NATIONAL VETERINARY INSTITUTE

WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2017

SVA report 50:2018

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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 2017.

Uppsala, May 2018

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Summary

The health situation of Swedish wildlife

Source: SVA annual report 2017, SVA Wildlife section 2017.

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. Wildlife disease surveillance is done using 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 2017, SVA received 1 625 carcasses or parts of wild animals for examination. Of these, 547 were large carnivores, where many samples come from compulsory sampling of licensed hunting of lynx, wolf, and brown bear. There were 139 cases of reportable diseases, in 32 different wildlife species, reported to the Board of Agriculture and the OIE. Monitoring of CWD (Chronic Wasting Disease) in fallen or sick cervids began in 2016 and was intensified throughout the country in 2017. A targeted survey of moose was performed in the western parts of the county of Jämtland, as this area borders on areas in Norway where CWD has been detected in three moose. All cervid carcasses tested for CWD in Sweden have been negative. The first cases of bird flu type H5N8 were diagnosed at SVA in autumn 2016, and additional positive cases were detected during 2017. White-tailed eagles and other birds of prey appear to be particularly affected when compared with the bird flu outbreak with H5N1 virus in 2006. Avian paramyxovirus outbreaks on the island of Gotland resulted in hundreds of dead rock pigeons. Following widespread outbreaks of rabbit haemorrhagic disease caused by the new RHDV type 2 virus in 2016, there were very few outbreaks reported in wild rabbits in 2017, possibly due to immunity against the virus in animals that survived infection the year before. However, two major outbreaks were noted on Gotland and in the county of Västra Götaland. The number of reported cases of extensive dorsal skin lesions in moose increased again in 2017, to around 40 reports, after a very low number reported in 2016. A serologic study of sarcoptic mange in wolves and lynx finalized in 2017 showed that almost 13% of necropsied wolves, and 12% of examined lynx had antibodies against sarcoptic mange, regardless if there were visible skin lesions or not. In general, the wildlife health situation for Swedish wildlife is favourable, as the level of significant endemic infectious diseases remains low, and the rare disease outbreaks that occur do not yet 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 2017.

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 governmental funding, partly from the Environmental Protection Agency.

The Wildlife Disease Council (Viltsjukdomsrådet, VSR) 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 aActive disease surveillance activities on wildlife in Sweden. The Council consisted of Klas Allander, Per Risberg, and Ola Inghe from the EPA and Dolores Gavier-Widén, Torsten Mörner, and Erik Ågren, with Henrik Uhlhorn as secretary, from SVA. VSR held two meetings during the past year.

The Hunters Association's wildlife health monitors 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 with reporting disease and mortality events in wildlife, assists with the collection of wildlife tissue samples from hunted game species and helps with submission of fallen wildlife for general disease monitoring.

DEFINITION

General disease surveillance involves diagnosis of 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 presence of specific diseases or disease agents. Most often, these investigations are initiated by findings from 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 2017

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
Aleksija Neimanis, Veterinary officer, BSc, MSc, Dipl ACVP, MVetSci.
Henrik Uhlhorn, Veterinary officer, PhD
Karin Olofsson, Veterinary officer, PhD
Holly Cedervind, Veterinary officer
Tomas Meijer, researcher, PhD
Ewa Backman and Carina Bohlin, administrators

The four large carnivores

Holly Cedervind, Tomas Meijer, and 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 2017. Upper row from left: Aleksija Neimanis, Erik Ågren, Karin Olofsson, Gete Hestvik. Lower row from left: Caroline Bröjer, Ewa Backman, Henrik Uhlhorn, Carina Bohlin. Missing in photo: Holly Cedervind och Tomas Meijer. Photo: Karin Bernodt, SVA.

Wildlife disease surveillance 2017

NUMBER OF CASES RECEIVED (CARCASSES OR PARTS OF WILD ANIMALS) IN 2017

Of the 1 618 cases listed in the tables, where species was established, 1 016 were mammals, 585 were birds and 17 were amphibians. Cases are grouped according to species, in descending numbers, in tables 1-3 below. The large numbers of lynx and brown bears examined are due to compulsory submission of samples from the licensed hunt of these species for ongoing and future research.

Mammals	Number[1]
Brown bear	310
Lynx	158
Otter	113
Moose	97
Wolf	60
Wolf/dog hybrid	7
Roe deer	36
European brown hare	30
Bat	29
Red fox	26
Wild boar	22
Fallow deer	20
Wild rabbit	19
Porpoise	17
Wolverine	12
Red deer	10
Hedgehog	8
Mountain hare	8
Red squirrel	7
Badger	7
Beaver	3
Hare, sp. not specified	3
Mouflon	3
Pine marten	3
Raccoon dog	2
Brown rat	1
Arctic fox	1
Grey seal	1
Polecat	1
American mink	1
Wood mouse	1
Totalt mammals	**1 016**

