in Norway was done throughout the rest of the year. Another two seemingly healthy, wild reindeer hunted within the same area where the first case was found, were positive for CWD prions, resulting in a total of five CWD cases in Norway.

Where does the infection come from? It is unclear where the CWD prions originated and how long the disease has been present in Norway. The incubation period is long- over a year- from infection to disease, so it is likely that the infection has been present in Norway for several years. By the end of 2016, approximately 11 000 cervids had been tested for CWD in Norway. Most were hunted moose, red deer and wild reindeer, but fallen wildlife of all cervid species were also included. No further cases of CWD were detected.

Restrictions were imposed as a result of the CWD findings in order to limit the spread of CWD prions. Restrictions on transporting live cervids is probably the most important measure. Other regulations include bans on putting out salt licks for wildlife and feeding of wild deer.

Surveillance in Sweden began almost immediately after CWD was found in Norway, as there is natural movement of cervids across the border between the countries. It is possible that the infection also could be present in Sweden. To get a better picture of the situation in Sweden, intensive work to plan and initiate a relevant monitoring program occurred in 2016. Liaison meetings with government agencies and information meetings with stakeholders were held. In addition to hunters, deer farmers and reindeer herders are also affected by the possible presence of CWD through their involvement in the monitoring program and in the possible actions taken if CWD is found in Sweden.

SVA monitors CWD in Sweden and in 2016, all adult deer sent to SVA have been analyzed. No positive case was found in 2016. SVA has also received extra funding by the Environmental Protection Agency to enhance the disease surveillance for cervid species in general.

Cervid species	Number
Moose	74
Roe deer	14
Reindeer	2
Red Deer	6
Total	**96**

Table. Number of cervids tested for CWD at SVA in 2016. All animals were negative.

Continued monitoring in 2017 is planned. To collect the randomly found fallen or euthanized sick cervids is not enough to monitor CWD in a comprehensive way. The Board of Agriculture and SVA are prepared to start a more active monitoring, as soon as the European Commission has decided on a surveillance plan for monitoring CWD within the Member States

involved. Among other things, SVA is preparing for more extensive sampling of road-killed moose and reindeer.

A retrospective study of CWD was conducted in the fall of 2016. Sweden had not actively monitored CWD after the conclusion of the EU-wide monitoring of CWD in 2007. This decision was taken because CWD not found anywhere within the EU or in Norway at that time (2007-2010). In 2016, a retrospective study of stored frozen brain samples from adult, emaciated cervids necropsied at SVA during the period 2008-2016 was done. The study was funded by the environmental protection agency. A total of 270 cervids were tested with TSE-ELISA technique, and all samples were negative.

ANTHRAX

Omberg, Östergötland county

From July to August 2016, a total of 15 animals were found dead in an anthrax outbreak in the region of Omberg, next to Lake Vättern. Three rather decomposed moose carcasses were positive for anthrax, in addition to one sheep, one horse, and nine cattle, that were found dead in the grazing paddocks of six different farms. Five dead roe deer found in the area were negative for anthrax. Approximately 3 000 domestic animals were vaccinated in the area to limit the outbreak. Molecular analysis of the isolated anthrax bacteria indicated a common origin for the positive cases, but the exact source and distribution route have not been established.

According to historical records, anthrax is known to have caused outbreaks in the Omberg area previously. Several old anthrax graves with buried animal carcasses are present in the area, and there is anecdotal information on animal carcasses being dumped in bogs when outbreaks occurred about a century ago. Data from the 1920s mention about 20 moose that were found dead with anthrax during one outbreak in the area. Cervids are very susceptible to anthrax and typically die acutely when infected. However, wild boar and carnivores such as red fox are thought to be more resistant to anthrax. Pigs can also develop chronic anthrax infections in the throat area and can serve as carriers of the infection. The newly established population of wild boar in the area therefore may affect the epidemiology of an outbreak. In addition, wild boar root in the earth when foraging, and may expose any anthrax spores present in the ground. The Board of Agriculture funded the analyses of dead domestic animals and wildlife from the area where the anthrax was suspected, as anthrax is a notifiable disease.

A follow-up study of anthrax in wildlife was done in the autumn and winter of 2016. Blood samples from game shot during hunting were analyzed for antibodies against anthrax to look at anthrax infection prevalence in the region. Samples were collected from the area where domestic animals had been vaccinated previously. Control samples were collected from an area outside of the vaccination area. The results will be reported in 2017.

Anthrax also received international attention in 2016. In Yamal, in northern Russia, a very large outbreak of anthrax in reindeer occurred. More than 2 300 reindeer died and more than 20 people were infected, most likely because of thawing of the permafrost during the unusually hot summer, exposing anthrax spores from historic outbreaks. Vaccination of reindeer had helped avoid outbreaks for decades, but vaccination had not been done this year. In 2016, there were also reports of anthrax in elephants and buffaloes in India, and in Africa, hippos and antelopes were among the affected wildlife. Human cases occur if meat from affected animals is consumed.

