STATENS VETERINÄRMEDICINSKA ANSTALT

WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2020

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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 2020.

Uppsala, 15 April 2021
Erik Ågren, Head of the Wildlife section
Aleksija Neimanis, Head of section for Research and Development

DEFINITIONS

General disease surveillance involves diagnosis of disease and cause of death through necropsy, histopathology and ancillary testing of wildlife found sick or dead. Also, monitoring of reports from the public, other authorities, social media, and news sources is included in detecting disease or increased mortality in wildlife.

Targeted disease surveillance involves targeted sampling and examination of sick or healthy wildlife to investigate specific diseases or disease-causing agents. Most often, these investigations are initiated by findings from general disease surveillance, or when information about emerging diseases or ongoing outbreaks is reported within Sweden or in neighbouring countries.

Summary

The health status of Swedish wildlife

References: SVA annual report 2020, SVA Wildlife section and SVALA database; 2020.

Health and disease surveillance of wild animals is mainly done through post-mortem examinations and ancillary testing of wildlife found dead and through targeted collection of wildlife samples, the latter often done within various research projects.

Reporting from other authorities and the general public also provides information on the current disease status of wildlife. Diseases of wild animals that can spread to or from domestic animals or humans are prioritized.

In 2020, 2,510 wildlife carcasses or samples were received. Samples from farmed game, zoo animals and from other captive wildlife species are also received, but these cases are not presented here. Of the cases received, 673 were from large predators, many of which came from the mandatory sampling of hunted lynx and brown bear. Also, 178 cases of reportable diseases involving 23 wild animal species were reported to the Swedish Board of Agriculture and the OIE.

The most important events related to wildlife diseases in 2020 have been the fourth finding of Chronic Wasting Disease (CWD) in the country, in an older female moose in Västerbotten County, which is the second county after Norrbotten where this prion disease has been found. The case was detected within the ongoing national surveillance of CWD. Intensified monitoring of CWD during the autumn moose hunt was carried out in Västerbotten with the help of the hunter community, but no further cases were detected.

At the end of the year, highly pathogenic avian influenza (H5N8) was found in barnacle geese, eagle owl and peregrine falcon, an infection also noted in nearby countries in Europe during this period. The bacterial disease tularemia was also noted in 2020, but except for some cases in Norrbotten, these cases were sporadic involving single hares and differs from the large outbreak among wildlife and humans in 2019. Monitoring of African swine fever in wild boar found dead is slowly increasing after long-standing information efforts aimed at the hunter community and the general public.

During the year, a programme for health and disease monitoring of marine mammals was launched in collaboration with the Swedish Museum of Natural History (NRM), funded by the Swedish Agency for Marine and Water Management. Improved knowledge on the health and diseases of harbour porpoises was presented in a joint report from SVA and NRM, in which ten years of necropsies of porpoises have been compiled.

A new PCR-method was used to conduct a retrospective study of *Echinococcus granulosus* tapeworms in Swedish wolves. Two fecal samples from 2012 were positive, the first recorded cases in wild wolves in the country. This canine intestinal parasite has been present for a long time in Sweden, but only isolated cases have been noted in the last 50 years, and only in intermediate hosts such as reindeer and moose.

Wildlife disease surveillance in Sweden 2020

The government's instruction to SVA (Regulation 2009:1394) states that the veterinary authority shall monitor and analyse the disease status of wildlife in Sweden.

SVA is the only veterinary laboratory in the country that systematically works with disease surveillance of wildlife. The work is based mainly on the necropsy of sick or dead wildlife, and screening of samples from hunter harvested animals for specific infectious agents. Additionally, SVA cooperates with other wildlife research groups and projects to get a broader picture of the health and disease situation of wildlife. This report presents the activities and results of the wildlife work at SVA in 2020.

General wildlife disease surveillance Fallviltsundersökningen at SVA is the surveillance of causes of death and diseases of fallen game, i.e. wildlife found dead or euthanised, or examination of pathological lesions found in hunted game species during field dressing or at slaughter. General wildlife disease surveillance in Sweden has been ongoing since 1948, initiated by Professor Karl Borg at SVA.

The wildlife disease surveillance programme was initiated in 2006 in cooperation with the Swedish Environmental Protection Agency (EPA) to finance additional wildlife studies, including targeted disease surveillance. The basic wildlife work at SVA is financed by the Wildlife Conservation Fund (Viltvårdsfonden), the Swedish EPA, and state funding.

The Wildlife Disease Council (Viltsjukdomsrådet) is a group of experts and officials from the Swedish Environmental Protection Agency (EPA) and SVA. The council discusses wildlife health issues, wildlife management and jointly recommends targeted initiatives for SVA to carry out during the year. In 2020, the Council consisted of Klas Allander, Eleonor Glad and Ola Inghe from the EPA, and Dolores Gavier-Widén, Erik Ågren, and Aleksija Neimanis from SVA. Henrik Uhlhorn, SVA serves as secretary. In 2020, the council held two meetings.

European brown hare found dead in the field by a wildlife interested person. Necropsy at SVA showed it had died of the bacterial disease pseudotuberculosis, a disease in hares that was diagnosed more frequently in 2020.

Financing the wildlife work at SVA

The wildlife work is financed mainly by grants from the Swedish Game Conservation Fund (Viltvårdsfonden), the Swedish Environmental Protection Agency, Government funding, and project funding from the Swedish Board of Agriculture.

The Game Conservation Fund is a research fund based on the annual state game conservation fee that each person participating in hunting in Sweden must pay. SVA receives an annual grant and the total was 4.05 million SEK in 2020. This funding is mainly used to run the general wildlife disease surveillance program with examination of received fallen wildlife to study diseases and causes of death. As this funding originates from hunters, focus is on game species. Received carcasses and samples are utilized also for targeted disease surveillance, relevant research, and to add samples to the biobank archive for future research. The aim is to make sure the work done is for the benefit of our wildlife populations.

The Swedish Environmental Protection Agency (EPA) funds the work with large predators, which amounted to 2.5 million SEK in 2020. In addition, the Wildlife Disease Council with experts from SVA and the EPA meet twice a year to prioritize projects to carry out. Types of projects funded include investigation of ongoing disease outbreaks or increased wildlife mortality, and establishment of specific laboratory analytic methods for wildlife samples. Together with government funding, these grants jointly finance the basic work with wildlife disease surveillance. Wildlife disease surveillance at SVA is facilitated by the expertise and infrastructure already in place to carry out veterinary diagnostics for domestic species.

The Swedish Board of Agriculture may provide grants for specific studies of selected listed animal diseases that are reportable to the EU and to the OIE. The purpose is to monitor the occurrence of a specific disease or pathogen in wildlife, or to monitor wildlife to show freedom from a specific disease.

Wildlife staff 2020

The wildlife work is mainly carried out by staff from the Department of Pathology and Wildlife Diseases (POV). The work is based on pathological examination of wildlife, but other departments and laboratories throughout SVA are involved with ancillary testing and analyses of infectious agents and chemical substances, or with epidemiology. Collaboration with external wildlife researchers at Swedish University of Agricultural Sciences (SLU) and other national or international institutes is also an important part of the work with wildlife.

Section of Wildlife 2020

Erik Ågren Deputy head of Department, Head of section, Veterinary Officer, Dipl. ECVP, DipECZM (Wildlife population health). OIE National Focal point for wildlife diseases.
Karin Olofsson-Sannö Veterinary Officer, PhD
Gustav Averhed Veterinary Officer
Janna Nises Veterinary Officer, Large carnivores
Neele Doose Veterinary Officer
Elina Thorsson Veterinary Officer
Jasmine Stavenow Biologist, MSc. Large carnivores, marine mammals
Marit Liljefors Technician
Frida Öhrn Veterinary Officer
Tina Jansson Temporary necropsy assistant

Section of Research and Development 2020

Aleksija Neimanis Head of section, Veterinary Officer, BSc, MSc, MVetSci, PhD, Dipl. ACVP
Caroline Bröjer Veterinary Officer, MSc, PhD, DipECZM (Wildlife population health)
Gete Hestvik Veterinary Officer, PhD
Henrik Uhlhorn Veterinary Officer, PhD
Ulrika Larsson Pettersson Biomedical analyst

Other staff within the department and SVA

Administrators Ewa Backman och Carina Bohlin. Necropsy assistants Hans Kanbjer, Johan Karevik, Lars Hammarsten. Technicians Sandra Karevik, Katarina Jendelöv, Madeleine Johannessen, Benny Eriksson, Anders Åslund. Biomedical analysts Gudrun Andersson, Shaqe Hafstad, Mariam Kerro, Angelica Stefansdotter. Dolores Gavier-Widén DVM, Professor, head of department.

rapporteravilt.sva.se

The general wildlife disease surveillance is based on citizen science. To facilitate reporting of cases of sick or dead wild animals, an online reporting form that can be used on any digital platform, including smartphones, is available at the following web-address: rapporteravilt.sva.se. When an interesting case suitable for examination is reported, the SVA staff contact and, if possible, organize shipment of the carcass or samples to SVA for examination.

RAPPORTERAVILT.SVA.SE

The use of SVA's on-line reporting system rapporteravilt.sva.se to report diseases and mortality in wild animals has increased since the soft launch in 2017. In the last two years, around 1,370 reports were received annually.

In addition, the wildlife section is contacted by e-mail and telephone. More than 4400 e-mails consisting of reports of wild animals and subsequent replies were exchanged in 2020 and over 800 telephone calls in which memo notes were taken about findings of wildlife cases were received.

During 2020, the COVID-19 pandemic limited the number of face-to-face lectures that the wildlife section's employees have been able to perform, but we have participated in several webinars and digital lectures.

The main wildlife diseases monitored in 2020 were Chronic Wasting Disease (CWD) and African swine fever, but also avian influenza that spread throughout Europe during autumn and winter.