Amphibians	Number
Common frog	10
Common toad	7
Total amphibians	**17**

Birds	Nr
White tailed eagle	93
Greenfinch	34
Mallard	29
Common buzzard	28
Jackdaw, Rock dove	25
Mute swan	24
Ural owl	22
Tawny owl, Sparrow hawk, Common kestrel	18
Great grey owl	16
Eagle owl	15
Crow	13
Golden eagle, Magpie	12
Bullfinch	10
House sparrow, Hawk owl, Peregrine falcon	9
Blackbird, Trumpeter swan	8
Goshawk, Osprey, Black-headed gull	7
Long-eared owl, Rook	6
Chaffinch, Wood pigeon, Cormorant	5
Pigeon, Herring gull, Hawfinch, Great spotted woodpecker	4
Fieldfare, Common eider, Red kite	3
Marsh harrier, Willow ptarmigan, Rough-legged buzzard, Redpoll, Grey-headed woodpecker, Green woodpecker, Siskin, Goose sp., Grey heron, Canada goose, Eurasian hobby, Robin, Merlin, Capercaille	2
Long-tailed duck, Mallard, Bee-eater, Blue tit, Common gull, Greylag goose, Red-necked grebe, Cuckooo, Common goldeneye, Corn crake, Raven, Kingfisher, Woodcock, Eurasian jay, Black grouse, Tree sparrow, Boreal owl, Ptarmigan, Black-tailed godwit, Waxwing, Coot, Pallid harrier, Steppe eagle, Black stork, Bean goose, Crane, Black-legged kittywake, White stork, White-backed woodpecker	1
Total birds	**585**

Total number of wildlife species received at SVA 2017, as parts of, or whole carcasses. Not all submissions were, or could, be examined.

Wildlife diseases in focus 2017

CWD

***Chronic wasting disease* (CWD) 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. Later that year, two cases of CWD were found in moose, and in 2017, there was also one case in red deer. No cases of CWD have been found in Sweden.**

In the efforts to combat CWD in Norway, control zones were established in the areas where the infection was detected. Special regulation of hunting, handling of carcasses and slaughter offal was introduced. Within the zones, all dead cervids must be tested for CWD, and special restrictions apply to feeding or transportation of cervids and use of salt licks. As CWD has only been found in one zone of the Nordfjella wild reindeer herd, all reindeer in that zone were culled in 2017 and 2018. The area will be kept empty of cervids for at least five years before reintroduction of genetically similar wild reindeer from nearby flocks. In Norway, over 40 000 cervids have been analyzed for CWD since 2016. In 2017, 25 648 cervids were tested, with nine further positive reindeer cases from the Nordfjella area, one red deer, and one moose. By the end of 2017, there were 13 wild reindeer, three moose and one red deer positive for CWD. The Norwegian CWD surveillance can be followed at http://apps.vetinst.no/skrantesykestatistikk/NO/.

Surveillance of CWD in Sweden was initiated again after the first finding in Norway and has since been based on testing of fallen stock. All adult cervids found dead or euthanized that have been submitted to SVA for necropsy have been tested for CWD.

A targeted **CWD screening of moose in the county of Jämtland** was performed at the end of the moose hunt in the fall of 2017. With help from the Swedish Hunting and wildlife management Association, local hunters and game handling plants contributed to the testing of hunter-harvested moose. As carcasses tested for CWD cannot be approved for human consumption until a negative test result has been obtained, a well-functioning routine with rapid shipping and analysis is required. This work was funded by the Environmental Protection Agency. During a few weeks in the autumn, 63 moose were examined from Jämtland. All 184 cervids analyzed for CWD in 2017 were negative.

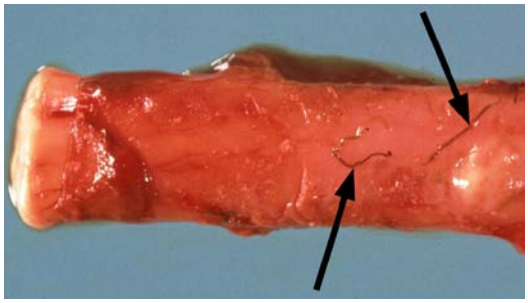
Cervid sp.	Number examined 2017
Moose	136
Roe deer	13
Reindeer	21
Red deer	6
Fallow deer	8
Total	**184**

Number of cervids examined for CWD at SVA during 2017. All tested animals were negative.

The European Commission came to a decision in 2017 (EU 2017/1972) on how CWD surveillance shall be conducted in the six Member States that have moose or reindeer populations; Sweden, Finland, Estonia, Latvia, Lithuania and Poland. Each country is to test at least 6 000 cervids from 2018 to 2020. During 2017, SVA set up a national surveillance plan based on the various distributions and densities of cervids with information from the University of Agricultural Sciences, SLU and funded by the Environmental Protection Agency. Samples are primarily to be taken from at-risk cervids, which are any animals showing signs of disease that may be consistent with CWD, such as emaciation with abnormal behavior, as well as found dead adult cervids, and road-killed cervids. A set number of free-ranging, farmed, and semi-domesticated cervids are to be sampled from each defined geographic sampling unit.

MENINGEAL WORM IN MOOSE

During 2017, several reports of emaciated and sick moose calves were received, mainly from the counties of Västra Götaland and Gävleborg. At necropsy the meningeal worm *Elaphostrongylus* was found. When this parasite makes its way into the membranes of the spinal cord or brain of moose, signs of clinical disease such as ataxia or recumbency can be seen. Calves are more often affected than adults.



The meningeal worm is seen as thin black threads on the spinal cord a moose (arrows). Photo: SVA.