SVAvet article about the anthrax outbreak on Omberg 2016

Deceased Moose found at Omberg. A sample from the Moose was positive for anthrax. Photo: Anna-Maria Erixson

RABBIT HEMORRHAGIC DISEASE

Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2) was first detected in France in 2010 and quickly spread among wild and domestic rabbits in several countries in Europe. This new virus can also cause disease in rabbits vaccinated against the classic RHD virus. In addition, RVHD2 can infect and cause disease in some species of hares, including the European brown hare, in southern Europe.

Large outbreaks of RHDV2 among wild and domestic rabbits occurred in southern Sweden since April 2016. Extensive mortality amongst the city's wild rabbits began in Solna and Stockholm and then was seen in Gävle in June. From July, wild and domestic rabbits in the Gothenburg area, along the West Coast in Halland, and Skåne, in Blekinge,Kronoberg and Kalmar counties, as well as on Gotland and Öland were affected by RHDV2. A vaccine against RHDV2 has been available in Sweden since the fall of 2016. The first two known cases of RHDV2 in the mountain hare (*Lepus timidus*) were diagnosed at SVA. The hares were found dead on an island off the southeast coast, Hallands Väderö.

In 2016, wild rabbit populations also were affected by the viral disease myxomatosis. . Myxomatosis outbreaks have been ongoing for several years, and continue to affect rabbits in the counties of Skåne and Halland.

Both myxomatosis and rabbit hemorrhagic disease are notifiable diseases when the diagnosis is made at a laboratory. Reports are sent to the Board of Agriculture, and then to the OIE (the World Health Organization for animals).

BIRD FLU

Wild birds examined by necropsy at SVA are routinely investigated for the presence of avian influenza virus as part avian flu surveillance within the EU. In 2016, 354 wild birds of 65 different species (see table page 4, where most, but not all birds listed were sampled for avian influenza). In the fall of 2016 an aggressive form of avian influenza virus (highly pathogenic AIV) was found in wild birds, and a few poultry farms were also affected. The type of influenza virus was H5N8, the same type found in a few mute swans in Stockholm in 2015, and also in many wild birds and poultry in several European countries in 2016. This type of avian flu causes a general infection in birds, with lesions and inflammation in the brain. H5N8 influenza virus has never been shown to cause clinical disease in humans.

The table below shows the birds that were positive for H5N8. In addition, avian influenza virus was also found in one mallard and one goshawk, but further typing of the virus could not be done in these two cases.

Bird	H5N8-positive
White-tailed eagle	4
Herring Gull	2
Black-headed Gull	2
Crow	2
Goshawk	1
Buzzard	1
Sparrowhawk	1
Goldeneye	1
Tufted duck	1
TOTAL	17

Birds positive for highly pathogenic avian influenza virus H5N8 in Sweden in 2016.

PASTEURELLOSIS FALLOW DEER

During the summer, approximately 50 dead fallow deer in the municipality of Nyköping were reported to the County Administrative Board of **Södermanland**. Infection with Pasteurella infection was diagnosed in samples received from one animal. In 2013 and 2014, extensive mortalities due to pasteurellosis occurred in fallow deer in the county and in 2013, outbreaks were also confirmed in Örebro county. Pasteurellosis is also believed to have caused mass death among saiga antilopes in Kazakhstan in 2015, when some 130 000 antelopes, representing approximately 40% of the world population, died over a few weeks.

MOOSE MORTALITY

Several dead moose were reported from **Värmlandsnäs,** county of Värmland, in the summer of 2016. Two carcasses were received for examination and in both animals, chronic inflammation of the gastrointestinal tract was diagnosed. In both cases, there was suspicion that intestinal parasites could be an underlying problem.

ROE DEER DIARRHEA

In 2016, as in previous years, a number of **reports of roe deer diarrhea**, were received from southern Sweden. Intestinal parasites that can cause diarrhea were found in several fawns. In older roe deer with diarrhea, chronic bowel inflammation was seen. The underlying cause or causes of roe deer diarrhea is still unclear, despite many studies through the years. New methods for finding and identifying viruses in clinical samples are now underway to try to identify possible etiologies of roe deer diarrhea.

AVIAN MORTALITIES

Mallards, Grödinge, Stockholm

In February 2016, some 30 mallards were found dead. A single bird was sent to SVA and it was emaciated and had no other lesions. It likely starved and may be representative of weak birds that congregated in the open waters of the local sewage treatment plant, and then died there.