Wildlife cases 2020

NUMBER OF WILD ANIMALS OR PARTS OF ANIMALS RECEIVED IN 2020

A total of 2,510 wildlife cases were submitted to the Department of Pathology and Wildlife Diseases in 2020 from the following groups: mammals (1,749), birds (723), reptiles (25, mostly turtles euthanised as invasive alien species) and amphibians (8). Wildlife samples are also submitted to other departments at SVA, mainly consisting of muscle samples for *Trichinella* analysis from hunted wild boar and brown bear.

Mammals	Cases
Total	**1749**
Brown bear	442
Moose	329
Lynx	162
Bat	129
European brown hare	105
Roe deer	81
Wild boar	80
Muskrat, Otter	78
Wolf	31
Mountain hare	30
Wolverine	29
Harbour porpoise	26
Red squirrel	21
Wild rabbit	18
Hedgehog, Red fox	18
Fallow deer	14
Mouse	11
Mink	9
Grey seal, Red deer	6
Harbour seal	5
Yellow-necked mouse, Vole	4
Badger, Raccoon dog	3
Shrew, Arctic fox	2
Beaver, Beaked whale, Canine, Cat, Least weasel, Wood mouse	1

Amphibians	Cases
Total	**8**
Common toad	6
European green toad	1
Moor frog	1

Reptiles	Cases
Total	**25**
Turtle (*Trachemys scripta subsp.*)	22
Turtle (*Mauremys* sp.)	2
Slowworm	1

Birds	Cases
Total	**723**
White-tailed eagle	80
Great grey owl	58
Eurasian siskin	34
Barn swallow, Rook	27
Jackdaw	26
Sparrow hawk	24
Blackbird, Goshawk	22
Mute swan	21
Rock pigeon	20
Ural owl	19
Common eider, Tawny owl	18
Blackheaded gull	17
Common buzzard, Kestrel	16
Eagle owl, Golden eagle	13
Bullfinch, Pigeon (unspecified)	12
Greenfinch, Wood pigeon	11
Mallard	10
Great cormorant	9
Great tit, Great spotted woodpecker, Magpie, Osprey	7
Chaffinch, Fieldfare, Hawfinch, Red kite	6
Barnacle goose, Herring gull, Long-eared owl, Peregrine falcon	5
Boreal owl, Montagu´s harrier, Rough-legged buzzard, Song thrush	4
Blue tit, Common redpoll, Eurasian hobby, Grey partridge, Hooded crow, Kingfisher, Swallow, Waxwing	3
Black and White Flycatcher, Black woodpecker, Eurasian jay, Great black-backed gull, Greylag goose, Gull (unspecified), Hazel grouse, Northern hawk owl, Pheasant, Raven, Trumpeter swan, Yellowhammer	2
Blackcap, Brambling, Capercaille, Common murre, European honey-buzzard, Eurasian pygmy owl, Eurasian treecreeper, Goldcrest, Goldfinch, Horned grebe, House sparrow, Marsh harrier, Merlin, Nuthatch, Razorbill, Red-throated loon, Robin, Short-eared owl, Spotted flycatcher, Swift	1

Wildlife diseases in focus 2020

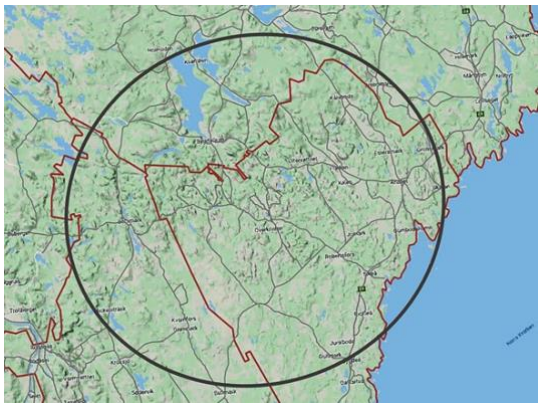
CWD – NEW CASE IN SWEDEN 2020

CWD, *Chronic wasting disease*, was found in Sweden in three moose in 2019. A fourth case was confirmed in September 2020 in Robertsfors in Västerbotten County.

New case 2020

Increased surveillance in Västerbotten

As CWD was detected in a female moose in Robertsfors municipality in September 2020, an increased surveillance was initiated involving only moose. The surveillance started after the rut when hunting season was paused, but unfortunately 60-70% of the moose quota was already filled before the rut period. The increased surveillance area was approximately 2.5 km radius around the positive moose case site, and 95 hunted moose were sampled and analysed with the help and efforts from the local moose hunting teams. All analysed samples were negative.



Map with the circular area for the extended monitoring of CWD in mainly Robertsfors municipality, Västerbotten County. Municipal boundaries in red.

Similarities with previous cases

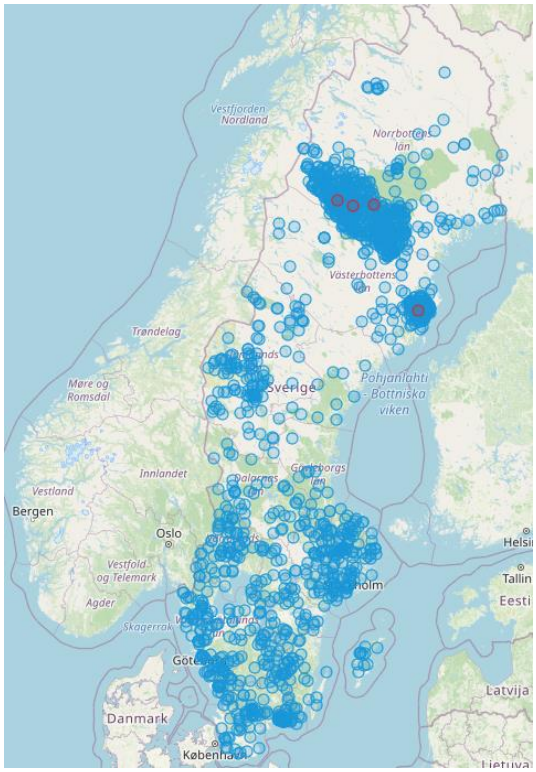
The fourth CWD-positive moose was, like the previous cases, an older female, 14 years old, and the hunter assessed it as injured and thin but it did not show any neurological symptoms before being put down. The hunter took samples and submitted them to SVA for analysis of CWD. The analysis was positive in the rapid ELISA test and later confirmed with Western Blot, for brain stem, but as in previous cases in moose in Sweden, the lymph nodes were negative.

National surveillance of CWD

Below is a table showing the number of samples that were analysed in 2020, and in total since 2018. The EU-regulated national surveillance will continue throughout 2021.

*Table with the number of samples received from wild cervids examined for CWD at SVA in 2020 and number of positive cases. *Fallow deer are not included in the EU surveillance but are sampled in cases when there is clinical suspicion of CWD.*

SPECIES	2020	POSITIVE	TOTAL
Roe deer	71	0	154
Moose	248	1	1 311
Red deer	84	0	12
Reindeer	991	0	2 669
*Fallow deer	4	0	5



Map of CWD surveillance in Sweden. The four red rings are positive moose, the blue ones are negative samples. For details see interactive map at cwd.se

The history of CWD in Europe
Very surprisingly, a case of CWD was found in a wild reindeer in Norway in 2016. To manage this contagious variant of CWD in Norway, zones were established to demarcate the wild reindeer area of Nordfjella where the disease had been detected. Specific regulation of hunting, and handling of carcasses and slaughterhouse waste was introduced. Within the zones, all dead cervids have been tested and special restrictions apply to feeding wildlife and using salt licks. The entire wild reindeer herd in the area was culled and the area will be kept empty of wild reindeer for at least five years before the restocking with healthy genetically similar wild reindeer from nearby herds.

Across Norway, more than 120,000 cervids have now been examined for CWD from 2016 - 2020. A total of 29 CWD-positive animals have been found in Norway by the end of 2020; eight moose, twenty wild reindeer and one red deer. However, Norwegian researchers have shown that CWD in moose and red deer is not similar to the contagious variant of CWD seen in wild deer in North America but appears to be a more spontaneous or sporadic disease. The Veterinary Institute of Norway continuously report the results of their CWD monitoring http://apps.vetinst.no/skrantesykestatistikk/NO/.

EU monitoring 2018 - 2020
In autumn 2017, the European Commission regulated surveillance of CWD for six Member States (EU 2017/1972). Sweden, Finland, Estonia, Latvia, Lithuania, and Poland are the EU member states with moose or reindeer, and each country should examine at least 6,000 cervids over a three-year period, between 2018 and 2020.

In 2017, SVA developed a surveillance plan for Sweden based on data from The Swedish University of Agricultural Sciences (SLU) regarding the population sizes of different cervid species and their geographical distribution, work funded by the Swedish Environmental Protection Agency.

SVA conducts the surveillance in Sweden together with the Board of Agriculture. To ensure coverage of the country, the 6,000 samples were distributed by county and municipality, depending on the deer species present and the estimated animal density in the different regions. The most interesting cases to sample are so-called animals at risk, i.e. animals that show signs of disease that may indicate CWD. Emaciated cervids that also have signs of brain lesions are of greatest interest to investigate. Any found dead adult cervid is also sampled. To obtain a sufficient number of samples in all areas, hunter-dog teams within the National Wildlife Traffic Accident Council and reindeer owners can contribute with samples from traffic-killed animals, as these are also considered at-risk animals.

Surveillance of CWD in Sweden resumed after the first find in Norway in 2016. Previously, limited surveillance had been carried out in the EU until 2008, without any positive cases being found. From 2016, all found dead, euthanized sick or traffic-killed adult cervids received for examination at SVA have been examined for CWD. EU surveillance 2018-2020 also includes farmed red deer and domestic reindeer.

The Swedish surveillance can be followed on SVA's website www.cwd.se, where maps and tables are updated continuously as analyses are completed. Other CWD surveillance components in Sweden in recent years have been targeted sampling of hunter-harvested moose felled in Jämtland County November-December 2017 and increased surveillance in Norrbotten County in 2019 and Västerbotten County in 2020.

Contagious or sporadic variant?
CWD is caused by prions, a malformed prion-protein that enzymes cannot break down. Instead, they accumulate in the body and especially in the brain, which over many months gradually leads to increasing brain damage with signs such as salivation and behavioral changes. The disease always leads to emaciation and then death, and there is no vaccine or treatment available.