PASTEURELLOSIS IN FALLOW DEER

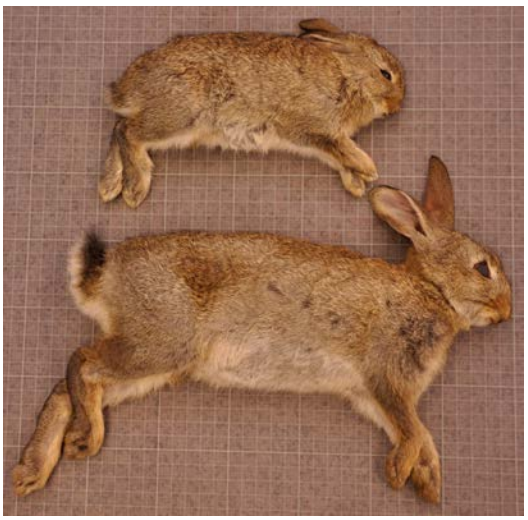
Several reports of mortality among fallow deer in the central-eastern parts of Sweden were received during the summer. The bacterium *Pasteurella* was cultured from one submitted case from Östergötland and one case from Södermanland.

MYXOMATOSIS

Myxomatosis is a rabbit disease caused by a *Leporipox* virus and is strongly suspected when rabbits are found with swelling around eyes, nose, or genitals. Throughout the year, SVA received many reports of suspected cases from the counties of Skåne, Halland, Gotland, and Stockholm. The diagnosis was confirmed on two submitted wild rabbits; one from Stockholm and one from Halland.

RABBIT HAEMORRHAGIC DISEASE

Rabbit Hemorrhagic Disease Virus Type 2 (RHDV2) was discovered in France in 2010 and spread rapidly among wild and domestic rabbits through several countries in Europe. Vaccination against the classic RVHD virus is not protective against the new strain. Also, some hare species, including European brown hare and mountain hare can be affected by the new strain, which in Sweden has been present since at least May 2013.



A young and an adult wild rabbit that have died of the new rabbit haemorrhagic disease virus RHDV2. Unlike the classic strain, RHDV2 can also kill rabbits younger than 8 weeks. Photo: SVA.

RHDV2 swept through the southern half of Sweden in 2016, affecting wild and domestic rabbits, and several mountain hares died of RHDV2 on the island Hallands Väderö. There were fewer reports of RHDV in 2017, possibly because of immunity in wild rabbits that survived the outbreak in 2016, and because vaccines against RHDV2 became available in Sweden from the autumn of 2016. However, two major outbreaks of RHDV2 took place on Gotland and in Västra Götaland in 2017. The disease is reportable, and when the diagnosis is made, the cases are reported to the Board of Agriculture and then to the OIE (World Organization for Animal Health).

SALMONELLA AND TRICHOMONOSIS IN PASSERINES

In 2017, scattered observations of mortality in passerines, especially in greenfinches, were reported throughout the country. Infection with Trichomonas parasites is the one suspected cause, and this parasite was found in various submitted bird species, such as greenfinch, rock dove, wood pigeon and kestrel. Passerine mortality in late winter is

usually attributed to salmonellosis, and this bacterium was also found in submitted bullfinches and redpolls from the southern half of the country. Single cases of salmonella were also diagnosed in other bird species such as green woodpecker, greater spotted woodpecker, gray owl and kestrel.

AVIAN PARAMYXOVIRUS

Paramyxovirus in wild birds can cause high mortality outbreaks, especially in pigeons and poultry. In Sweden, two outbreaks in poultry were observed in the counties of Kalmar in August and in Skåne in November. The farms had to cull 4 000 and 28 000 hens, respectively. Hundreds of dead rock pigeons were found on the island of Gotland at the end of the year. Local poultry farmers were warned, so that the poultry could be kept indoors to avoid being infected by wild birds.

POISONING OF WILD BIRDS

A large flock of jackdaws was found dead in mid-July in the town of Ljungskile. Toxicology showed carbamate poisoning as the cause of death. Carbamate is a snail poison previously used in agriculture, but it is now banned.

More than 150 mallards were found dead in January in the town of Mariefred and were found to be poisoned, probably intentionally, with a mouse poison called Black Pearl (alphachloralos). This was the second incident of mortality in mallards due to the same poison and at the same site since 2015.

AVIAN INFLUENZA

Wild birds examined by necropsy at SVA are routinely screened for avian influenza virus to report the avian influenza situation to the EU. In 2017, a total of 452 wild birds of 73 different species were tested. Wild birds have succumbed to the highly pathogenic avian influenza virus H5N8 since 2016 and the last documented case in Sweden was in March 2017. There were 34 wild birds found with H5N8 in Sweden. H5N8 continued to be detected in many wild birds and poultry in several European countries during 2017. H5N8 influenza has never been detected in humans.

Species	H5N8-positive
Mute swan	15
White-tailed eagle	7
Mallard	4
Peregrine falcon	2
Goshawk	2
Common buzzard	1
Crow	1
Rook	1
Hawk owl	1
Total	**34**

Wild birds positive for highly pathogenic avian influenza H5N8 in 2017.

Goshawk found dead in Staffanstorp, Skåne that was positive for avian influenza H5N8. Photo: David Wanegård.

Targeted wildlife disease surveillance 2017

TRICHINELLA

Trichinella parasites are only very sporadically found in wildlife in Sweden. All species that eat infected small rodents or other Trichinella-infected meat can be infected with Trichinella larvae, and then become carriers of the parasite in their own muscle tissue.

Between 2013 and 2017 a total of 71 trichinella positive wildlife cases were found, quite evenly distributed over the years. The exception was 2015, when only wolves were included in the targeted surveillance 0f necropsied wildlife at SVA.