Mallards, Malmö

In the autumn, hundreds of dead mallards were found in Malmö. Living mallards showed signs of paralysis. Submitted birds showed no evidence of infectious disease. Botulism toxin could not be detected in oneserum sample that was tested. Blue-green algae had been detected in water samples from the ponds, so algal poisoning is one possible explanation for the mass mortality.

Corvids, Ängelholm

A mortality event in May was detected when about 60 dead corvid birds were found in a park area. Neither disease nor poisoning was found. All examined birds showed blunt trauma, and it is possible that the flock of birds were startled at night and flew into solid objects.

Mass mortality, starlings

From Uppsala and Nyköping, there were reports of flocks of young starlings that flew into solid objects and died. Examined birds showed acute blunt trauma, and no other findings. Underlying causes such as freak weather conditions were discussed, but the actual cause is still unclear.

SALMONELLOSIS AND TRICHOMONIASIS IN PASSERINES

During 2016, we received scattered reports of sick and dead green finches and other passerines where trichomoniasis was suspected. From January to April in the southern half of Sweden, bullfinches, siskins and other green finches were diagnosed with salmonellosis. During this period, more domestic cats than usual were also diagnosed with salmonellosis. These cats were probably infected after catching sick birds.

AVIAN PARAMYXOVIRUS

In early 2016, there were reports of death and disease among rock pigeons from **Malmö** and its surroundings. Pigeon paramyxovirus type 1 was found in examined birds. A poultry farm south of Malmö was affected by Newcastle disease (also caused by paramyxovirus) in November, but this virus was not the same type as the pigeon virus found earlier.

Targeted wildlife disease surveillance 2016

TRICHINELLA SURVEILLANCE

Trichinella is only very sporadically found in wildlife in Sweden. All wildlife species that eat rodents or other meat infested with Trichinella larvae can become infected, and then they become carriers of the parasite.

In 2012-2016, a total of 79 trichinella positive wild animals were found and cases were fairly evenly distributed over the years. The exception was in 2015, when the surveillance of wildlife at SVA only included wolves.

Wild boar and brown bears that are shot during the licenced hunting have to be examined for trichinella parasites if the meat is to be sold. This enables monitoring of trichinella in these species, which together cover most of the country. SVA is one of several laboratories that offer trichinella diagnostics, and it is therefore difficult to compile a total number of analyses that have been done. However, all positive findings are sent to SVA, which is the veterinary reference laboratory for Sweden.

In the table below, the number of positive cases of trichinella in carnivores and wild boar are shown. For bear and wild boar, positive cases are shown, but not the total number of samples tested. All positive cases in bear and wild boar have been found in animals shot during normal hunting. Over these five years, an average of 264 bears and average of over 92 000 wild boars are hunted per year. These figures give an idea of how uncommon trichinella is in Sweden.

Other wildlife species examined for trichinella at SVA during this five-year period included 8 arctic foxes, 14 badgers, 5 pine martens, 87 otters, 143 owls, 22 buzzards, 16 eagles, as well as 19 hawks and falcons. No trichinella was detected in these samples.

Lynx had the highest total number of trichinella findings within2012-16, but the prevalence in wolverines and wolves was higher. Photo: Karin Bernodt, SVA

Animal species	2012	2013	2014	2015	2016	Total	% pos
Lynx	8 (140)	8 (173)	4 (71)	0 (0)	7 (103)	**27 (487)**	**5,5**
Raccoon dog	0 (3)	0 (1)	1 (17)	0 (0)	0 (0)	**1 (21)**	**4,8**
Red Fox	0 (69)	4 (149)	0 (53)	0 (2)	1 (55)	**5 (328)**	**1,5**
Wolf	5 (26)	2 (43)	2 (32)	0 (46)	3 (43)	**12 (190)**	**6,3**
Wild boar*	6 (-)	3 (-)	6 (-)	1 (-)	3 (-)	**19 (-)**	
Brown bear*	1 / -	5 (-)	1 (-)	1 (-)	1 (-)	**9 (-)**	
Wolverine	0 (8)	3 (27)	3 (27)	0 (0)	0 (1)	**6 (63)**	**9,5**
Total	**20**	**25**	**17**	**2**	**15**	**79**	

*Table of trichinella findings in wildlife necropsied at SVA in the past five years, and positive findings in wild boar and brown bear from all laboratories in Sweden. The number of positive cases are listed, with the total number of animals examined in brackets. *For hunted bears and wild boar, the total number of examined samples is not shown.*

Surveillance projects and wildlife research 2016

The Swedish Environmental Protection Agency (EPA) has a fund for targeted surveillance projects of more acute character. SVA plans the projects and applies for funding of pilot studies that need to be launched on short notice when increased morbidity or mortality in wildlife occurs. Time is usually of the essence to be able to collect suitable samples during a disease outbreak in wildlife. The acute projects that have been running in 2016 are described below, as well as monitoring projects on infectious diseases that the Board of Agriculture finances as part of the EU disease surveillance.

