STATENS VETERINÄRMEDICINSKA ANSTALT

WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2021

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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 2021, for the funding parties; specifically for the Wildlife management fund *Viltvårdsfonden*, the Swedish Environmental Protection Agency and the Swedish Agency for Marine and Water Management.

Uppsala, 22 April 2022
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.

Photo: Erik Ågren, SVA

Summary

The health status of Swedish wildlife

References: SVA annual report 2021, SVA Wildlife section and SVALA database; 2021.

Swedish wildlife populations monitored by SVA are generally considered to have a good health status, with few cases of more severe diseases. Health and disease surveillance of wild animals in Sweden is mainly done by 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 2021, 3,212 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. In addition, 390 cases of reportable diseases involving 51 wild animal species were reported to the Swedish Board of Agriculture and the OIE.

Year-round surveillance of avian influenza dominated the wildlife work in 2021 and required time and resources to handle submitted carcasses, perform analyses, and report results. Several different variants of influenza viruses were recorded throughout the year.

Another major task was to finalize the EU-regulated surveillance of Chronic Wasting Disease (CWD) in the country. No further positive animals were detected in 2021. The current hypothesis is that CWD in Nordic moose is not as contagious as in wild reindeer in Norway and represents sporadic disease in old moose from spontaneous formation of prions.

In 2021, the second national surveillance effort for the red fox tapeworm *Echinococcus multilocularis,* was initiated. A positive fox scat from a new area, Kungsbacka municipality, was found in 2021. Intensified surveillance also was done in Uddevalla and Gnesta, two municipalities with known presence of the parasite, and showed that foxes are still infected in these areas. Continued studies are done to follow the geographic spread in these areas and determine if a deworming campaign is feasible in the future.

SVA and other Swedish authorities collaborate to prevent introduction of the African swine fever virus. SVA routinely analyses all fallen wild boar submitted for necropsy, and so far, the virus has not been detected in Sweden.

SVA collects samples and data within the programme for health and disease surveillance of marine mammals in collaboration with the Swedish Museum of Natural History (NRM), which improves our knowledge on these species.

In 2021, 837 large carnivore carcasses or sampled carcasses of brown bear, lynx, wolf, and wolverine were submitted to SVA. Many samples were from the licensed hunts where compulsory sampling is done. Results add to the knowledge of these species and help authorities manage these populations. In general, Swedish large carnivores are in good health.

Wildlife disease surveillance in Sweden 2021

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 2021.

General wildlife disease surveillance *Fallviltsundersökningen* at SVA is the surveillance of causes of death and diseases of fallen game, that is 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 when it was 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 Game Management Fund (*Viltvårdsfonde*n), the Swedish EPA, the Swedish Agency for Marine and Water Management, and state funding.

The Wildlife Disease Council (*Viltsjukdomsrådet*) is a group of experts and officials from the Swedish EPA and SVA. The council discusses wildlife health issues and jointly recommends targeted initiatives for SVA to carry out during the year. In 2021, the Council consisted of Klas Allander, Eleonor Glad and David Schönberg-Alm from the EPA, and Dolores Gavier-Widén, Erik Ågren, and Aleksija Neimanis from SVA. Henrik Uhlhorn, SVA serves as secretary. In 2021, the council held two meetings.

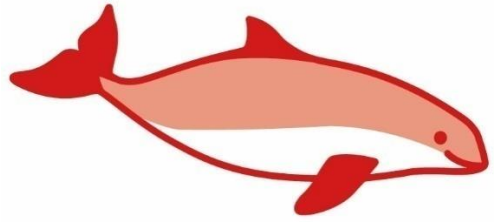
Red squirrel. Photo: Erik Ågren, SVA

Financing the wildlife work at SVA

The wildlife work is financed mainly by grants from the Swedish Game Management Fund (*Viltvårdsfonden*), the Swedish Environmental Protection Agency, the Swedish Agency for Marine and Water Management, direct governmental funding, and project funding from the Swedish Board of Agriculture.

The Game Management Fund is based on the annual state game conservation fee that each person participating in hunting in Sweden must pay. SVA receives an annual grant. In 2021, 5 million SEK was used to run the general wildlife disease surveillance programme with examination of received fallen wildlife to study diseases and causes of death. This programme has run since the late 1940s. As this funding originates from hunters, focus is on game species, but all wild mammals, birds, amphibians, and reptiles are included in the overall work. 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 that 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 2.6 million SEK in 2021. In addition, the Wildlife Disease Council with experts from SVA and the EPA meet twice a year to prioritize timely projects such as 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. In 2021, funding was given for monitoring Echinococcus, avian influenza, trichinella, and African swine fever.