Hunter-harvested wild boar and brown bear must be examined for Trichinella if the meat is to be sold. This regulation results in good monitoring of the Trichinella situation in these wildlife populations, which together cover most of the country. SVA is one of several laboratories that offer Trichinella analysis service, therefore the total the number of trichinella analyses for the entire country is not known exactly. However, all positive findings have to be sent to SVA, which is the national reference laboratory. The table below shows the number of positive Trichinella cases for bear and wild boar and all were found in hunter-harvested animals. For the past five years, on average, 247 bears and over 94,000 wild boar were harvested annually. These numbers give an idea of how rarely Trichinella is found in wildlife in Sweden.

Some other wildlife species also have been sampled for Trichinella screening at necropsy at SVA. However, all have been negative during this past five-year period and samples include two beavers, eight arctic foxes, 11 badgers, 5 martens, 47 otters, 53 owls, 13 buzzards, 7 eagles, and 7 hawks and falcons.

Of the examined wildlife species during 2017, Trichinella was most commonly found in wild boar. Photo: Karin Bernodt, SVA.

Species	2013	2014	2015	2016	2017	Totalt
Lynx	8 (173)	4 (71)	0 (0)	7 (103)	4 (80)	**23 (427)**
Raccoon dog	0 (1)	1 (17)	0 (0)	0 (0)	0 (0)	**1 (18)**
Red fox	4 (149)	0 (53)	0 (2)	1 (55)	0 (0)	**5 (259)**
Wolf	2 (43)	2 (32)	0 (46)	3 (43)	1 (45)	**8 (209)**
Wild boar*	3 (-)	6 (-)	1 (-)	3 (-)	7 (-)	**20 (-)**
Brown bear*	5 (-)	1 (-)	1 (-)	1 (-)	0 (-)	**8 (-)**
Wolverine	3 (27)	3 (27)	0 (0)	0 (1)	0 (0)	**6 (55)**
Total	**25**	**17**	**2**	**15**	**12**	**71**

*Table with Trichinella findings in wildlife necropsied at SVA the past five years. Numbers represent positive cases, with total number of examined animals in brackets. * For bear and wild boar, testing is mainly done from hunter harvested animals, and may be tested at other laboratories, so total number of tests are not given. All positive findings have to be reported to the national reference laboratory, SVA.*

Surveillance projects and wildlife research 2017

The Swedish Environmental Protection Agency (EPA) has a fund for targeted surveillance projects of more acute character. SVA plans the projects and makes an application for the funding of studies that need to be launched at 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 2017 are described below, in addition to monitoring projects on infectious diseases financed by the Board of Agriculture as part of the EU disease surveillance.

MOBILE APP FOR WILDLIFE REPORTING

A reporting form for web-based or smartphone reporting was developed by SVA in 2016 and launched in 2017 to allow the public and professionals to easily report findings of dead or sick wildlife at the web-address **rapportavilt.sva.se**. Data from these reports can regularly be compiled in tables and maps at SVA for a quick overview of ongoing wildlife diseases and give an indication of larger mortalities or disease outbreaks. The report includes information on what animal species is involved and the geographic position (GPS). An image can be attached from the smartphone camera and there is a free text box to enter further information if necessary. During 2017, the number of reports from rapporteravilt.sva.se has gradually increased, where informative photos sometimes may allow direct diagnosis by the wildlife pathologist. Other reports are still submitted by telephone and email.

SARCOPTIC MANGE IN WOLF AND LYNX

In 2017 a serologic study was conducted on the occurrence of sarcoptic mange in wolves and lynx. In necropsy-collected blood samples from 306 wolves from 2010 to 2016, 39 wolves were considered to be positive and had *Sarcoptes* antibodies. The proportion of Sarcoptes-positive wolves varied, with a tendency for increasing numbers of affected animals in later years. Twenty-five females and 14 males were positive, and of these, 14 wolves were less than one year old. This result shows that puppies are affected to the same extent as adults. All wolves that showed skin lesions consistent with mange at necropsy were antibody - positive. Five other wolves that were positive in serology did not have typical skin changes. This indicates that wolves can be infected with scabies without obvious skin changes, or that skin lesions may heal and the animal can survive a sarcoptic mange infection, as antibodies can persist for many months after an infection. There were 34 of 288 (12%) necropsied lynx from the counties of Uppsala, Dalarna, and Gävleborg from 2003 to 2016 with antibody titres, and considered positive for sarcoptic mange. The prevalence of mange-positive animals was stable over the years. In three of these years, 19% or more of the investigated lynx were affected by mange. Previous studies have considered lynx to be relatively resistant to sarcoptic mange, but this study indicates that the disease is more frequent in some years. The overall prevalence of mange in the studied lynx differed between the three counties, with 4% affected in Uppsala, 12% in Dalarna and 19% in Gävleborg. The difference between the counties may be due varying densities of red fox and the presence of sarcoptic mange in these fox populations, as foxes are suspected to be an important source of mange infection in lynx.

RODENTICIDES SCREENING IN WOLVES WITH MANGE

In a mange-infected wolf in Norway, presence of rodenticides was found during toxicological screening. As a follow-up to this finding, liver samples from ten Swedish mange-affected wolves were analyzed. In five wolves, low levels of three different types of rat poison were detected. The incidence of rat poisoning in this limited study was lower in wolves, both in levels and proportion of animals, compared with birds of prey and red foxes in previous studies (also very few animals examined). The levels of rodenticide found in the wolves were below the estimated threshold for clinical toxicity (poisoning), but the finding suggests undesirable secondary spread of rodenticides in the environment.

LAGOVIRUS IN RABBITS

SVA participates in an EU project (ECALEP) that charts and studies non-pathogenic lagovirus strains closely related to rabbit viral haemorrhagic disease virus (RHDV). Non-pathogenic strains are thought to target the gastrointestinal tract while RHDV virus affects the liver, causing liver failure. The studies of non-aggressive strains will increase our understanding of RHDV type 2 and other pathogenic lagoviruses.