The structure of prions can vary and therefore there are different types of prion diseases and different variants of disease. In the case of cervids, both contagious and sporadic variants are discussed, the latter also called spontaneous or atypical variants.

The four Swedish moose with CWD were all older females and prions have only been detected in the brain stem and brain tissue, but not in lymph nodes or other organs. This suggests that prions do not spread outside the brain and spinal cord. This was also found in

the few other cases of atypical CWD detected in moose in Norway and Finland. However, in the Norwegian wild reindeer in Nordfjella area and in affected cervids in North America, CWD is a more contagious form. In this form, the diseased animal secretes prions via saliva, faeces and urine, infecting other animals by direct contact and also indirectly as the soil and vegetation is infected. Prions survive for many years in the environment as they are very resistant to degradation.

There is much to suggest that CWD in moose in Sweden is an atypical or sporadic variant that occurs spontaneously, possibly an age-related, and perhaps less contagious variant of the disease. The fact that three Swedish cases in 2019 were found within about 80 km of each other is notable, but not proof of contagiousness. To better understand this disease in moose and what variant of CWD they have, many more animals need to be analyzed. Further studies of samples from CWD-positive moose are ongoing in collaboration with researchers in Norway and several other countries.

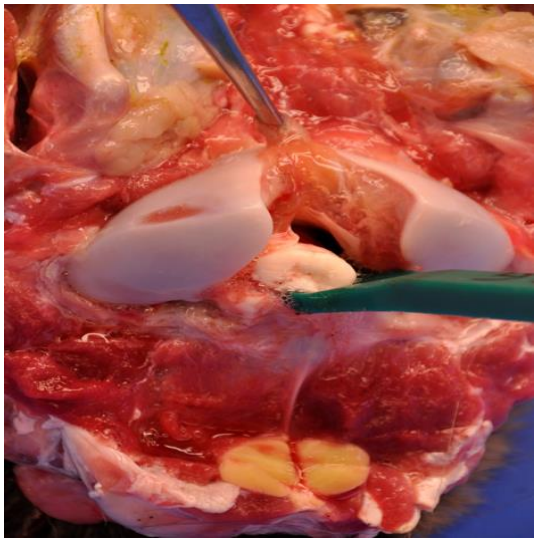
Collection and sampling

To determine whether a cervid is carrying prions, we need to analyze brainstem tissue. In addition, lymph nodes from the head should also be tested. They are important for assessing whether the prions have spread from the brain to other parts of the body, which would support an infectious variant of the disease. If those submitting samples for CWD testing cannot take the samples themselves, the whole skull is sent to SVA. Only adult cervids are tested as the disease has a long incubation period, i.e. it takes a long time from the animal's first exposure to prions until clinical signs of disease are apparent.

THANKS to the hunters and other samplers

For the surveillance to be carried out, the authorities need hunters and other wildlife enthusiasts to help in reporting and submitting samples for analysis. We have some way to go to reach the final target of 6,000 samples but want to thank all of the people who have submitted samples thus far. In addition, we thank the two Swedish hunters´ associations and county administrative boards for all the help we have received so far and hope for continued cooperation until the end of 2021.

SVA provides free kits for sampling as well as packaging materials for anyone who wants to help submit samples for the CWD surveillance. These can be ordered by telephone or on cwd.se.



Spoon sample: Sampling of the brain stem from the back of a moose skull using a special sampling spoon included in the CWD sampling kit sent out by SVA.

CWD.SE

HIGHLY PATHOGENIC AVIAN INFLUENZA NEW OUTBREAK OF H5N8

In late 2020, a major outbreak of highly pathogenic H5N8 avian flu virus (AIV) began, a type found earlier that year in Russia and Kazakhstan. The infection is believed to have spread west with migratory birds to several countries in western Europe.

In 2020, 410 wild birds of 72 different species were swabbed and analyzed for AIV. Six cases of highly pathogenic H5N8 avian influenza were detected. The positive birds were four barnacle geese, a peregrine falcon and an eagle owl. All birds were from Skåne County except for a barnacle goose from Gotland.

Barnacle goose found dead with avian flu. Wild birds necropsied at the SVA are routinely sampled for avian influenza virus. This is the most effective way to pick up introduction of influenza viruses and surveillance is carried out by SVA and financed partly by the Swedish Board of Agriculture. Surveillance results are then reported to the EU.

Table of necropsied wild birds listed in various species groups, examined for avian influenza virus in 2020.

Order	Negative	Positive
Raptors	196	2
Passerines	146	0
Ducks, geese etc	47	4
Gulls	11	0
Galliform	4	0
Total	**404**	**6**

Further analyses of some birds that were negative on the initial swabs were later found to be positive for AIV, which can occur.

SALMONELLA CHOLERAESUSIS AN UNWELCOME FINDING IN WILD BOAR!

In September 2020, domestic pigs in a Skåne farm were found to carry the bacterium *Salmonella* Choleraesuis, which can cause septicaemia and sudden death in this species. After the finding, an investigation of wild boar was initiated in the area. The bacterium was found in both sick and seemingly healthy hunted wild boar. Late in the year, the bacterium was also detected in Södermanland in mid-Sweden.

Wild boars dying of septicaemia can exhibit swollen internal organs such as a large liver, spleen, or lymph nodes and may have pneumonia, but bacterial culture of tissues is needed to confirm if a wild boar died of salmonellosis.

It was known that up to 18% of Swedish wild boars can carry salmonella. However, these are other types of *Salmonella* that rarely make the animals sick. *Salmonella* Choleraesuis had not been detected in domestic pigs in Sweden since 1979 and to date, there is no identified source of this spread in both wild and domesticated pigs. In several Central European countries, the bacterium has been detected in wild boars in recent years. In 2012–2013, Denmark suffered several outbreaks in domestic pigs, indicating that an imported infection from another European country is possible.

In 2020, a SVA study found *Salmonella* in 40 wild boar samples, most of which were of the Choleraesuis type. The findings of *Salmonella* in wild boars in general are important as all types of this bacterium can cause disease in humans. The Choleraesuis type is particularly important as serious disease can occur in both pigs and humans. The monitoring in Skåne and Södermanland will be expanded to cover more areas with wild boar populations. All sick and euthanized or killed boars submitted to SVA are now investigated for *Salmonella* (and also for the viral disease African swine fever) and hunters around the country have been asked to submit samples from sick or hunted wild boars as part of this monitoring in 2021.

SARS-COV-2 HUMANS, MINK, AND WILDLIFE

The SARS coronavirus that was first reported from Wuhan in China at the end of 2019 and so drastically affected the global community, first appeared in Sweden in January 2020. The virus is similar to other coronaviruses originating in bats and is believed to have been transmitted to humans via an unknown intermediate host.

Already in April 2020, the first cases of SARS-CoV-2 were reported in farmed mink in the Netherlands, which were then followed by reports of outbreaks in farmed mink in other countries. In October, the infection was also found in Swedish farmed mink. Globally, millions of farmed mink have since been euthanized.

Research has shown that several canids, felids, mustelids, cervids, and rodents can be infected and spread the infection between them. Disease outbreaks have been seen in zoos in primates and large cats, where the animals are likely to have been infected by their keepers. Among wild animals, the virus has so far only been found in a single wild mink in the United States. However, the mink was found in close proximity to a mink farm.

In Sweden in 2020, a wild ferret, three wild mink and some wild rabbits found dead near a mink farm were examined for SARS-CoV-2. All these animals were negative. Further monitoring of coronavirus in wild animals will continue in 2021.

Bat found dead, with a typical hole in the wing membrane after a cat bite. Bats can carry many different types of coronaviruses and are of interest to investigate, to track which wildlife can carry or spread viruses to humans.

Reported wildlife diseases 2020

SVA reports all diagnosed cases of reportable diseases in animals to the Board of Agriculture, who then reports on to the EU and OIE.

Of the wildlife cases examined in 2020, the finding of chronic wasting disease (CWD) in a fourth moose, and in a second county, Västerbotten, was the most significant. Tularemia was detected in dead hares in 2020, but not as frequently as in 2019. At the end of the year, highly pathogenic avian influenza was found in wild birds, and several cases of pseudotuberculosis caused by the bacterium *Yersina pseudotuberculosis*, was documented in hares. Pseudotuberculosis has only been detected in very rare cases in previous years.

The number of reported cases in wildlife only reflects the cases actually examined at SVA or other laboratories. Further research and analyses can be done with samples saved in biobanks, and new cases can be discovered after this official reporting has been done. The prevalence of a disease in wildlife cannot be determined, but we do get an indication if a disease is present or not, if it is introduced, and if it increases or decreases over time.

Table with the number of positive cases of reportable OIE-listed diseases detected in wildlife diagnosed in laboratories in the country in 2020. Source: SVA Laboratory Data System SVALA.

Disease	Species, number of cases	Totalt
Avian pox	Hooded crow 1	1
Chronic wasting Disease (CWD)	Moose 1	1
Chytrid disease	Moor frog 1	1
Echinococcus multilocularis	Red fox 1	1
European brown hare disease	European brown hare 7	7
Highly pathogenic avian influenza	Barnacle goose 4, Great horned owl 1, Peregrine falcon 1	6
Malignant catarrhal fever	Moose 1	1
Myxomatosis	Wild rabbit 4	4
Pasteurellosis	Fallow deer 1	1
Pigeon paramyxovirus	Rock pigeon 5	5
Pseudotuberculosis	European brown hare 8	8
Rabbit hemorrhagic disease	Wild rabbit 5	5
Salmonellosis	Bullfinch 8, Red poll 2, Siskin 23, Blackheaded gull 4, Porpoise 1, Wild boar 31	69
Sarcoptic mange	Lynx 3, Red fox 1, Wild boar 1	5
Toxoplasmosis	European brown hare 3	3
Trichomoniasis	Chaffinch 4, Bullfinch 1, Greenfinch 4, Siskin 1, Rock pigeon 1, Hawfinch 4	15
Trichinosis	Lynx 6, Wild boar 9	15
Tularemia	Mountain hare 20, European brown hare 10	30
TOTAL		**178**

Facts on reporting of animal diseases
A number of important animal diseases are reported to the Swedish Board of Agriculture when they are diagnosed at SVA or other laboratories. Notifiable animal diseases and infectious agents are listed in the Swedish Board of Agriculture's regulations SJVFS 2012:24 (K4). The OIE - the World Health Organisation for Animal Health (oie.int) have Listed diseases, and also a list of other wildlife diseases and infectious diseases in wild animals that are of interest to follow, see the link https://www.oie.int/wahis_2/public/wahidwild.php/Diseaseinformation/popup/diseaselist.