SCABIES IN WOLF AND LYNX

By analyzing levels of antibodies against sarcoptic mange in stored tissues from necropsied wolves and lynx, we can study the prevalence of scabies in these wildlife populations and assess the risk for this disease for populations at a regional or national level. Looking at antibody levels also provides information on the frequency of individuals that have been infected but did not have visible changes of mange at necropsy, compared to animals with apparent skin lesions and died due to scabies. Results will be reported in 2017.

SMARTPHONE APP REPORTING

An application for smartphones is being developed by SVA to allow for easy and on-the-spot reporting of dead or diseased wildlife to SVA and the wildlife disease surveillance program. The reports can then be compiled into tables and maps on the SVA website which gives an up-to-date overview of current wildlife diseases.
An"app icon" can be created for smartphones for quick access. The rapporteur enters data on the affected wildlife species, gives a geo-position through activation of the smartphone's GPS, can take a photo with the phone camera, and can add free text for further information.

RABBIT HEMORRHAGIC DISEASE, THE NEW VIRUS RHDV2, 2015-2016

Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2) was discovered in France in 2010 and quickly spread among wild and domestic rabbits by several countries in Europe. The new virus type also affected rabbits that had been vaccinated against the classic RHD virus. RVHD2 has caused rabbit hemorrhagic disease to re-emerge in parts of Europe. It has also infected some species of hares, which the classic virus type does not. In Sweden, SVA has now established that RHDV2 has been present in wild rabbits since at least May 2013, but the first major outbreaks were not observed until 2016. Factors responsible for the time delay from first detection to widespread outbreaks are not known.
In 2016, RHDV2 was also found as cause of death of two mountain hares (*Lepus timidus*) on the island of Hallands Väderö. It was the first report of RHDV2 in this species.

SVA is part of an EU project that maps the presence of RHDV2 and other lagoviruses in the country and studies the disease to increase our knowledge of its importance for Swedish rabbits and hares.

SKIN ULCERS IN MOOSE 2015-2016

Reports of widespread skin ulcers in the lumbar area of male moose were received in the summer and fall of 2015, but in 2016, only a few reports of this syndrome reached SVA. The project is continuing in 2017 to further investigate possible causes behind these skin lesions. Massive infestation of deer keds (*Lipoptena cervi*) is one possible underlying cause, as chronic itching and secondary bacterial infections are the proposed pathogenesis of these changes.

VIRUS SCREENING OF WILD BOAR

Blood samples from wild boar shot during hunting are sent in by helpful hunters to SVA to monitor some important pathogens affecting wild boar and domestic pigs. African swine fever (ASF) has been present in recent years in Russia and Eastern Europe. All wild boar examined by necropsy at SVA are screened for this virus. In 2016, all 19 sampled wild boar were negative. Additionally, blood samples from 197 wild boar were negative for classical swine fever and pseudorabies (Aujeszky's disease).

Statens vilt – Wildlife of the State

SVA cooperates with the Swedish Museum of Natural History (NRM) in Stockholm regarding listed species of concern called “Statens vilt”. These species have to be reported to the police when a carcass is found. Species include large predators, whales, several birds of prey, and a number of other threatened birds and mammals. SVA performs necropsies and disease surveillance, and the skins and skeletons of these species are then sent to NRM for further biological and environmental contaminant studies, and to be archived in the Museum's collections.

MARINE MAMMALS

SVA collaborates with NRM in examining porpoises and other dead cetaceans, and in disease monitoring of seals sent to NRM or SVA. SVA's research is focused on determining the cause of death and diseases, and NRM staff studies environmental toxins, diets, and genetics.

SVA and the NRM has received specific funding from HaV, the Swedish Agency for Marine and Water Management, to collect and examine dead porpoises *(Phocoena phocoena*) to increase our knowledge of these animals. Ten porpoises were necropsied in 2016 and causes of death included liver failure, trauma, parasitic pneumonia, and bycatch in fishing gear.

In February, two striped dolphins (*Stenella coeruleoalba*) stranded and died on the Swedish west coast, which attracted some media attention. These dolphins typically live in the open sea and are therefore rare in Swedish waters. The dolphins were necropsied at SVA, together with staff from NRM, and the cause of death was circulatory collapse, which can be a result of stress. No underlying disease was found.