In the autumn and winter of 2016/2017, several mountain hares (*Lepus timidus*) died of the new RHDV type 2 virus on the small island of Hallands Väderö off the west coast. RHDV2 has also caused mortality in European brown hares in other countries. In a new pilot study, supported by the Environmental Protection Agency, SVA continues to investigate the presence of RHDV2 in populations of rabbits and hares in Sweden. Additionally, the genetics of this new virus is rapidly changing and molecular methods are being used to track these changes. Finally, the project also aims to further develop the diagnostic methods available to improve our ability to detect the virus.

INFECTIOUS AGENTS OF WILD BOAR

African swine fever (ASF) has been detected and is spreading in Russia and Eastern Europe over the past number of years. As part ASF-monitoring in Sweden, all 16 fallen wild boar examined at SVA in 2017 were negative for ASF. Based on necropsy findings, one of these cases was suspected as a possible ASF case. It was a five-month-old juvenile found dead next to a grain dryer in August, outside Uppsala. There were no external lesions and there were hemorrhages in the intestine and in several internal organs. Virus analysis was done with highest priority, and fortunately all tested tissues were negative for ASF virus. The final diagnosis for this case was clostridiosis, an aggressive bacterial infection.

In addition to the ASF-monitoring, 136 blood samples from hunter-harvested wild boar, sent in by helpful hunters to SVA, were screened for a number of important pathogens affecting or carried by wild boar and domestic pigs. All samples were negative for the viral diseases classical swine fever and pseudorabies (Aujeszky's disease).

ULCERATIVE DERMATITIS OF MOOSE

In 2015, about 150 cases of widespread dorsal skin ulcerations with suppurative inflammation were reported. In 2016, only few cases were reported, but in 2017 the number of reports increased to about 40. Investigations have been carried out to try to identify the cause of these skin wounds, some of which may be over 1meter diameter in size. Screening for viruses in general, and a specific herpes virus test were both negative. Massive hatching of deer ked (*Lipoptena cervi*) or other parasites are still suspected to be possible primary causes of a severe itch that leads to chronic scratching, secondary bacterial skin infections and extensive ulceration of the skin.

*Male moose (*Alces alces*) with a large ulcerating dorsal skin lesion. Photo: SVA.*

Statens vilt – Wildlife of the state

SVA cooperates with the Museum of Natural History (NRM) in Stockholm regarding listed wildlife species of concern, also called “Statens vilt”. These are species that have to be reported to the police when a carcass is found. The species include large predators, whales, several species of 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 biology studies, environmental contaminant studies, and for archiving in the Museum's collections.

MARINE MAMMALS

SVA collaborates with NRM regarding porpoises and other cetaceans, and also monitors diseases in seals that are sent to NRM, and occasionally to SVA. The investigations at SVA are focused on determining the cause of death and documenting diseases, while NRM monitors environmental toxins, diet, health status, and genetics.

SVA and NRM received funding from the Sea and Water Authority (HaV) in 2017, to collect and investigate dead porpoises, with the aim of increasing our knowledge of this species. Seventeen porpoises (*Phocoena phocoena*) were examined during 2017. Diseases detected included pneumonia caused by Salmonella enterica, a lung embolus due to heart valve inflammation, and bacterial meningitis. At least nine cases were incidentally caught in fishing gear and most of these animals were in normal or good body condition. Further details can be found in the NRM report 2:2018 “Tumlare 2017. Health status and causes of death in collected animals”, by Roos, Neimanis, and Ågren.

Necropsy of a porpoise found dead on the Swedish west coast. 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 dead animals or animal parts of these four large carnivores found dead in nature are to be submitted for examination at SVA. Also, when large predators are shot in the state regulated licensed hunting, the entire skinned carcass or certain parts of the animal are to be sent to SVA.

LARGE CARNIVORES 2017

In 2017, SVA handled carcasses or parts of carcasses of 547 large predators. The majority of these cases are carcasses or samples from licensed hunts or other management-related culling. Other causes of death include vehicle accidents on road or railroad, as well as parasite infestations such as sarcoptic mange that usually leads to emaciation. Some of the large carnivore cases are part of criminal investigations.

The examinations of large carnivore carcasses result in a good overview of population health of these species. When monitoring natural mortality of wild species, one must assume that a number of dead animals are never found. Therefore, only a minimum number of known deaths can be given. However, with similar surveillance methods and efforts over a longer time span, variations in mortality of a specific cause can be compared over time.

Carnivore	2013	2014	2015	2016	2017
Bear	345	337	312	314	310
Wolverine	30	26	37	14	12
Lynx	181	84	57	116	158
Wolf	50	36	73	47	67*
Total	**606**	**483**	**479**	**441**	**547**

Number of carcasses or parts of large predators submitted to SVA. Source: Carnivore database, SVA.
** Of these 67, seven were wolf/dog hybrids.*

The summaries below describe causes of death and health status for the large carnivore species; bears, lynx, wolverines, and wolves, investigated at SVA in 2017. Further details are available in the SVA report on Large Carnivores 2017 (in Swedish).