Targeted wildlife disease surveillance 2020

The Swedish Board of Agriculture finances projects to monitor certain serious infectious diseases in animals. It is important to demonstrate if such a disease has been introduced to Sweden as well as to have data to show freedom of disease. Sweden is free from many epizootic diseases, and surveillance contributes to helping maintain this status.

AFRICAN SWINE FEVER

African Swine Fever (ASF) is a serious viral disease that affects only wild boar and domestic pigs. The disease has **not** yet been found in Sweden but monitoring and preparedness for this disease is very important for early detection of any possible introduction to the country. In 2020, 70 dead or euthanised, sick wild boar were tested for ASF virus; all were negative.

After ASF was introduced to Europe from an introduction in Georgia in 2007, the disease has spread via Russia to our immediate area and is now present from the Baltic countries to eastern parts of Germany.

The Swedish Board of Agriculture (SBA) is responsible for and coordinates the eradication efforts if African swine fever is detected in the country. There is a basic regulatory framework within the EU on how to combat the infection if it is detected. SVA has a standing expert group on ASF which contributes with knowledge and participates in regular SBA teleconference meetings between authorities, County Administrative Boards, municipalities, and stakeholders such as hunters, forest owners, farmers, the meat industry and others.

Report dead wild boar!

The control of an ASF outbreak will have a significant impact on everyone in the affected areas. This is why early detection is so important. Report all dead wild boar, so that they can be tested! Please use the webform

rapporteravilt.sva.se

INFECTIOUS AGENTS IN WILD BOAR

In addition to the surveillance of African swine fever of wild boar found as fallen game, 108 blood samples from hunter harvested wild boar were analysed during the year. The samples were submitted to SVA by helpful hunters to monitor key infectious agents that affect suids, and in some cases, also humans. All samples were negative for the viral diseases ASF, classical swine fever and pseudorabies (Aujeszky's disease).

Hunters take blood samples from hunter harvested wild boar to contribute to monitoring of infectious diseases.

AVIAN INFLUENZA

Wild birds necropsied at SVA are routinely tested for the presence of avian influenza viruses when suitable carcasses are available. This is financed by the Swedish Board of Agriculture, which then reports the results to the EU. For results of the monitoring in 2020, see above under the heading *Wildlife diseases in focus 2020*.

TRICHINELLA 2020

Trichinella parasites are only very sporadically found in Swedish wildlife. Any animal that eats small rodents or other *Trichinella*-infected meat can become infected with *Trichinella* larvae and become carriers of this muscle parasite themselves.

In 2020, 15 positive samples were detected in lynx and wild boar, identified as the species *T. britovi*, *T. nativa,* and *T. pseudospiralis*. In the last five years (2016 – 2020), a total of 74 *Trichinella* positive samples from wildlife were found, relatively evenly distributed over the years (see table below).

Wild boar and brown bear meat from hunting must be examined for *Trichinella* if the meat is to be sold. This gives a good monitoring of *Trichinella* infection in these populations, which combined, cover most of the country.

SVA is one of several laboratories that offer *Trichinella* testing. If *Trichinella* is found, the sample should always also be sent to SVA, as Sweden's veterinary reference laboratory. All *Trichinella* findings in bears and wild boar were found on animals shot during normal hunting. During the past five years, around 260 bears and around 120,000 wild boars were harvested by hunters annually. These figures give an idea of how rare the presence of *Trichinella* is in Swedish wildlife.

Other species. In addition to the species listed in the table, 58 beavers, five badgers, three harbour seals, one grey seal and one seal of unknown species have also been examined for *Trichinella* in 2020. All these samples were negative.

*Table with a compilation of positive cases of Trichinella in wildlife in Sweden over the last five years. Figures indicate the number of positive cases with total number of analyzed samples in parentheses. *For bear and wild boar, samples from hunter harvested animals may be analysed by several different laboratories. Positive results should always be reported and submitted to SVA, the national reference laboratory.*

Species	2016	2017	2018	2019	2020	Total
Lynx	7 (103)	4 (80)	6 (53)	6 (129)	6 (91)	**29**
Raccoon dog	0 (0)	0 (0)	1 (21)	0 (1)	0 (0)	**1**
Red fox	1 (55)	0 (0)	0 (0)	0 (11)	0 (0)	**1**
Wolf	3 (43)	1 (45)	3 (17)	2 (14)	0 (1)	**9**
Wild boar*	3 (91 289)	7 (111 845)	9 (106 055)	5 (~138 500)	9 (~161 000)	**33**
Brown bear*	1 (225)	0 (180)	0 (232)	0 (219)	0 (150)	**1**
Total	**15**	**12**	**19**	**13**	**15**	**74**

Surveillance and research projects 2020

The Swedish Environmental Protection Agency has allocated funds that SVA can apply for to carry out active projects in acute situations, so-called emergency grants. When there is an increase in morbidity or mortality in wildlife during the year it is important to obtain several fresh samples or carcasses for examination as soon as possible. Projects that were carried out during 2020 are described below.

ECHINOCOCCUS GRANULOSUS IN WOLVES

In 2020, two cases of dog tapeworm *Echinococcus granulosus* were found in a retrospective study of biobank samples from wolves necropsied in 2012 at SVA.

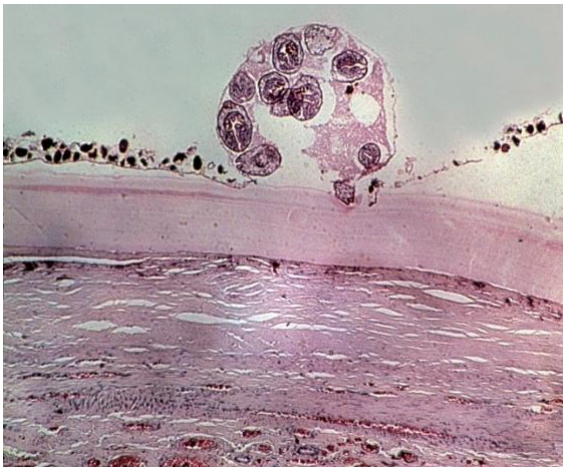
This was the first time the dog tapeworm *Echinococcus granulosus (also known as E. canadensis*) has been identified in Swedish wolves, although the samples were collected in 2012. The parasite has been detected in Sweden previously, as it was not uncommon in reindeer herding in the first half of the 20th century in both reindeer and herding dogs. Since the 1980s, only hydatid cysts (the intermediate stage) have very rarely been found in cervids which are the intermediate host of the parasite. In northeastern Finland, this tapeworm is not uncommon in wolves and both reindeer and moose.

A new PCR-analysis method specific for *E. granulosus* was set up in 2019 at SVA. Available biobank samples from necropsied wolves were used to do a retrospective study.

Two out of 114 wolf faecal samples were PCR-positive for *E. granulosus*. The two positive wolves were both born in Sweden; one was a male born 2007 in the Amungen-pack and the second was an offspring from this male, a female born 2011 in the Tenskog-pack. The male was shot to protect livestock in October 2012 in Ljusdal, Gävleborg county. The female was shot during a protective hunt in December 2012 in Berg municipality, Jämtland county. No other analysed wolf from the period 2012 - 2020 was positive. The study was financed by the Swedish EPA.

The results show that the parasite is still present in the country, but in a very low prevalence. This 3 mm long tapeworm is related to the fox tapeworm *E. multilocularis* but has a different life cycle. Canids are the main host and cervids serve as the intermediate host carrying the larval stage called hydatid cysts, which are fluid-filled cysts that grow in the lung, liver or other internal organs.

Echinococcus granulosus is monitored continuously as many cervids are examined at meat inspection in abbatoirs slaughtering semi-domesticated reindeer or in wildlife handling units inspecting hunter harvested deer. Hydatid cysts can be found by palpation or incising organs at inspection. Hunters can also look for cystic structures during evisceration of cervids. SVA receives suspicious cysts every now and then from cervids but have only found two cases in moose since 1980, the second in 1996, and in three slaughtered reindeer 1996 – 1997.



Microscopic image of part of the cyst wall of a hydatid cyst, the larval stage of Echinococcus granulosus found in cervids. A small brood capsule is seen in the fluid-filled lumen, attached to a germinal layer of cells lining the inside of the cyst. The darker round objects in the capsule are protoscolices, which are the tapeworm heads with sharp hooks. Each head develops into a 3 mm adult tapeworm in the canid that eats the cysts.

ECHINOCOCCUS MULTILOCULARIS IN PREVIOUSLY INFECTED AREAS

In 2020, *Echinococcus multilocularis* was found to be still present in red foxes in two of three previously infected areas.

In both Gnesta and Uddevalla municipalities, several fox droppings collected in the autumn of 2020 were positive for the fox tapewom *Echinococcus multilocularis* (*E.m.*). This was a follow-up study of the presence of this parasite in three of five previously known infected areas of the country. In this limited study, 235 red fox droppings were collected from a few square kilometers within each area where the parasite had been found previously in 2011 - 2014, to find out whether the parasite was still present or not. In the Gnesta area, 7 out of 12 droppings were positive and in the Uddevalla area 12 out of 109 samples were positive. No positive samples were found in Katrineholm municipality (64 samples) or in Finspång municipality (44 samples). Previously known positive sites in the municipalities of Borlänge and Växjö were not included in this study, which was funded by the Swedish Environmental Protection Agency.