Necropsy of one of the two dead striped dolphins found beached on the west coast in 2016, a rare species in Swedish waters. Veterinary pathologist Aleksija Neimanis from SVA, and center is biologist Anna Roos from the Museum of Natural History, interviewed by Swedish television in a live broadcast at the start of the necropsy at SVA. Photo: SVA

The four large carnivores

Many of the wildlife cases handled at SVA are carcasses or tissue samples from the four large carnivores: wolf, lynx, bear, and wolverine. The Environmental Protection Agency is responsible for the regulations regarding management of wildlife populations, and all animals or animal parts of these four large carnivores found dead in nature are to be submitted for examination at SVA. Additionally, when large predators are killed during licensed hunting, the entire skinned carcass or certain parts of the animal must be sent to SVA.

LARGE CARNIVORES 2016

In total, SVA received 441 carcasses or samples of large carnivores that died in 2016. Most cases were animals that were shot during licensed hunting or culled for management reasons.

The investigations at SVA give insight into the health status of the large carnivore populations. Trauma, mainly road-kills, dominate the cause of death; 10 bears, 29 lynx and 8 wolves. Other cases give information on diseases and natural causes of death that are not human-induced. Some to many dead large carnivores are of course never found. Therefore, it is not possible to calculate prevalence of disease or mortality in these populations. By using the same monitoring scheme for several years, however, variations in the mortality rate for a specific cause of death can be compared over time.

More details can be read in the SVA report on large carnivores-2016 (in Swedish). http://www.sva.se/globalassets/redesign2011/pdf/djurhalsa/vilda_djur/rovdjur/sva-rapport-stora-rovdjur-2016.pdf

Carnivore	2012	2013	2014	2015	2016
Bear	374	345	337	312	264
Lynx	150	181	84	57	116
Wolf	35	50	36	73	47
Wolverine	10	30	26	37	14
Total	**569**	**606**	**483**	**479**	**441**

Table. Number of carcasses or parts of large predators received at SVA 2012-2015. Source: Large carnivore database, SVA, SVA Annual report 2016.

BROWN BEAR

Of 264 brown bear cases in 2016, 215 were tissue samples collected from hunted bears. Twenty-eight bears were culled in management actions or to protect domestic animals. Three bears were killed in self-defense in bear attack situations. Ten bears were killed by cars or trains. In addition, five bears were found dead from other or unknown causes (decomposed bodies). The health situation of the bear population is considered good.

WOLVERINE

Wolverines appear to be generally healthy, as few diseases have been found over the years. Fourteen wolverine bodies were examined in 2016, of which 12 had been culled. One case was a juvenile, killed by another predator (usually intraspecific mortality, as other wolverines may kill juveniles in particular), and one was poached.

WOLF

A total of 47 wolves were submitted to SVA in 2016. Most cases were from the licensed hunt or from culling, which totaled 31 wolves. Only one wolf was shot to protect domestic animals in 2016, compared to six wolves in 2015. Eight wolves died in road traffic or train accidents. Five wolves died from disease or trauma other than traffic. In two of these cases, we concluded that other wolves had killed these animals (intraspecific mortality). Two wolves were victims of poaching. The health status of the wolf population is good in general, although sarcoptic mange occurs occasionally, affecting four wolves in 2016. Mange could potentially have a negative impact on individual packs, but not at the population level.

LYNX

In 2016, a total of 116 lynx were submitted to SVA, which is an increase from 58 lynx in 2015. The increase was mainly due to a licensed hunt (44 lynx) and a slight increase in culling (31). A slight increase in the number of lynx killed in traffic accidents (29) also occurred. In general, the health status of the lynx population is good, but like the wolves, lynx are occasionally affected by sarcoptic mange.

Infection with sarcoptic mange causes extensive skin lesions and the lynx usually dies from emaciation. The incidence of scabies in lynx and wolves is linked to the prevalence of scabies in the red fox, which is the main host for the parasite. In 2016, seven lynx examined were diagnosed with mange.

Radio P4 Uppland interviewing wildlife veterinarian Holly Cedervind in the post mortem room at SVA before the necropsy of a lynx. Photo: Erik Ågren, SVA.

OIE reporting 2016

The OIE is the World Organization for Animal Health, an international body that follows and compiles information on important animal diseases that have been diagnosed around the world. The Swedish Board of Agriculture reports the Swedish cases of specifically listed animal diseases that have been diagnosed in both domestic animals and wildlife. The number of cases of a disease detected in wild animals, however, reflects only the number of diagnoses found among the cases submitted to SVA, or occasionally to some other laboratory. The number of wild animals that actually are affected by a specific disease cannot be determined, but in the event of a major disease outbreak, the number of reports and submitted cases usually increase. A continuous and systematic wildlife disease surveillance program gives us an indication of what diseases occur in the country and in particular, if new or previously unknown diseases have emerged.