BEAR

In 2017, whole bodies or samples from 310 bears were examined. Of these, 209 were harvested during licensed hunting. From hunted bears, only a set of tissue samples collected by official inspectors, are sent to SVA. Seventy bears were culled in protective hunting, and two bears were shot while protecting domestic animals (JF § 28). Another two bears were shot in bear attacks on humans (self-defence, Chapter 24, BrB). Thirteen bears were killed by traffic; seven as roadkills and six on the railroad. In addition, some bears were received for forensic investigations. The health situation in the bear population can in general be considered as good.

WOLVERINE

The wolverine population appears to have a good health status, as few diseases are found in this species. Twelve wolverines were necropsied in 2017, of which 10 were culled to prevent damage in reindeer herds. One animal was killed in traffic, and one was part of a forensic investigation.

LYNX

In 2017, 158 lynx were examined at SVA. Of these, 80 animals were hunted in the licensed hunt and 35 were culled in protective hunting. Thirty lynx were killed in traffic, mostly on roads. The overall health of the lynx population is in general good, with the exception of sarcoptic mange that affected nine lynx in 2017.

WOLF

A total of 60 wolves were investigated by SVA in 2017. The main cause of death for wolves was management-related hunting, with 25 animals taken in the licensed hunt and 23 under protective culling. Two wolves were killed in protection of domestic animals (§28 JF). Three wolves died in traffic and seven wolves died of sarcoptic mange.

One wolf was a forensic case. The health situation of wolves is in general good.

In addition to these wolves, seven juvenile wolf-dog hybrids in one family group were culled in 2017 and necropsied at SVA.

Brown bear female with three cubs (zoo animals). Photo: Karin Bernodt, SVA.

OIE reporting 2017

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. How many wild animals actually 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 diseases have emerged or if previously undetected disease-causing agents are present.

Detected 2017	Total	Species
Avian influenza (H5N8)	34	Goshawk 2, Mallard 4, White tailed eagle 7, Hawk owl 1, Mute swan 15, Crow 1, Buzzard 1, Peregrine falcon 2, Rook 1
Pigeon paramyxovirus 1	6	Rock pigeon
Tularemia	7	European brown hare
Elaphostrongylus	6	Moose
Rabbit viral Hemorrhagic Disease	10	Rabbit
Myxomatosis	6	Rabbit
Poxvirus	1	Porpoise
Pasteurellosis	2	Fallow deer
Pseudotuberculosis	1	Mountain hare
Sarcoptic mange	17	Lynx 7, Raccoon dog 1, Red fox 3, Wolf 5, Wild boar 1
Salmonellosis	13	Squirrel 1, Bullfinch 5, Redpoll 1, Green woodpecker 1, Siskin 1, Gray owl 1, Greater woodpecker 1, Kestrel 1, Porpoise 1
Trichomonosis	24	Chaffinch 1, Greenfinch 17, Wood pigeon 4, Rock pigeon 1, Kestrel 1
Trichinella	12	Lynx 4, Wolf 1, Wild boar 7
Total	**139**	

The number of cases of OIE non-listed wildlife diseases detected in wild animals in 2017 and reported to the Swedish Board of Agriculture. Source: SVA's laboratory information system SVALA.

Wildlife diseases, international overview 2017

AVIAN INFLUENZA

The outbreak of highly pathogenic avian influenza (H5N8) in 2016 in Sweden continued until the end of March 2017. A poultry farm in the county of Södermanland was affected, and 50,000 birds were destroyed according to regulations on contagious diseases. At least three different highly pathogenic avian flu virus strains (H5N8, H5N2, H5N6) have continued to circulate in Europe and caused minor outbreaks in wild birds, especially in mute swans (*Cygnus olor*), and a number of outbreaks in domestic poultry in Italy, the Netherlands, Germany, Switzerland, and the United Kingdom. The H5N6 variant found in Europe is not considered to affect humans, which differs from the virus occurring in Asia which also infects humans.

CWD

The findings of chronic wasting disease in wild reindeer, moose, and red deer in Norway has led to a response plan where zones were established around known infected areas, and special regulations were introduced, regarding hunting, handling of carcasses and slaughter waste, limiting transportation of live animals, and banning salt licks for wild cervids. Within the zones, all dead cervids must be tested for CWD prions. Culling of the single infected wild reindeer herd of Nordfjella was completed in early 2018. The area will be kept empty of cervids for at least five years before restocking with new wild reindeer. In Norway, about 25, 000 cervids were screened for CWD in 2017, including about 11,000 semi-domesticated and about 3,000 wild reindeer in 2017. Of these, 9 wild reindeer from Nordfjella, one moose and one red deer, were positive for CWD in 2017.

WEST NILE VIRUS

By 2017, more than 200 human cases of West Nile Fever have been reported in the EU. The mortality rate for humans who fell ill was about 9%. The disease occurs in wild birds and is spread by mosquitoes, which also can infect humans and horses. The mosquito species that spreads the West Nile virus was detected by a researcher from SVA in the summer of 2017 in Falsterbo, in southernmost Sweden.

SAIGA ANTILOPE MASS MORTALITY

Recent research results confirm that the mass mortality of Saiga antilopes in Kazakhstan 2015, when about 200,000 animals died in a period of a few weeks, was caused by an outbreak of the bacterium *Pasteurella multocida* type B. The antilopes can carry the bacteria without any clinical symptoms, but acute mortalities may occur if the bacteria are activated by stress factors. Climatological factors (extreme heat and humidity) are considered to have triggered the outbreak. Similar climate conditions also preceded antilope mass mortalities in 1981 and 1988. In the autumn of 2017, about 10% of the Mongolian subspecies of Saiga antilopes died in an outbreak of Peste des Petits Ruminants, caused by a morbillivirus. This mortality was likely a consequence of previous outbreaks of the disease in sheep and goats in Mongolia.