In areas where the parasite was still detected, continued monitoring of an expanded study area is planned to find out if the infection is still confined to this limited area or has spread further. If the infected area is limited, an attempt could be made to eradicate the parasite by regular targeted deworming of red foxes over several years. Medicated baits would be placed manually at den sites and along fox trails at regular intervals. Any foxes shot by hunters in the area as well as all collected fox droppings would be tested.

Since the first finding of *E.m.* in 2011, SVA has conducted national monitoring of the parasite in red foxes throughout the country in a study that concluded in 2014. The parasite was found in five different areas; within Uddevalla, Katrineholm, Gnesta, Borlänge, and Växjö municipalities. In these areas, a more intensified sampling of around 30 hunter harvested foxes per area was then carried out. The result was that the parasite appeared to occur only in very limited areas and could not be found again in foxes from Borlänge or Växjö. These areas have not been investigated since 2014. However, a single follow-up sampling of a small number of fox droppings from the Gnesta area in 2018 showed that the infection was still present there.

In recent years, several cases of human alveolar echinococcosis caused by *E.m.*, have been found in Sweden. In some cases, it could not be excluded that the patients had become infected within the country. Therefore, monitoring of *E.m.* is now a priority for the Public Health Agency of Sweden and the Swedish Board of Agriculture. A follow-up national monitoring of *E.m.* in red foxes is carried out by SVA from 2021, with funding from the Swedish Board of Agriculture.

Typical fox droppings, collected for the monitoring of Echinococcus multilocularis. Gloves on and good hand hygiene are important when handling materials with potentially infective agents that can affect humans!

TULAREMIA SEROLOGY DEVELOPMENT

In this project, a new analytical method, a competitive ELISA, to detect and determine titres of antibodies against the bacterium *Francisella tularensis*, the causative agent of tularemia, in blood samples from various wildlife species was developed. The method was tested and evaluated on blood samples from dogs, wild boar, red foxes, wolverines, wolves, bears, European brown hares, lynx and raccoon dogs. Since blood samples taken at necropsy often are of poor quality, a robust analytical method not hampered by haemolysis is required. The study was funded by the EPA.

EUROPEAN BROWN HARE DISEASE OUTBREAK 2019, FURTHER STUDIES

Rabbit haemorrhagic disease (RHD) and European brown hare syndrome (EBHS) are caused by two pathogenic viruses in the genus Lagovirus; RHD virus and EBHS virus. Both diseases are associated with liver infections in rabbits and hares and cause epizootics with high mortality.

In 2010, a new variant of RHDV was discovered in France. The virus, RHDV2, causes disease in both rabbits and hares. This virus was detected in Sweden in 2013. Several studies have since shown that recombination between different lagoviruses occurs. An Italian study has recently shown recombination between EBHSV-like viruses and RHDV2, which may have resulted in an additional type of virus that may affect hares.

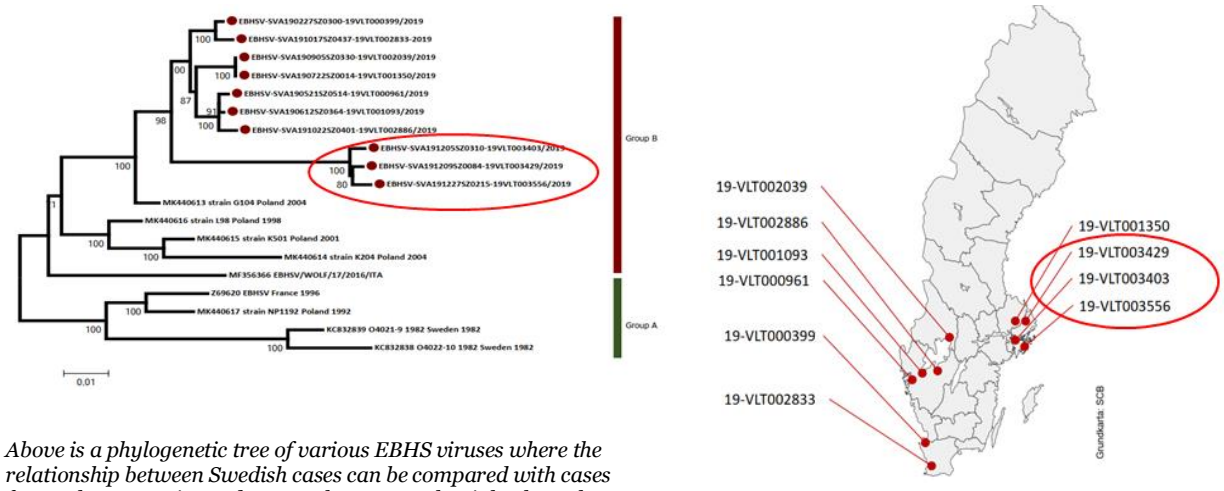
During the autumn of 2019, a very sharp increase in reports of dead hares was seen in Sweden even after a major outbreak of tularemia during the year had subsided. A large proportion of the hares submitted to SVA during the outbreak had changes consistent with EBHS, which could be confirmed by immunohistochemical examination. Some cases were confirmed using PCR technology. Extensive outbreaks of EBHS were also reported in France in autumn 2019.

In 2020, the Swedish Environmental Protection Agency funded a project to map the outbreak of EBHS in Sweden in 2019 and to sequence and compare isolated viruses with viruses from previous outbreaks in Europe.

In 2019, 60 of 128 necropsied European brown hares were positive for EBHS, but none of 48 mountain hares examined. An additional fourteen European brown hares without clear pathological changes tested positive for lagovirus infection using immuno-histochemistry and EBHS was confirmed with PCR analysis.

Whole genome sequencing was performed on viruses from ten hares. In the past, EBHS viruses have been divided into groups A and B. Group A was predominant until the early 2000s, but from then on, only group B, which in turn has different subgroups, was detected. Viruses from the Swedish hares belonged to group B. There are few whole genome sequences to compare with, but the Swedish cases fall into two groups; one with three virus variants from Uppland and Södermanland in December 2019 and a second cluster of viruses from southern Sweden.

However, it is not clear why there was such a large outbreak of EBHS in Sweden in 2019 at the same time as the outbreak of tularemia.



Above is a phylogenetic tree of various EBHS viruses where the relationship between Swedish cases can be compared with cases from other countries and years. The map on the right shows how closely related cases also cluster geographically. Source: SVA

AFRICAN SWINE FEVER PATHOLOGY STUDIES

There are several knowledge gaps regarding the pathogenesis and pathology of African swine fever (ASF) in wild boars at the gross and microscopic level. This information is needed for disease control measures including the development of a vaccine for this disease.

In collaboration with international colleagues, SVA has worked to further develop our tools and methods to be able to map the pathology that occurs in different stages of the infection. Using material from a large experimental study, SVA has tested a system for classifying and grading pathologic changes in lung tissue and tonsils in domestic pigs and wild boar. The grading system will now be applied to study other organs from infected animals microscopically and to compare findings with the presence of viruses in the tissues. This will allow us to describe and compare the disease picture and changes throughout the course of the disease for ASF in both wild boar and domestic pig.

When ASF has spread to a new country, early detection has been crucial in limiting its spread and eradicating the disease. Those countries that do not find the disease early have not been able to eradicate the infection among wild boar. The management becomes very time-consuming and extremely expensive, in addition to negative impacts on hunting, animal husbandry, free movement, and other activities in infected areas. Being able to recognize pathologic changes seen in ASF infection plays a key role in preparedness and early detection.

In 2020, SVA has also participated in a review of existing knowledge of ASF pathology, which resulted in a recent open source publication. This resource is available as support for necropsies on domestic pigs or wild boar: https://www.wageningenacademic.com/doi/10.3920/978-90-8686-910-7_4 .

Posters from the Swedish Board of Agriculture informing about African swine fever are used to prevent unintentional introduction of this virus to Sweden.

GARDEN WILDLIFE HEALTH, SWEDEN - VILTHÄLSA INPÅ KNUTEN

***Vilthälsa inpå knuten* is a newly started project with the aim of getting a more comprehensive picture of wildlife health in our urban and populated areas.**

In this project, SVA has contact with several hundred volunteers around the country who were part of a study on salmonella bacteria at bird feeders and reported that they also were willing to report sick and dead birds at their feeders to the SVA. Many people who feed birds in the winter or all year around have, over the years, contributed with reports and submissions of dead birds to SVA for examination. With this citizen science effort, we have discovered outbreaks of the bacterial disease salmonellosis in passerines and the emergence of the parasitic disease trichomoniasis, also called canker, in greenfinches in 2008.

In addition to reports concerning garden birds, SVA is now expanding the surveillance to include reporting of all sick or dead wildlife in gardens such as badgers, hedgehogs, bats, and foxes. By having a large group of reporters spread throughout the country, we can continuously obtain information that contributes to wildlife disease surveillance of the species that live in close proximity to humans. SVA can also spread information about ongoing projects and news about wildlife diseases to the network. The full development of this network is planned to take place in the coming years and will provide opportunities for regular reporting of observed species as well as both the occurrence and absence of health problems.

In England, the Garden Wildlife Health programme has been running for several years, which is a similar so-called citizen science programme and SVA has used it as a model for developing *Vilthälsa inpå knuten*.

Dead yellowhammer on the snow under a bird feeder. These cases are important for the surveillance of disease outbreaks in passerines and other garden birds.

Interesting cases 2020

Here we present some cases from 2020 of special interest. These include a new or rare disease, outbreaks of mortality, or just an odd case that makes a pathologist happy!

PSEUDOTUBERCULOSIS OUTBREAK IN EUROPEAN BROWN HARES IN SKÅNE

Pseudotuberculosis is an infection caused by the bacterium *Yersinia pseudotuberculosis* that, after infection via ingestion, causes scattered abscesses and general infection in animals, and in rare cases also humans. The disease name reflects that the disease can look like tuberculosis at necropsy.

In late autumn, it was noted that a large proportion of European brown hares found dead and sent in to SVA from the southernmost county of Skåne had died of pseudotuberculosis. The disease is known to vary greatly in prevalence from year to year and in the previous several years we have barely seen a single case. An increased occurrence could be associated with cool and humid weather conditions during the autumn-winter period. An increased incidence in hares also indicates an increased risk of infections in other wildlife species such as deer and birds.