The Swedish Agency for Marine and Water Management finances the work with health and disease surveillance of marine mammals done at SVA and at the Museum of Natural History. This work is part of the national environmental surveillance through the results of necropsies of stranded marine mammals and collection of data and samples for biobanks and research.

Wildlife staff 2021

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 2021

Erik Ågren Deputy head of Department, Head of section, Veterinary Officer, Dipl. ECVP, DipECZM (Wildlife population health). OIE National Focal point for wildlife diseases.
Henrik Uhlhorn Veterinary Officer, PhD
Karin Olofsson-Sannö Veterinary Officer, PhD
Gustav Averhed Veterinary Officer
Minerva Löwgren Veterinary Officer
Elina Thorsson Veterinary Officer, Marine mammals. Resident ECZM (Wildlife population health)
Marit Liljefors Technician
Tina Jansson Temporary necropsy assistant
Linda Thelin Biologist, Large Carnivores

Section of Research and Development 2021

Aleksija Neimanis Head of section, Veterinary Officer, BSc, MSc, MVetSci, PhD, Dipl. ACVP
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Ellinor Spörndly-Nees Veterinary Officer, PhD
Jasmine Stavenow Biologist, MSc., Marine mammals
Ulrika Larsson Pettersson Biomedical analyst
Emil Wikström-Lassa Veterinary Officer, PhD-student

Other staff within the department and SVA

Administrators Ewa Backman och Carina Bohlin, Julia Tibell, Christina Rosander. 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.

Wild birds were a major work task during 2021 due to a continuous avian influenza outbreak. Image from the BSL3 lab for highly infectious material. Photo: SVA

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.

THANK YOU FOR YOUR REPORT!

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. Report data on some diseases or screening projects are uploaded and mapped to be followed on the SVA website sva.se.

The most important wildlife diseases to monitor and receive reports on in 2021 were sick or dead cervids for the CWD - chronic wasting disease surveillance, dead wild boar to be tested for African swine fever virus to ensure that this disease had not been introduced into the country, and dead birds to continue monitoring the extensive and continuous outbreak of avian influenza.

MED LÅNAD BLICK – WITH A BORROWED GLANCE, ART AT SVA

An art project took place at SVA in 2020–2022 with art professional Johanna Hästö from *Konstfrämjandet* and Maria Nöremark, epidemiologist at SVA – and also an art school graduate. The project was financed by the Vinnova call *Residence X*, where a workplace invited a professional artist with no knowledge about the work function or operation, to bring new perspectives. The idea was to test how art could be used to reflect over the inner dialog of the workplace SVA.

Johanna has worked with sketching onsite at SVA where she focuses intensely on the object but does not look at the actual sketch. The image on this page is a waxwing, a bird that the artist found dead in her vegetable garden and reported it to the SVA wildlife disease surveillance **rapporteravilt.sva.se**

ART AT SVA

Waxwing, sketch by Johanna Hästö 2021

Wildlife cases 2021

NUMBER OF WILD ANIMALS OR PARTS OF ANIMALS RECEIVED IN 2021

A total of 3,212 (2,510) wildlife cases (2020 case numbers in brackets) were submitted to the Department of Pathology and Wildlife Diseases in 2021 from the following taxa: 2,092 mammals (1,749), 1,099 birds (723), 14 reptiles (25) which were turtles euthanised as invasive alien species, and 3 amphibians (8), as well as 4 unidentified species. 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	**2 091**
Brown bear	596
Red fox	385
Lynx	168
Moose	137
Otter	108
Roe deer	83
Wild boar	78
European brown hare	74
Harbour seal	66
Wolf	57
Bat	50
Harbour porpoise	43
Hedgehog	33
Mink	28
Wild rabbit	25
Polecat	21
Fallow deer	18
Pine marten, Red squirrel, Wolverine	16
Mountain hare	15
Grey seal	13
Red deer	6
Mole	5
Beaver, Hare, Shrew, Weasel	4
Badger, Canine, Mouse spp.	3
Stone Marten, Vole	2
Dog, Humpback whale, Mouflon, Raccoon dog, Seal.	1