AFRICAN SWINE FEVER

During 2017, African swine fever continued to spread westward from Russia and Belarus, by a few kilometers per month, in the wild boar population. In late June 2017, African swine fever was detected in wild boar in the Czech Republic, near the border of Slovakia. Because the infection emerged far from previously known infected areas in Poland and Moldova, spread by human activity is believed to be involved via uncooked pork products from the east. In the Czech Republic, attempts are ongoing to cull all wild boar in the infected area. In Poland, new areas with outbreaks in wild boar were observed north of Warsaw in November. In the Baltic countries the disease is now spread throughout most parts of the countries, and on the major islands of Estonia in the Baltic Sea.

BAT RABIES

In Switzerland and Belgium, one case of bat rabies virus (EBLV-1) in each country was detected in Serotine bats (*Eptesicus serotinus*) in 2017. This was the first case in Switzerland since 2002, while Belgium had one case in 2016 in the same species.

SNAKE FUNGAL DISEASE

Snake fungal disease (caused by *Ophidiomyces*) described in North American snakes, has now been found for the first time in Europe in a study of shed snake skins in the United Kingdom, in grass snake (*Natrix natrix*) and the Czech Republic in dice snake (*Natrix tessellata*). Eight percent of the examined skins were positive for the fungus, with visible skin lesions. The disease is thought to have contributed to mortality in snakes. The European variant of the fungus differs from the North American type.

VULTURES IN INDIA STILL THREATENED

The anti-inflammatory drug diclofenac, which has been shown to cause kidney damage (renal gout) and mortality in vultures, almost eradicating one of the most common vulture species in India, was banned in 2006 for veterinary use. Despite the ban, the Indian vulture populations have not recovered. This probably is due to diclofenac still being available for human use, and that other anti-inflammatory drugs that also are toxic for birds, are still available on the market.

Publications 2017

SVA staff produce a number of publications, both peer-reviewed scientific as well as popular science publications, and written reports. 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 2017 relating to wildlife, where staff from the Wildlife section or other departments at SVA are authors or co-authors (SVA staff names in bold).

SCIENTIFIC PUBLICATIONS

Bengtsson B, Persson L, Ekström K, Ericsson Unnerstad H, **Uhlhorn H**, Börjesson B. High occurrence of mecC-MRSA in wild hedgehogs (*Erinaceus europaeus*) in Sweden. Veterinary Microbiology, 2017 Aug; 207: 103-107.

Boijsen B, **Uhlhorn H**, **Ågren E**, Höglund J. Nodular onchocercosis in red deer (*Cervus elaphus*) in Sweden. Int. J. Parasitology: Parasites and Wildlife 2017, 6 (3): 340-343.

Ecke F, Singh NJ, Arnemo JM, Bignert A, Helander B, Berglund ÅMM, Borg H, **Bröjer C**, Holm K, Lanzone M, Miller T, Nordström Å, Räikkönen J, Rodushkin I, **Ågren E**, Hörnfeldt B. Sublethal Lead Exposure Alters Movement Behavior in Free-Ranging Golden Eagles. Environ Sci Technol, 2017 May 16; 51(10):5729-5736. doi: 10.1021/acs.est.6b06024. Epub 2017 Apr 26.

Grandi G, **Uhlhorn H**, **Ågren E**, **Mörner T**, Righi F, Osterman-Lind E, **Neimanis AS**. Gastrointestinal parasitic infections in fallen and debilitated moose (*Alces alces*) in Sweden. Journal of Wildlife Diseases, 2018, 54(1):165-169.

Grandi G, Lind EO, Schaper R, **Ågren E**, Schnyder M. Canine angiostrongylosis in Sweden: a nationwide seroepidemiological survey by enzyme-linked immunosorbent assays and a summary of five-year diagnostic activity (2011-2015). Acta Vet Scand, 2017 Dec 19; 59(1):85.

Hestvik G, **Uhlhorn H**, Södersten F, Åkerström S, Karlsson E, Westergren E, **Gavier-Widén D**. Tularaemia in European Brown Hares (*Lepus europaeus*) and Mountain Hares (*Lepus timidus*) Characterized by Histopathology and Immunohistochemistry: Organ Lesions and Suggestions of Routes of Infection and Shedding. J Comp Path, 2017, 157:103-114. doi 10.1016/j.jcpa.2017.06.003.

Hestvik G, **Uhlhorn H**, Åkerström S, Södersten F, **Gavier-Widén D**. *Francisella tularensis* in muscle from diseased hares – a risk factor for humans? Epidemiol Infect, 2017 Dec; 145(16):3449-3454. doi 10.1017/S0950268817002540.

Jansson DS, **Bröjer C, Neimanis A**, Mörner T, Murphy CL, Otman F, Westermark P. Post mortem findings and their relation to AA amyloidosis in free-ranging Herring gulls (*Larus argentatus*). PLoS One, 2018 Mar 1; 13(3):e0193265. doi: 10.1371/journal.pone.0193265. eCollection 2018.

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, 2017 Mar; 409(7):1877-1885.