The photo shows lungs from a European brown hare found dead in Åstorp in Skåne, with several pale, yellow abscesses caused by the bacterium Yersinia pseudotuberculosis, resulting in the disease pseudotuberculosis.

STARVATION IN EIDERS ON THE WEST COAST

From February to May, many eiders found dead, floating, or beached along the Bohus west coast area were reported. About twenty eiders from Strömstad, Sotenäs, Lysekil and Kungsbacka municipalities were submitted for examination.

All had died of emaciation without any other signs of disease, except for a male eider from Kungälv municipality that had a mild cerebral and meningeal inflammation.

Lack of food, mainly mussels, is a known factor behind previous declines in different eider populations. Recently, there have been reports of declining numbers of wild mussels on the west coast but the reasons for the decline are poorly understood. Warmer water temperatures, declining nutrient availability and competition with other species are factors under discussion.

Dead eider on the beach. Unknown photographer.

INCREASED BAT MORTALITY

Most years, SVA only receives about ten bats annually for necropsy. However, in 2020 an unusually high number of dead bats were reported and of these, 127 were submitted to SVA. Many reports indicated that multiple bats were found dead together, up to 40 in one place. The reason for the increased reporting and the number of cases is unclear. Therefore, extensive sampling of the received cases was done at SVA.

Bats are associated with several different zoonoses (infections between animals and humans), including several viruses, such as coronavirus. Bats can carry many of these without becoming sick and are therefore interesting to monitor for various disease-causing microorganisms.

The study mapped and described the 2020 mortality reports in bats and archived samples for future studies. All fresh bat carcasses were necropsied. However, only a few were fresh enough to useful for microscopic tissue examination. The causes of death are summarised in the table below.

Table of causes of death of bats submitted to SVA for necropsy in 2020.

Cause of death	Number
Starvation	33
Trauma	39
Drowning	3
Pneumonia	1
Not fresh/ Diagnosing not possible	51

Emaciated bats were most commonly juveniles (85%). When many bats were found in the same place, they were mostly juveniles. Those who died from trauma were in normal body condition and most had been killed by smaller predators (usually domestic cats). Bats that died of drowning or pneumonia were all juveniles. Secondary findings were intestinal parasites in two bats and renal coccidiosis (single-celled parasites) in one. Several bats also had skin mites. Many bodies were too decomposed to examine.

To conclude, most bats died either from trauma or emaciation. One hypothesis for the increased mortality was that the mild winter of 2019–2020 may have resulted in greater than usual bats surviving and being able to reproduce, resulting in increased recruitment of young bats. Anecdotal reports of fewer insects than normal during the summer due to the cold weather in July may have resulted in increased mortality among bats due to food shortages, especially among juveniles. This is supported by the fact that most bats that died of emaciation were young.

The large number of deaths from external trauma may be because in some places, the population was larger than usual, and thus more animals died, but the mortality rate (proportion of bats that died) remained unchanged.

Monitoring mortality among bats as well as the microorganisms they carry helps us understand how bat populations are doing and evaluate the potential role of bats as carriers of various infectious agents.

EARLESS WILD BOAR!

In the autumn of 2020, a wild boar was felled in a hunt. When the hunter went to the animal, he saw that both external ears were missing. The female was in normal body condition and estimated to be 2 - 3 years old.

The only finding at necropsy was the lack of external ears. In the area where the ears would have been, an indentation with a slightly rough surface was found in the intact skin. When the skull was skinned, the ear canals were covered with connective tissue. Under the connective tissue both ear canals were present, but they were narrower than normal and completely ossified. On the back of the head, in the neck region, signs of bone repair were seen, consistent with an old traumatic injury with irregular bone deposits.

One theory is that the animal has experienced some kind of external trauma as a piglet. A predator or other wild boar may have bitten off the ears and caused an injury and infection of the skull bone that healed. However, a congenital malformation cannot be completely excluded.

The upper picture shows what the boar without the external ears looked like. The lower image shows left a normal skull from a wild boar and to the right the skull of the boar without ears. Note the irregular and thickened bone deposits in the neck area.

DO WE HAVE TURTLES IN SWEDEN? YES! AS INVASIVE ALIEN SPECIES!

In 2020, SVA examined 24 turtles that had been caught in Swedish waters and euthanized, as these *Trachemys* sp. are listed as invasive alien species by the EU https://ec.europa.eu/environment/nature/invasivealien/list/index_en.htm since 2016. The Swedish Environmental Protection Agency finances a project led by the Swedish Association of Hunting and Wildlife Management, where field staff follow up tips from the public if alien species are spotted. The staff locates and traps these animals. In addition to turtles, the project has also worked with invasive raccoon dogs, muskrats, stone martens and mink, but also single raccoons, exotic squirrels, and other exotic pets that have been illegally brought into the country and then released or escaped.

Captured animals are euthanized and sent to SVA for examination and surveillance of infectious agents. Reptiles sold as pets can carry different types of salmonella bacteria, which occasionally have infected pet owners. All turtles examined in 2020 at SVA were negative for salmonella. Some of the female turtles carried eggs, raising the question of whether these turtles have been able to reproduce in the wild. The Swedish climate is probably too cold for the eggs to develop normally, but with climate change and milder winters, turtles already seem to be able to overwinter in southern parts of the country.

Don't release exotic animals!
Exotic pets can spread unwanted infections, cause enormous ecologic damage among Swedish wildlife and damage biodiversity. Additionally, these released animals suffer as they try to survive in for them an alien and unnatural environment.

Red-eared sliders (Trachemys spp.) that were trapped in Swedish watercourses and euthanized because they are listed as invasive alien species in the EU.

Wildlife diseases, international focus 2020

AVIAN INFLUENZA

In 2020, several outbreaks of avian influenza and several different strains of avian influenza virus have affected Europe. At the end of 2019, a new variant of highly pathogenic H5N8 influenza appeared in Poland and in the first half of 2020, a dozen countries, mainly in eastern Europe, had reported cases of the disease in poultry and wild birds.

In October 2020, a new introduction of highly pathogenic avian influenza, mainly of the H5N8 subtype, appeared in western Europe, starting in the Netherlands and Germany. Swans, ducks, waders and poultry primarily were affected. The outbreak in Europe was preceded by cases in Russia and Kazakhstan and the infection is believed to have spread to Europe with migratory birds. In addition to H5N8, H5N1, H5N3, H5N4, and H5N5 strains are also circulating.

CWD IN THE NORDIC COUNTRIES

In 2020, Finland reported its second case of CWD in a 18-year-old female moose from Laukaa in central Finland. Norway also reported its eighth case in moose, a 13-year-old male from Bamble in southern Norway and the first case of CWD in a male moose.

Additionally, in September, Norway detected CWD of the contagious type in a hunter-harvested wild reindeer from Hardangervidda. This area is the neighbouring wild reindeer area Nordfjella, where the entire wild reindeer population was killed in an attempt to eradicate CWD. A plan on how to deal with CWD in this new area has not yet been finalized.

Research results obtained in 2020 suggest that the prion strains in wild reindeer in Norway are slightly different from the North American strains. This suggests that the prions did not necessarily originate from North America, but that this infectious variant of CWD in wild reindeer may have evolved in Norway.

AFRICAN SWINE FEVER

African swine fever (ASF) has currently spread throughout much of Asia and it continues to spread in Europe. In the first quarter of 2020, more than 4,000 cases were diagnosed in Europe, more than twice as many as the previous year, mainly in Poland, Hungary and Romania. In November 2019, after the disease had been kept in check along the eastern border of Poland, the first case appeared in western Poland. In September 2020 the first dead ASF-positive wild boars west of the German-Polish border were confirmed, despite game fences erected in 2019. Based on age assessment of cadavers, the infection is believed to have entered Germany as early as July 2020.

BLUE TITS, SUTTONELLA ORNITHOCOLA

Finland, the United Kingdom, Belgium, the Netherlands, Luxembourg, and Germany reported increased mortality in blue tits in 2020. The mortality rate was highest in northern and northwestern Germany, where some 26,000 dead blue tits were reported. At necropsy, affected birds had pneumonia and serositis caused by the bacterium *Suttonella ornithocola*. In Sweden, no increased mortality rate in blue tits was reported, but one single case of *Suttonella* infection was found in a blue tit sent in from Eskilstuna, where several blue tits had died at a bird feeder. This was the first confirmed case of this disease in Sweden.

Marine mammals

A NEW SURVEILLANCE PROGRAMME

In 2020, SVA set up a national health and disease surveillance programme, in collaboration with the Swedish Museum of Natural History (NRM), funded by the Swedish Agency for Marine and Water Management, within their Environmental Monitoring Program. A coastal network was developed to effectively handle carcasses, transport them to a local freezer and then further transport to SVA for examination.

SVA is responsible for investigating stranded seals (animals with unknown cause of death), while NRM handles by-caught and hunter-harvested seals. Porpoises (*Phocoena phocoena*) are examined jointly by SVA and NRM. Reporting of dead seals and whales by the public is done via NRM's website, and copies are also sent to SVA. Further collaboration between NRM and SVA includes sample collection from all examined animals regardless of where the examination is done. Various analyses are carried out to fulfill the aims of a comprehensive health and disease monitoring programme, which includes studying health status, diseases, cause of death, parasites, and effects of environmental contaminants.

In 2020, SVA investigated only a limited number of marine mammal carcasses to test the network we established and to be able to evaluate which logistics best suit the programme. Bycaught seals and samples from hunter-harvested seals are continuously examined by NRM to monitor population health and environmental toxins. Porpoises and other whales that are stranded or found dead are jointly examined by the SVA and NRM to determine the cause of death, identify any diseases, monitor infectious agents of interest, and collect samples and data from our marine mammals. Together, the studies increase our knowledge about food habits, health status and genetics, as well as impacts of environmental contaminants and other anthropogenic activities on these species.