*Stone marten (*Martes foina*) is an invasive species in Sweden. Two were found and euthanized 2021. Photo: SVA*

Reptiles	Cases
Total	**14**
Turtle (*Trachemys scripta subsp.*)	14

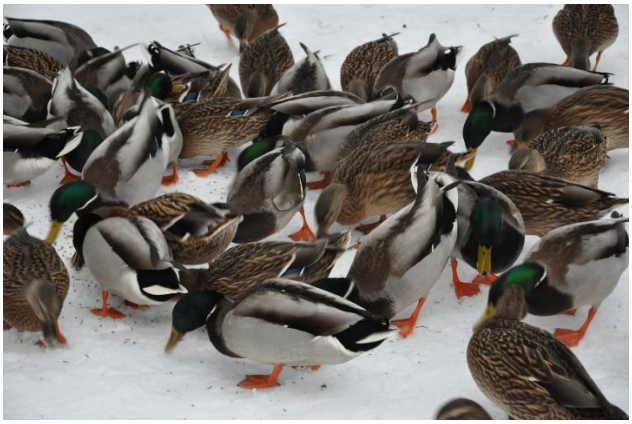
Turtles are invasive species and do not belong in Swedish nature. Trapped and euthanized turtles are examined at SVA. Photo: SVA

Amphibians	Cases
Total	**3**
Toad	2
Frog	1

*Common toad (*Bufo bufo*). Poto: Erik Ågren, SVA*

Birds	Cases
Total	**1 099**
White-tailed eagle	113
Greenfinch	47
Sparrow hawk	44
Buzzard, Mallard, Mute swan	39
Goshawk, Blackbird	33
Rock pigeon	28
Common murre	27
Eagle owl, Jackdaw	26
Rock pigeon	20
Grey heron	25
Barnacle goose	25
Peregrine falcon	24
Golden eagle, Tawny owl	23
Chaffinch, Pheasant	21
Magpie, Kestrel	18
Crow, Herring gull, Trumpeter swan	17
Ural owl	16
Greylag goose, Canada goose, Great grey owl	15
Pigeon, Black-headed gull	13
Common eider, Song thrush	12
Yellowhammer	10
Great tit	9
Red kite, Common redstart, Greater spotted woodpecker	8
Blue tit, Osprey, Cormorant	7
Fieldfare, Hawfinch, Kingfisher, Tufted duck, Waxwing, White stork	6
Bullfinch, Long-eared owl, Partridge, Raven, Rook, Barn swallow	5
Bean goose, Capercaille, Eurasian hobby, Eurasian siskin, Grey-headed woodpecker, Unknown aves, Wren	4
Black-backed gull, Eurasian jay, Goldeneye, Marsh harrier, Nuthatch, Swift, Woodcock, Wood pigeon	3
Brambling, Common crane, Eurasian coot, Eurasian pygmy owl, Goosander, Great bittern, Greater white-fronted goose, Mew gull, Moorhen, Oyster catcher, Redpoll, Swan, Tengmalm´s owl, White wagtail	2
Barn owl, Bearded reedling, Blackcap, Black grouse, Chiffchaff, Crossbill, Eurasian wryneck, European goldfinch, Goose, Great crested grebe, Great egret, Green woodpecker, Gyr falcon, Hawk owl, Hazel grouse, House sparrow, Jaeger, Kingfisher, Lesser black-backed gull, Marsh tit, Merlin, Montague´s harrier, Northern wheatear, Pink-footed goose, Robin, Rough-legged buzzard, Short-eared owl, Spotted flycatcher, Spotted nutcracker, Stock dove, Tree sparrow, Velvet scoter, Water rail	1

Sick greenfinch, with the parasitic disease trichomoniasis. Remember to wash your hands after handling wildlife, especially sick or dead animals. Photo: Erik Ågren, SVA



Mallards found dead are always tested for avian influenza virus. These waterbirds can both carry virus and sometimes become clinically ill and die of more aggressive types of this virus. Photo: Erik Ågren, SVA

Dead buzzard, found by the public and reported to SVA in the online reporting form rapporteravilt.sva.se Photos can be attached to the report, and all reports are appreciated by SVA!

Reportable wildlife diseases 2021

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

In 2021, cases of avian influenza and salmonellosis dominated the reportable diseases. The number of reported cases in wildlife only reflects the cases 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. While the prevalence of a disease in the wildlife population is not known, we 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 2021. Source: SVA Laboratory Data System SVALA.