Diagnoses 2016	Number of cases	Animal species
Avian influenza (H5N8)	18	Goshawk 1, Herring gull 2, Mallard 1, White-tailed eagle 4, Goldeneye 1, Crow 2, Buzzard 1, Magpie 2, Black-headed gull 2, Tufted duck 1, Sparrowhawk 1
Paramyxovirus (PMV-1)	5	Rock pigeon
Fowl pox	1	Rock pigeon
Calicivirus (EBHS)	2	European brown hare
Tularemia	6	European brown hare
Rabbit Hemorrhagic Disease (RHD)	44	Wild rabbit 43, Mountain hare 1
Myxomatosis	2	Wild rabbit
Listeriosis	1	Fallow deer
Pasteurellosis	1	Fallow deer
Pseudotuberculosis	4	European brown hare 3, Mountain hare 1
Sarcoptic mange	15	Lynx 6, Wolf 8, Wild boar 1
Salmonellosis	32	Bullfinch 19, Common redpoll 5, Greenfinch 1, Siskin 2, Green woodpecker 1, Hedgehog 2, Great spotted woodpecker 1, Great tit 1
Toxoplasmosis	2	European brown hare
Trichomoniasis	1	Rock pigeon
Trichinellosis	15	Brown bear 1, Lynx 7, Red fox 1, Wolf 3, Wild boar 3
Total	**149**	

The number of positive cases of OIE listed wildlife diseases detected in wild animals after examination at laboratories in the country in 2016, and which have been reported to the Board of Agriculture. Source: SVA's laboratory data system SVALA

Wildlife diseases internationally 2016

CWD

The first case of CWD in Europe was found in Nordfjella in southern Norway in April 2016, in a sick, wild reindeer that died. Two CWD cases were then found in sick moose from Selbu, far north of the reindeer case, in May and June. Another two wild reindeer were found positive for CWD in 2016, but these were from hunted reindeer in August and September. In total, five cases have been found in Norway and approximately 11,000 cervids were tested in 2016. Immunohistochemical studies show that the microscopic changes in the brains of the positive Norwegian reindeer are consistent with how CWD is expressed in North American cervids, while the Norwegian moose cases have a different appearance. The significance of this is still unclear.

RABBIT HEMORRHAGIC DISEASE, RHDV2

Rabbit hemorrhagic disease caused by RHD virus type 2 is spreading around the globe. Reports came from Australia in February, Finland in May, and from Canada in the autumn. In Scotland, a report showed that the population of wild rabbits had declined by 90% since 1995, largely due to jaundice.

AFRICAN SWINE FEVER

African swine fever in eastern Europe continues to spread and it is established in the wild boar population. So far, almost 400 outbreaks have been reported in Russia and include over 700 infected wild boar and 220 000 domestic swine (culled). Estonia had outbreaks of ASF on Saaremaa in August and two outbreaks were reported from Moldovia in September.

WEST NILE VIRUS

The mosquito-borne West Nile fever virus is present in southern Europe, and the first cases were reported from Italy and Romania in July. Recent studies also show that more than 50% of people who survive WNV infection develop persistent memory problems (Vasec, Nature, 2016).

CLIMATE CHANGE & WILDLIFE MORTALITY

High mortality in Guillemots in Alaska was observed as a result of starvation due to changes in the availability of prey fish.

Domoic acid, Alaska. The neurotoxin domoic acid is produced by marine algae called diatoms. The toxin causes brain damage and death. Presence of domoic acid was detected in two-thirds of surveyed marine mammals (whales, seals, and otters) outside Alaska, unusually far north of previously known areas for domoic acid mortality (Lefebvre et al., 2016).

Adelie penguin mass mortality. Mortality of 150 000 penguins was reported to have occurred after the penguins were land-locked by icebergs, with 6 km to the open sea, at Cape Denison, Antarctica.

Anthrax, Russia. On the Yamal Peninsula, anthrax graves that had thawed during unusually hot weather in July for the tundra areas are suspected to have caused outbreaks of anthrax in reindeer. As vaccination had been cancelled this year, more than 2 000 reindeer died and there were more than 20 human anthrax cases, with at least one death. A huge buffer zone was established and vaccination of over 700 000 reindeer was re-instated.

BAT LYSSA VIRUS

In southern Finland, bat lyssa virus was demonstrated in a Daubenton´s bat (*Myotis daubentonii*) with neurological symptoms in October 2016. This is the second case of bat rabies in Finland. In Sweden, antibodies to bat lyssa virus have recently been found in a few sampled bats, but the virus was not found in these animals. Sweden is still classified as rabies-free.

PUBLICATIONS 2016

In 2016, SVA staff participated in the writing of a number of scientific and popular science publications, written reports, and responses to referrals from various authorities. To acquire knowledge and information, and to disseminate results from the work on wildlife diseases at SVA, the staff at the Department of Pathology and Wildlife Diseases participated in various international and national conferences. Listed below is a selection of publications from 2016 relating to wildlife, where staff from the Wildlife section or other department at SVA are authors or co-authors (SVA staff names in bold).