SEALS

The majority of seal carcasses examined originated from the west coast and the Baltic Sea coast, with only two from the Gulf of Bothnia (see map below). The total number examined included six grey seals and five harbour seals, with an age distribution of six young-of-the-year and five adults. Below is a brief summary of the necropsy findings in marine mammals examined in 2020. For more information and details, see the report "Health, Diseases and Causes of Death in Marine Mammals 2020".

Grey seals

Of the six grey seals examined, five had notable lesions at necropsy, which were attributed as the cause of stranding death. An old grey seal female had a malignant bone tumor that had spread to the lungs. Despite the neoplasia, there were remnants of a fetus in the uterus.

One of the two other adult grey seals examined died from a gunshot wound, and the other, a male from Gävleborg, had severe, parasitic inflammation in the colon with deep intestinal ulcers. Of three male pups, one died of emaciation, and another was abandoned and in poor condition, so it was euthanized. The third pup died of a generalized streptococcal infection that involved the vertebrae.

Grey seal female with a malignant bone tumor in the right front leg could not use this leg, which was indicated by very long claws compared to the claws on the left front leg.

Harbour seals

Five harbour seals were necropsied. Three had traumatic lesions as the cause of death; an adult female and a male and female pup. Disease was found in two male pups, one with a bone infection and the other had severe parasitic pneumonia caused by the nematode *Ostostrongylus circumlitus*.

WHALES

Whales belong to State Wildlife

The Hunting regulations NFS 1987:905 states that anyone who finds dead animals belonging to the State must report the finding to the Police Authority as soon as possible. These animals, including our large predators, whales, most species of birds of prey and a number of other endangered birds and mammals end up at SVA or in the collections of the Swedish Museum of Natural History (NRM).

Porpoises

In 2020, SVA examined 31 porpoises, one was submitted by a fisherman after accidental by-catch and the remainder were found dead, stranded along the coast. Four of the stranded animals were assessed to be by-caught in fishing gear, which was determined by characteristic net marks on the body or other typical necropsy findings. Five other porpoises most likely died from by-catch. Three porpoises had died due to diseases; pneumonia, general infection from bite injuries, and severe ulcers, respectively. Five examined calves were considered to have been abandoned by the mother and died, and one newborn calf in poor condition was euthanized as it was motherless. Two porpoises died of trauma; one because of dystocia and the other had lesions consistent with predation. One porpoise died of emaciation and another drowned, but the cause of drowning could not be definitively determined. In eight cases, the cause of death could not be determined due to the decomposed condition of the carcasses. Three of these were collected from the Baltic Sea, perhaps from the acutely threatened Baltic Sea population. Valuable samples and data to learn more about the porpoise populations were collected from all animals examined even if the cause of death could not be determined.

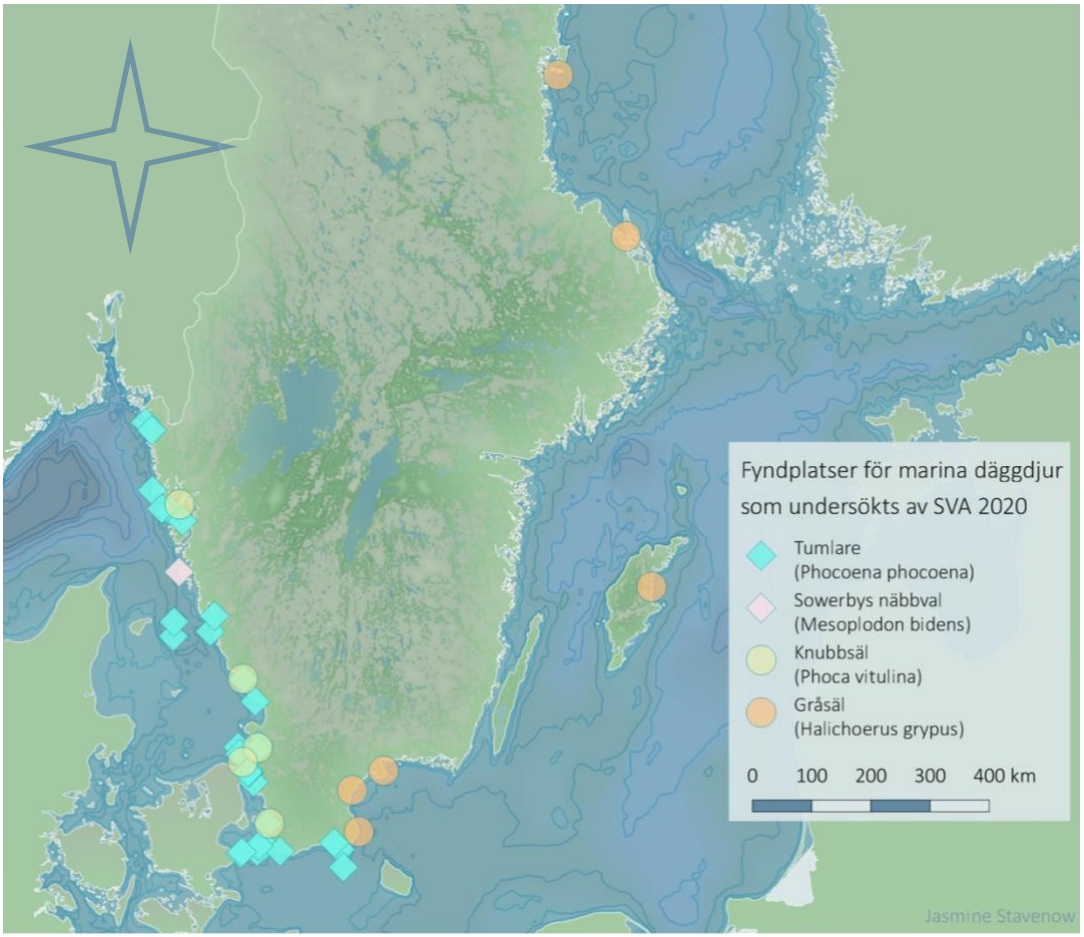
The porpoise is Sweden's only resident whale species, and the population found in the Baltic Sea is critically endangered.

Other whales

In July 2020, a Sowerby's beaked whale swam into a marina in Öckerö municipality. As the whale was in very poor condition, swimming into boats and rocks and had a severe injury under the jaw, the animal was euthanized. SVA and NRM staff traveled to the marina and carried out our first joint field necropsy of a larger whale. At necropsy, the male whale had a severe and deep injury to the jaw and throat region. The origin of the lesion could not be established with certainty. Like previous strandings of Sowerby's beaked whales in 2015 and 2019, this animal was young and not yet sexually mature. The necropsy provided SVA and NRM with important samples and data for future research.

Sowerby's beaked whales are not resident to Swedish waters. The normal habitat lies off the continental shelfs in the middle of the North Atlantic. This is why it is particularly noteworthy that, since 2015, five Sowerby's beaked whales have been stranded on Swedish coasts. Prior to 2015, the last dead beaked whale was reported almost 100 years ago. Because this whale is so rare in Swedish waters and there is so little knowledge about the species, stranded animals are an important source of information to increase our knowledge about them.

Field necropsy of a Sowerby´s beaked whale in July 2020, performed by staff from both SVA and NRM, in Öckerö municipality on the west coast. Beaked whales are very rare in Swedish waters and normally reside in the mid-Atlantic Ocean. Photo: Anna Bisther



The four large predators

A significant number of the wildlife carcasses or samples that are sent to SVA for examination consist of the four large predators; bear, lynx, wolf, and wolverine.

In 2020, SVA handled entire carcasses or parts from 673 large predators. The majority of carcasses originated from the licensed hunt or other management-related culling. Fallen wildlife cases– i.e. animals found dead or euthanized due to illness, are dominated by traffic accidents with cars or trains, or suffered from sarcoptic mange. Forensic examinations are carried out in cases that are part of criminal investigations.

SVA is tasked to manage any animal parts and entire carcasses from these large predators by the Swedish Environmental Protection Agency as part of the management of large predators. The Swedish Environmental Protection Agency's regulations NFS 2002:18 42§ state that found dead animals or animal parts of these species must be reported to the Police, who then send this material to SVA for examination. When large predators are killed during culling or felled during licensed hunting, all or some parts of the animal belong to the state according to the hunting decision, and these carcasses or parts are delivered to SVA.

The work with large predators at SVA is an important part of investigating the health and disease status in these populations. With consistent monitoring over many years, variation in diseases and causes of death can be followed and compared over time.

Below are summaries of the causes of death, disease findings and health status of the bears, wolverines, lynx, and wolves examined by SVA in 2020. More details are published in SVA's report on Large Predators 2020, as well as in the reports published after each licensed hunt for lynx and bear in 2020.

Table with number of predators received by SVA per year, for the period of 2016-2020, as whole body, parts of body, or samples taken. Source: SVALA and Annual Report 2019 for 2016-2019

Rovdjur	2016	2017	2018	2019	2020
Bear	264	310	360	377	444
Lynx	116	158	136	144	168
Wolf	47	67	37	28	31
Wolverine	14	12	7	11	30
Total	**441**	**547**	**540**	**560**	**673**

BROWN BEAR

444 whole bodies or samples were received from bears, of which 285 were from licensed hunting and only sets of tissue samples were sent to SVA. 144 whole bears were sent to SVA after being shot in protective hunting following county administrative board culling decisions. Two bears were killed in distress situations (Chapter 24. BrB) i.e., in self-defense. Eight bears were killed in traffic, including three in train traffic and five in car traffic. One bear cub died of predation, another found dead cub was submitted intact to the collections of the Swedish Museum of Natural History. The state of health of the bear population is considered good, and no specific diseases were noted in the examined bears. Minor findings included joint damage, inflammation of the peritoneum and bile ducts, as well as tooth damage and wear.

WOLVERINE

30 wolverines were examined in 2020 of which 25 were culled to protect reindeer herding. One animal was killed by traffic. Three cases were decomposed and cause of death could not be determined. Wolverines are considered to have good health status.