Disease	Species, number of cases	Total
Avian influenza (HPAIV and LPAIV)	Barnacle goose 19, Bean goose 2, Black-headed gull 1, Black-winged gull 2, Buzzard 14, Canada goose 9, Common eider 10, Common murre 1, Crow 1, Goldeneye 2, Great horned owl 10, Greylag goose 7, Grey seal 1, Herring gull 5, Jackdaw 2, Kestrel 1, Mallard 6, Marsh harrier 1, Mute swan 11, Goshawk 9, Oyster catcher 2, Peregrine falcon 11, Pheasant 7, Red fox 2, Tawny owl 2, Trumpeter swan 8, White-fronted goose 2, White-tailed eagle 9	157
Avian pox	Magpie 1	1
Echinococcus multilocularis	Red fox 16	16
European brown hare disease	European brown hare 2	2
Listeriosis	Fallow deer 2, Roe deer 1	3
Malignant catarrhal fever	Moose 1	1
Myxomatosis	Wild rabbit 5	5
Pasteurellosis	Fallow deer 3, Moose 1	4
Pigeon paramyxovirus	Rock pigeon 14	14
Plasmodium sp.	Blackbird 1	1
Pseudotuberculosis	European brown hare 13, Mountain hare 1	14
Rabbit hemorrhagic disease	Wild rabbit 13	13
Salmonellosis	Black-headed gull 1, Bullfinch 2, Great spotted woodpecker 1, Hedgehog 3, Jackdaw 4, Wild boar 64	75
Sarcoptic mange	Lynx 8, Red fox 4, Wild boar 1	13
Toxoplasmosis	European brown hare 4	4
Trichomoniasis	Chaffinch 8, Dove/pigeon 3, Great tit 1, Greenfinch 18, Hawfinch 2, Rock pigeon 3, Siskin 3, Sparrow hawk 1	39
Trichinosis	Lynx 6, Red fox 1, Wild boar 3, Wolf 1	11
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.

Wildlife diseases in focus 2021

CWD SURVEILLANCE IN NEW FORM

CWD, Chronic wasting disease has been diagnosed in Sweden in three moose in Norrbotten County 2019 and a fourth case 2020 in Västerbotten County

EU monitoring 2018 - 2021

In autumn 2017, the European Commission mandated surveillance of CWD for six Member States (EU 2017/1972). Sweden, Finland, Estonia, Latvia, Lithuania, and Poland are the countries that have moose or reindeer, and each country was to examine at least 6,000 cervids over a three-year period, between 2018 and 2020, which for Sweden was extended to include 2021.

Over these years, four old female moose were found positive in Sweden, three in the county of Norrbotten and one in Västerbotten County. In all cases, CWD was detected only in brain tissue and not in lymph nodes. This, along with various studies to type the prions, indicates that CWD in Nordic moose is an age-related and spontaneously occurring variant of CWD that is different from the infectious variant detected in cervids in North America.

The EU-mandated surveillance has ended, but CWD surveillance will continue. All cervids with clinical symptoms of CWD will still be sampled.

Intensified CWD-surveillance in Robertsfors, Västerbotten 2021

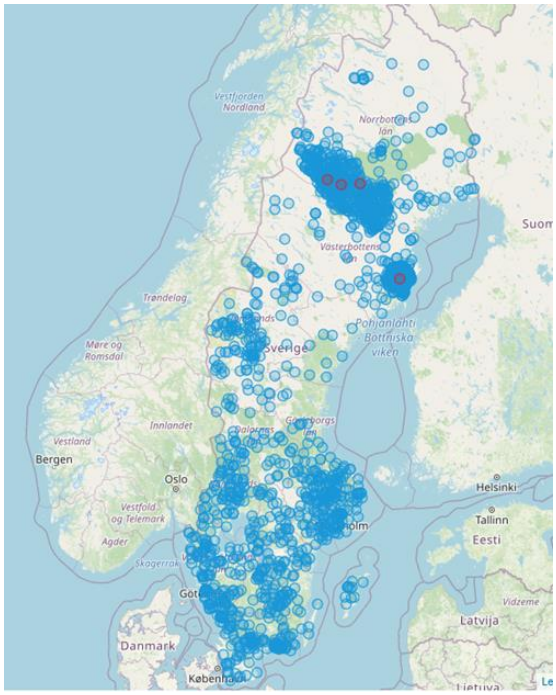
When CWD was detected in an old female moose in Robertsfors in 2020, an intensified surveillance was done that autumn and then during the moose hunt of 2021. No further cases were detected. The sampling in Västerbotten was very successful and the moose hunters did an excellent job of submitting samples for analysis. In total, samples were submitted from 382 moose from the area around Robertsfors. The intensified surveillance is over, but cervids with symptoms of CWD are still to be sampled and analysed.