Le Pendu J, Abrantes J, Bertagnoli S, Guitton JS, Le Gall-Reculé G, Lopes AM, Marchandeau S, Alda F, Almeida T, Alves PC, Bárcena J, Burmakina G, Blanco E, Calvete C, Cavadini P, Cooke B, Dalton K, DelibesMateos M, Deptuła W, Eden J-S, Fang W, Ferreira C, Ferreira P, Foronda P, Gonçalves D, **Gavier-Widén D**,Hall R, Hukowska-Szematowicz B, Kerr P, Kovaliski J, Lavazza A, Mahar J, Malogolovkin A, Marques R,Marques S, Martin-Alonso A, Monterroso P, Moreno S, Mutze G, **Neimanis A**, Niedźwiedzka-Rystwej P,Peacook D, Parra F, Rochi M, Rouco C, Ruvoën-Clouet N, Silva E, Silvério D, Strive T, Thompson G, TokarzDeptuła B, Esteves PJ. Proposal for a unified classification system and nomenclature of lagoviruses. Journal of General Virology. 2017, 98(7): 1658-1666. doi: 10.1099/jgv.0.000840

Lopes AM, Breiman A, Lora M, Le Moullac-Vaidye B, Galanina O, Nyström K, Marchandeau S, Le Gall-Reculé G, Strive T, **Neimanis A**, Bovin NV, Ruvoen-Clouet N, Esteves PJ, Abrantes J, Le Pendu J. Host specific glycans are correlated with susceptibility to infection by lagoviruses, but not with their virulence. Journal of Virology, 2017. doi: 10.1128/JVI.01759-17. (Epub ahead of print).

Neimanis AS, Ahola H, Zohari S, Larsson Pettersson U, **Bröjer C**, Capucci L, **Gavier-Widén D**. Arrival of rabbit haemorrhagic disease virus 2 to northern Europe: Emergence and outbreaks in wild and domestic rabbits (*Oryctolagus cuniculus*) in Sweden. Transboundary and Emerging Diseases, 2018, 65:213-220.

Neimanis A, **Neimanis A**, Åsberg C. (2017). Fathoming chemical weapons in the Gotland Deep. Cultural Geographies. ePub ahead of print. https://doi.org/10.1177/1474474017719069

Rising A, Cederlund E, Palmberg C, **Uhlhorn H**, Gaunitz S, Nordling K, **Ågren E**, Ihse E, Westermark GT, Tjernberg L, Jörnvall H, Johansson J, Westermark P. Systemic AA amyloidosis in the Red fox (*Vulpes vulpes*). Protein Science, 2017, 26 (11): 2312-2318.

SCIENTIFIC PRESENTATIONS

23rd biennial meeting of the Nordic section of the Wildlife disease association, Bornholm, Denmark, 9-11 May 2017
Oral presentations: **Bröjer C**: HPAI - H5N8 in Sweden 2016-2017. **Cedervind H:** Large carnivore work in Sweden. **Hestvik G**: Tularemia in Swedish wildlife. **Neimanis A:** Rabbit hemorrhagic disease virus 2 in Sweden and spill-over into mountain hares (*Lepus timidus*). **Olofsson K:** Alpha-chloralose poisoning in mallards. **Uhlhorn H**: Sarcoptic mange in Swedish wolves. **Ågren E:** Wildlife disease surveillance in Sweden 2015-16.

XXth World veterinary poultry association congress, Edinburgh, UK, 4-8 September 2017
Poster: Jansson DS, **Bröjer C,** Zohari S, Otman F, Jeremiasson M, **Hestvik G & Uhlhorn H** Pathology findings in poultry and free-living wild birds naturally infected with HPAIV H5N8.

11th EPIZONE annual meeting, Paris, France, 19-21 September 2017
Oral presentation (invited speaker): **Neimanis A**: Crossing barriers: The case of Rabbit Haemorrhagic Disease Virus 2.

REPORTS

NRM report 2:2018 Porpoises 2017. Health status and causes of death in collected carcasses. [In Swedish: Tumlare 2017. Hälsostatus och dödsorsaker hos insamlade djur]. By: A. Roos, A.S. Neimanis, and E.O. Ågren.

Disseminating knowledge

During the year, department staff have supervised one PhD student and two veterinary students on their final year projects and papers. The wildlife section staff has hosted groups visiting the necropsy room and given lectures on wildlife diseases and ongoing projects. Lectures on current wildlife diseases are given on a regular basis, mainly for various hunters´ organizations.

In autumn 2017, SVA organized a course in remote autopsy (RDA) for pathologists, in collaboration with The Swedish University of Agricultural Sciences SLU and Farm and Animal Health (Gård & Djurhälsan). The course demonstrated a commercial system from Canada headed by Kent Fenton (Feedlot Health Management), where a predetermined set of digital images are systematically taken of on-farm necropsied livestock and sent electronically to the FHM pathologist for interpretation. The images are assessed, and a diagnosis is given based on the gross lesions. Adaption of this protocol is planned to determine if it can be applied to field necropsies of wildlife.

WORKING GROUPS

Wildlife section staff have been participants in the following expert groups:

Wildlife Disease Council, Swedish 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 Wild Diseases: Dolores Gavier-Widén, Erik Ågren, Henrik Uhlhorn.

SVA´s Climate Council: Henrik Uhlhorn.

SVA's Zoonosis Committee: Henrik Uhlhorn.

Hoofed game Council (Klövviltsrådet, Swedish Environmental Protection Agency), SVA Representative: Caroline Bröjer

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

EWDA, European section, Wildlife Disease Association. Vice Chairman. in the EWDA Board: Erik Ågren

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

ECZM, European College of Zoological Medicine, Wildlife Population Health speciality, examination committee chair: Erik Ågren

Journal of Wildlife Diseases, assistant editor: Erik Ågren

OIE Focal point Wildlife Diseases: Torsten Mörner

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