Scientific publications

Armengol-Porta M, Tenorio-Abreu A, Bandt D, Coleman DC, **Gavier-Widén D**, Hotzel H, Kinnevey P, Lazaris A, Peters M, **Rangstrup-Christensen L**, Schlotter K, Shore AC, Ehricht R, Monecke S (2016) In vitro activity of ceftaroline against mecC-positive MRSA isolates. Journal of Global Antimicrobial Resistance 5:3-6

Balk L, Hägerroth PA, Gustavsson H, Sigg L, Åkerman G, Muñoz YR, Honeyfield DC, Tjärnlund U, Oliveira K, Ström K, McCormick SD, Karlsson S, Ström M, Van Manen M, Berg AL, Halldórsson HP, Strömquist J, Collier TK, Börjeson H, **Mörner T**, Hansson T (2016) Widespread episodic thiamine deficiency in Northern Hemisphere wildlife. Scientific Reports 6

Esteruelas NF, **Malmsten J**, **Bröjer C**, Grandi G, Lindström A, Brown P, Swenson JE, Evans AL, Arnemo JM. Chewing lice *Trichodectes pinguis pinguis* in Scandinavian brown bears (*Ursus arctos*). Int J Parasitol Parasites Wildl. 2016 Mar 9;5(2):134-8. doi: 10.1016/j.ijppaw.2016.02.002. PubMed PMID: 27330984;

Fuchs B, Zimmermann B, Wabakken P, Bornstein S, Månsson J, Evans AL, Liberg O,Sand H, Kindberg J, **Ågren EO**, Arnemo JM. Sarcoptic mange in the Scandinavian wolf *Canis lupus* population. BMC Vet Res. 2016 Jul 27;12(1):156.

Kollander B, Widemo F, **Ågren E**, Larsen EH, Loeschner K. Detection of lead nanoparticles in game meat by single particle ICP-MS following use of lead-containing bullets. Anal Bioanal Chem. 2016 Dec 14. [Epub ahead of print] PubMed PMID: 27966171.

Lycett SJ, Bodewes R, Pohlmann A, Banks J, Bányai K, Boni MF, Bouwstra R, Breed AC, Brown IH, Chen H, Dán A, DeLiberto TJ, Diep N, Gilbert M, Hill S, Ip HS, Ke CW, Kida H, Killian ML, Koopmans MP, Kwon JH, Lee DH, Lee YJ, Lu L, Monne I, Pasick J, Pybus OG, Rambaut A, Robinson TP, Sakoda Y, **Zohari S**, Song CS, Swayne DE, Torchetti MK, Tsai HJ, Fouchier RAM, Beer M, Woolhouse M, Kuiken T (2016) Role for migratory wild birds in the global spread of avian influenza H5N8. Science 354:213-217

Monecke S, **Gavier-Widén D**, Hotzel H, Peters M, Guenther S, Lazaris A, Loncaric I, Müller E, Reissig A, Ruppelt-Lorz A, Shore AC, Walter B, Coleman DC, Ehricht R. Diversity of *Staphylococcus aureus* Isolates in European Wildlife. PLoS One. 2016 Dec 16;11(12):e0168433. doi: 10.1371/journal.pone.0168433.

Miller AL, Olsson GE, Sollenberg S, Skarin M, **Wahlström H**, Höglund J (2016) Support for targeted sampling of red fox (*Vulpes vulpes*) feces in Sweden: A method to improve the probability of finding *Echinococcus multilocularis*. Parasites and Vectors 9

Miller AL, Olsson GE, Walburg MR, Sollenberg S, Skarin M, Ley C, **Wahlström H**, Höglund J (2016) First identification of *Echinococcus multilocularis* in rodent intermediate hosts in Sweden. International Journal for Parasitology: Parasites and Wildlife 5:56-63

Monecke S, **Gavier-Widén D**, Hotzel H, Peters M, Guenther S, Lazaris A, Loncaric I, Müller E, Reissig A, Ruppelt-Lorz A, Shore AC, Walter B, Coleman DC, Ehricht R (2016) Diversity of *Staphylococcus aureus* isolates in european wildlife. PLoS ONE 11

Norén K, Angerbjörn A, Wallén J, **Meijer T**, Sacks BN (2016) Red foxes colonizing the tundra: genetic analysis as a tool for population management. Conservation Genetics:1-12

Neimanis AS, Moraeus C, Bergman A, Bignert A, Höglund J, Lundström K, Strömberg A, Bäcklin BM. Emergence of the Zoonotic Biliary Trematode *Pseudamphistomum truncatum* in Grey Seals (*Halichoerus grypus*) in the Baltic Sea. PLoS One. 2016 Oct 18;11(10):e0164782.