How many cervids were analysed?

Below is a table with the number of samples analysed during monitoring in 2021, and in total since 2018. The EU-mandated surveillance was finalized at the end of 2021. However, monitoring of semi-domesticated reindeer and farmed red deer continued until 28 February 2022.

*Table. Number of samples received from wild cervids examined for CWD at SVA in 2021, number of positive cases, and total number for 2018-2021. *Fallow deer are not included in the EU-surveillance, but cases with clinical suspicion of CWD are tested.*

SPECIES	NO. 2021	POS. 2021	POS TOTAL	NO. TOTAL
Roe deer	63	0	0	221
Moose	433	0	4	1 788
Red deer	290	0	0	484
Reindeer	2 527	0	0	5 995
*Fallow deer	3	0	0	5



Map of CWD surveillance in Sweden. The four red rings in Norrland are positive moose cases, blue rings are negative samples. For more detail, see interactive map at cwd.se

Thanks to everyone who helped with CWD sampling!

The surveillance of CWD depends on the public, hunters and other wildlife enthusiasts submitting samples for analysis. Without your effort for wildlife disease monitoring, we would not have been able to carry out one of the largest surveillance programs that we have had. So, many thanks to all of you who contributed!

Surveillance continues in a new form

The EU-surveillance is over, but CWD-surveillance continues in a different form. The focus is now on adult cervids with two or more of the following symptoms that may indicate CWD: Emaciation, neurological signs, behavioural change, increased salivation and/or increased urination. If a suspected case is observed, please contact the wildlife section at SVA for instructions.

More information about the disease and ongoing surveillance: **CWD.SE**

Female moose. Photo: Henrik Uhlhorn, SVA

EXTENDED OUTBREAK OF HIGHLY PATHOGENIC AVIAN INFLUENZA

Highly pathogenic avian influenza (HPAI), especially H5N8, H5N5, and H5N1 circulated in Europe during 2021 and caused extensive mortality among wild birds and poultry. This influenza outbreak is the worst ever recorded when it comes to both number of birds and number of species affected in Sweden and the rest of Europe.

During 2021 SVA received more than 1500 reports of birds found dead. A selection of these were submitted for necropsy and sampled for avian influenza. When many individuals of the same species were reported dead in the same municipality, only one or two birds from the area were taken in for sampling. In 2021, 803 birds were sampled and 154 were positive for avian influenza. The exact subtype was confirmed in 141 birds.

Avian influenza was detected in 25 bird species, especially in waterfowl and raptors (see table below). In some species, for example peregrine falcon and barnacle goose, avian influenza was an important cause of excess mortality. Sampled birds in which avian influenza was not detected comprised 69 species, often with only one or two birds sampled per species.

Avian influenza of the subtypes H5N8 and H5N5 was detected in 24 poultry holdings and over 2.2 million poultry (domestic birds) had to be euthanized. To a large extent, the outbreaks in poultry seem to be associated with direct or indirect contact with wild birds. In addition, hundreds of game birds (pheasants) died of avian influenza.

Avian influenza was also diagnosed in two red foxes and a grey seal during 2021. The carnivores, as well as raptors, were probably infected by eating carcasses of birds that had died of avian influenza.

Remarkable for this avian influenza outbreak was that it persisted over a long time, including the summer months when avian influenza virus activity normally is low. This led to infection in chicks of the year in some species.

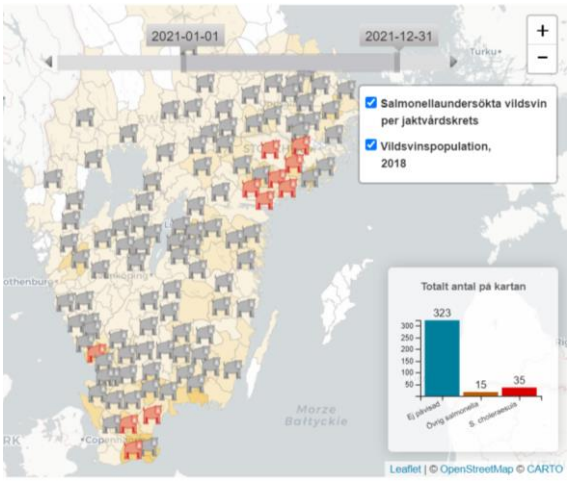
Table with the number of each wild bird species analysed and number of birds positive for avian influenza 2021.