LYNX

Of 168 examined lynx, 93 animals came from licensed hunting and 28 from other culling. Thirty-one lynx were killed in traffic, most in car traffic. One additional animal was probably killed in traffic. Disease diagnoses in six lynx were septicaemia, chronic arthritis, brain damage and three cases of sarcoptic mange. The health status of the population is generally good, with some mange cases as the exception.

WOLF

A total of 31 wolves were examined in 2020. Nineteen wolves were culled. Seven wolves died in traffic accidents. One wolf died of drowning and the cause of death was not determined for one decomposed carcass. Two males had cryptorchidism, as testicles were not in the scrotum. One older wolf had spondylosis, with bone fusing of vertebrae. Some animals had minor tooth defects. One wolf had older gunshot wounds.

Publications from SVA 2020

The staff at SVA author scientific and popular scientific publications, reports, and expert statements to other authorities. To disseminate, exchange, and obtain knowledge and information about wildlife diseases, staff at the Department of Pathology and Wildlife Diseases normally also participate in various international and national conferences where research results are presented. Due to the pandemic restricting travel, only virtual conferences or webinars have been possible in 2020. Below is a selection of publications from 2020 related to wildlife, where the names of authors from the Wildlife Section or other departments at SVA are written in **bold**.

SCIENTIFIC PUBLICATIONS, SELECTED

First Detection of Chronic Wasting Disease in Moose (*Alces alces*) in Sweden. **Erik O. Ågren, Kaisa Sörén, Dolores Gavier-Widén**, Sylvie L. Benestad, Linh Tran, Karolina Wall, **Gustav Averhed, Neele Doose**, Jørn Våge, **Maria Nöremark**. *Journal of Wildlife Diseases*, 57(2), 2021, pp. 000–000. DOI: 10.7589/JWD-D-20-00141

Characteristics of reproductive organs and estimates of reproductive potential in Scandinavian male grey wolves (*Canis lupus*). Amanda Petersen, Mikael Åkesson, Eva Axner, **Erik Ågren**, Camilla Wikenros, Anne-Marie Dalin. Animal Reproduction Science, Volume 226, 2021, 106693, ISSN 0378-4320, https://doi.org/10.1016/j.anireprosci.2021.106693.

Wild boar behaviour during live-trap capture in a corral-style trap: implications for animal welfare. Fahlman, Å., Lindsjö, J., Norling, T.A., Kjellander, P., **Ågren, E.O.**, Alm Bergvall, U. *Acta Vet Scand* 62**,** 59 (2020). https://doi.org/10.1186/s13028-020-00557-9

Retrospective Analysis Shows That Most RHDV GI. 1 Strains Circulating Since the Late 1990s in France and Sweden Were Recombinant GI. 3P–GI. 1d Strains. Abrantes, J., Lopes, A.M., Lemaitre, E., Ahola, H., Banihashem, F., Droillard, C., Marchandeau, S., Esteves, P.J., **Neimanis, A.** and Gall-Reculé, L., *Genes*, *11*(8), 2020. p.910.

No hasty solutions for African swine fever. **Gavier-Widén, D. Ståhl, K**. Dixon, L. *Science*. 2020, 367 (6478): 622-624.

Phylogeography and Genetic Diversity of *Francisella tularensis* subsp. *holarctica* in France (1947–2018). Kevin, M., Girault, G., Caspar, Y., Cherfa, M.A., Mendy, C., Tomaso, H., **Gavier-Widen, D.**, Escudero, R., Maurin, M., Durand, B., Ponsart, C., Madani, N. *Frontiers in Microbiology*. 2020 March 4 11. Article 287

REPORTS

SVA annual report. (Årsredovisning) 2019. Wildlife. Erik Ågren. In Swedish.

Wildlife disease surveillance in Sweden 2019. SVA report 60:2020. (Swedish and English). Editor: Erik Ågren

Large predators 2019. SVA report 61:2020. Stavenow J., Nises J., Ågren E.O. In Swedish.

Licenced lynx hunt 2020. SVA report 62:2020. Stavenow J., Ågren E.O. In Swedish.

Licenced bear hunt 2020. SVA report 62:2021. Stavenow J., Ågren E.O. In Swedish.

Surveillance of infectious diseases in animals and humans in Sweden 2019. Postmortem examinations in wildlife. Erik Ågren.

Health, disease, and causes of death in porpoises (*Phocoena phocoena*) in Sweden the last 10 years. SVA report 59:2020. **Neimane, A, J Stavenow, E Ågren, E Wikström**, A Roos. In Swedish.

Health, disease, and causes of death in marine mammals 2020. Results from necropsies and sampling of marine mammals at SVA. SVA Report 61:2021. **Neimane. A, Stavenow. J, Ågren. E.O**, Roos. A, Kallunki Nyström. J. In Swedish.

Communication

VISITS

The wildlife section regularly receives visitors to give lectures on wildlife diseases and inform about the work at the wildlife section and its ongoing projects. The section also hosts internships for visiting students or researchers, but due to the pandemic and restrictions, all visits were cancelled in 2020 from March.

COURSE ON INSPECTION OF LARGE PREDATOR CARCASSES

In June, the annual course for officials inspecting hunter-harvested large carnivore carcasses was held at SVA together with the Wildlife Damage Center (SLU). During the course, the inspectors and game administrators employed at various County Administrative Boards, as well as students, usually get hands-on practical sampling training, but this year the course had to be held as an online virtual event.

LECTURES AND PRESENTATIONS, SELECTED

2020-01-15—16 Visit to NINA, Trondheim, training in dental annulation aging of cervids. Presentation on the wildlife work at SVA, Erik Ågren
2020-01-30—31 BIOR 10-year anniversary conference, Riga. Presentation; One Health session, Wildlife Disease Surveillance, Erik Ågren
2020-02-10—11 CWD conference, NVI Oslo, Erik Ågren, Maria Nöremark, Kaisa Sörén.
2020-02-28 Visit to SVA by WWF, Russian wildlife managers working with the Siberian tiger. Presentation: Wildlife Disease Surveillance, Erik Ågren
2020-03-05 Podcast Skitjakt, ”Döden i skogen” guest: Erik Ågren
2020-06-09 16th meeting of the Jastarnia Group, ASCOBANS, digital. Presentation on causes of death, health and disease in necropsied porpoises 2008 - 2019. Aleksija Neimanis and Jasmine Stavenow.
2020-06-18 Course on inspection of large carnivores, SVA, digital. Jasmine Stavenow och Erik Ågren
2020-09-14 Information day regarding protective hunting of wolves, for the Swedish parliament Committee on Environment and Agriculture, SVA-responsibility, SVA-representative: Erik Ågren
2020-11-27 Sveriges Vildnad (Swedish Association for Hunting and Wildife Management), webinarium, presentation by Erik Ågren https://jagareforbundet.se/vilt/viltnyheter/2020/12/samhallets-acceptans-for-jakt-och-viltvard/
2020-12-09 Digital municipal hunt, Haninge municipality. Presenter: Erik Ågren

EXPERT OPINIONS 2020

SVA 2020/319 Yttrande rörande Förvaltning eller djurförsök med vilda djur (rapport 2019:19) N2019/02558/DL

SVA 2020/497 Yttrande rörande frågor om träning av hund i vilthägn. Frågor från Jordbruksverket rörande delar av regeringsuppdraget N2019/02262/DL *Uppdrag att utvärdera djurvälfärden vid träning inför prov och vid anlagstest i vilthägn*

SVA 2020/605 Yttrande över Naturvårdsverkets förslag om jakttider N2020-01735-FJR

SVA 2020/723 Yttrande rörande grytanlagsprovens och grytjaktens betydelse för bekämpning av smittsamma djursjukdomar. NV-0536-19

SVA 2020/875 Yttrande rörande Behovet av grytanlagsprov med levande grävling, N2020/01687

SVA 2020/997 Yttrande om utfordring av vilt. Näringsdepartementets promemoria om utfodring av vilt N2020/02817.

Working groups

The staff of the wildlife group participated in the following expert groups:

Wildlife Disease Council. Swedish Environmental Protection Agency &SVA, SVA-members: Dolores Gavier-Widén, Erik Ågren, Aleksija Neimanis. Secretary: Henrik Uhlhorn.

SVA Wildlife Disease Surveillance Council: Gunilla Hallgren, Karl Ståhl, Dolores Gavier-Widén, Erik Ågren, Henrik Uhlhorn, Aleksija Neimanis.

SVA Environmental and Climate committee: Aleksija Neimanis, Jasmine Stavenow

SVA Zoonosis centre working group: Henrik Uhlhorn for POV.

SVA R&D coordination group: Aleksija Neimanis

SVA Poultry forum: Caroline Bröjer

SVA:s Animal welfare organ: Henrik Uhlhorn, Gete Hestvik

Hoofed wildlife council (Swedish Environmental Protection Agency), SVA representative: Caroline Bröjer

Reference group invasive species. (Swedish Association of Hunting and Wildlife Management), SVA representative: Caroline Bröjer

Convention for Biologic Diversity (Swedish Environmental Protection Agency), SVA representative: Jasmine Stavenow

EWDA, European section, Wildlife Disease Association. Newsletter editor, EWDA board: Erik Ågren

EWDA Network for Wildlife Health Surveillance in Europe, committee member: Aleksija Neimanis

NWDA, Nordic section of Wildlife Disease Association, board members: Henrik Uhlhorn, Caroline Bröjer

International Wildlife Health Surveillance Working Group; Erik Ågren

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

Journal of Wildlife Diseases, assistant editor: Erik Ågren, Aleksija Neimanis

OIE Focal point Wildlife Diseases: Erik Ågren

References

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Neimane, A., Stavenow, J., Ågren, E., Wikström, E., & Roos, A. (2020). Hälso-och sjukdomsövervakning av marina däggdjur Del 2. Hälsa, sjukdomar och dödsorsaker hos tumlare (*Phocoena phocoena*) i Sverige de senaste 10 åren. SVA Rapportserie: 59:2020

Seifert, T., Tauber, F. and Kayser, B. 2001, A high resolution spherical grid topography of the Baltic Sea–revised edition. Proceedings of the Baltic Sea Science Congress, Stockholm.

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