Sainsbury, A. W., Yu-Mei, R., **Ågren, E**., Vaughan-Higgins, R. J., Mcgill, I. S., Molenaar, F., Peniche, G. and Foster, J. (2016), Disease Risk Analysis and Post-Release Health Surveillance for a Reintroduction Programme: The Pool Frog *Pelophylax lessonae*. Transbound Emerg Dis. doi:10.1111/tbed.12545

Tryland M, Stubsjøen SM, **Ågren E**, Johansen B, Kielland C (2016) Herding conditions related to infectious keratoconjunctivitis in semi-domesticated reindeer: A questionnaire-based survey among reindeer herders. Acta Veterinaria Scandinavica 58

Velarde R, Cavadini P, **Neimanis A**, Cabezón O, Chiari M, Gaffuri A, Lavín S, Grilli G, **Gavier-Widén D**, Lavazza A, Capucci L. Spillover Events of Infection of Brown Hares (*Lepus europaeus*) with Rabbit Haemorrhagic Disease Type 2 Virus (RHDV2) Caused Sporadic Cases of an European Brown Hare Syndrome-Like Disease in Italy and Spain. Transbound Emerg Dis. 2016 Sep 11. doi: 0.1111/tbed.12562. [Epub ahead of print]

Ågren EO, Söderberg A (2016) Congenital tracheal web malformation in a wild brown bear (*Ursus arctos*), Sweden, 2010. Journal of Wildlife Diseases 52:411-413

Scientific presentations

12th EWDA European Wildlife Disease Association conference, 26-31 Aug 2016, Berlin.
Erik Ågren arranged "Wildlife Forensic Workshop" 26 Aug.
Oral presentation: **Ågren Erik, Hakhverdyan M**, Handeland K, Vikøren T, **Uhlhorn H, Gavier-Widén D, Leijon M**. Novel retrovirus associated with ethmoid tumors in moose (*Alces alces*).
Oral presentation: **Neimanis, A., Ahola, H., Zohari, S.**, Capucci, L., **Gavier-Widén, D.** Emergence of Rabbit Haemorrhagic Disease Virus-2 (RHDV2) in wild and domestic rabbits (*Oryctolagus cuniculus*) in Sweden.
Oral presentation: Velarde, R., Lavazza, A., Cavadini, P., Chiari, M., **Neimanis, A.**, Cabezón, O., Lavín, S., Gaffuri, A., Grilli, G., **Gavier-Widén, D.**, Capucci, L. Detection of the new emerging rabbit hemorrhagic disease type 2 virus (RHDV2) in European brown hares (*Lepus europaeus*) from Spain and Italy.
Poster: **Ågren Erik, Caroline Bröjer, Gete Hestvik, Aleksija Neimanis, Uhlhorn Henrik, Gavier-Widén Dolores**. Improving myxomatosis outbreak mapping in Sweden.
Poster: **Caroline Bröjer, Jonas Malmsten, Erik Ågren, Henrik Uhlhorn, Gete Hestvik, Torsten Mörner**. Chronic pyotraumatic dermatitis in Swedish moose (*Alces alces*).

COMMUNICATING KNOWLEDGE

During the 12th conference of the European section of the Wildlife disease association (EWDA) SVA (Erik Ågren) organized a one-day workshop on Wildlife forensics with lecturers from the Swedish National Forensics Centre (NFC) in Linköping, and the Leibniz Institute for Zoo and Wildlife Research, IZW in Berlin.

REFERRALS

Answered referrals from other authorities, relating to wildlife:

Opinion of the SVA on referral relating to Government Commission on the strategy for the Swedish wildlife management N2015/05179/FJR (answer to the Environmental Protection Agency, jan-16)

WORKING GROUPS

Wildlife section staff have in 2016 been involved in the following working groups:

Wildlife Disease Council Environmental Protection Agency/SVA: Dolores Gavier-Widén, Erik Ågren, Torsten Mörner. Secretary: Henrik Uhlhorn.

SVA's Wildlife Surveillance Council: Department of Epidemiology and Disease Control: Gunilla Hallgren, Karl Ståhl, Torsten Mörner, Department of Pathology and Wildlife Diseases: Dolores Gavier-Widén, Erik Ågren, Henrik Uhlhorn.

SVA's Climate Council: Henrik Uhlhorn, Wildlife section.

SVA's Zoonosis Committee: Henrik Uhlhorn Wildlife section.

Ungulate game Council (Environmental Protection Agency), SVA representative: Caroline Bröjer

The reference group for invasive species. (The Swedish Association for Hunting and Wildlife Management), SVA representative: Caroline Bröjer

EWDA, European section of the Wildlife Disease Association. Co-Chair EWDA Board: Erik Ågren

NWDA, Nordic section of the Wildlife Disease Association. NWDA Chair: Aleksija Neimanis

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