Species	AIV pos	AIV neg
Barnacle goose	19	25
Buzzard	14	41
Peregrine falcon	11	22
Mute swan	11	37
Eagle owl	10	24
Eider	10	12
White-tailed eagle	9	91
Goshawk	9	29
Canada goose	9	15
Trumpeter swan	8	18
Pheasant	7	22
Greylag goose	7	16
Mallard	6	36
Herring gull	5	18
Tawny owl	2	21
Jackdaw	2	21
Goldeneye	2	3
Bean goose	2	3
Black-backed gull	2	2
Greater white-fronted goose	2	2
Oyster catcher	2	2
Murre	1	19
Crow	1	17
Kestrel	1	14
Black-headed gull	1	9
Marsh harrier	1	1
Total	154	501

Avian influenza was, for example, diagnosed in five white-tailed eaglets (from Gotland, Ekerö, and Norrtälje) that died in May and both adult and duckling eiders submitted from Gotland in July, had avian influenza.

Highly pathogenic avian influenza almost always results in acute death and few lesions are therefore observed during necropsy. Microscopic evaluation however, shows marked inflammation in the brain and heart in most species and inflammation and necrosis in the pancreas, liver, and spleen in some species. With special stains (immunohistochemistry), large amounts of virus can often be demonstrated in the tissues with inflammation.

SALMONELLA CHOLERAESUSIS NEW DISEASES IN WILD BOAR



The pathogen *Salmonella* Choleraesuis can cause sudden death with sepsis in pigs and was recognized in a herd of domestic pigs in 2020, in the south of Sweden (Skåne). *Salmonella* Choleraesuis had not been detected in Sweden since the 1970s and was an unwanted surprise because occurrence of *Salmonella* in Swedish livestock is rare. Surveillance of wild boar in Skåne detected the pathogen in found dead animals, and also in seemingly healthy, hunter harvested wild boar. At the end of 2020, the pathogen was also found in severely diseased wild boar in eastern Sweden (Södermanland).

During 2021, surveillance continued with sampling of both diseased and hunted wild boar sampled across Sweden. Out of 61 sampled diseased animals, 13 were positive for *S.* Choleraesuis and one for a different type of Salmonella. From 320 samples collected during hunting, 22 were positive for *S.* Choleraesuis and 14 for other types of Salmonella. Thus, the pathogen was more frequently found in animals that were found dead or euthanised. Most of the positive cases were found in Södermanland and Skåne, with few cases in other locations. Most likely, cases will be found in additional areas as the surveillance continues. For an updated surveillance map, see www.sva.se.

The Swedish Food Agency recommends general good hygiene during slaughter and handling of carcasses. Hunted, seemingly healthy animals can be consumed even if they are carriers of *Salmonella* in their intestine. Animals showing signs of disease are not to be used for food.

SARS-COV-2 IN FARMED MINK BUT NOT IN WILDLIFE

Sampling of a mink för analysis of SARS-CoV-2

During 2020, SARS-CoV-2, the virus that causes Covid-19, was detected in farmed mink in several European countries, including Sweden. It was found that the virus easily spread between mink and that mink were capable of infecting humans in their close vicinity. A compulsory surveillance of SARS-CoV-2 with weekly sampling on all Swedish mink farms was therefore implemented. In 2020, SARS-CoV-2 was detected on several farms while only one farm was positive in 2021.

Bats can carry different beta-coronaviruses, among them SARS-CoV-2 without becoming sick themselves, but mustelids have been shown to be very sensitive to infection with SARS-CoV-2. During 2021, wild bats and mustelids were screened for the presence of coronaviruses to evaluate their potential roll as carriers. The oral cavity and rectum of 100 bats and 48 wild mustelids (20 ferrets, 14 martens, 8 mink, 4 weasels, and 2 otters) were swabbed with e-swabs to obtain samples of saliva and faeces. Samples from all animals were analysed with PCR for the presence of SARS-CoV-2 and bat samples also analysed with PCR for other beta-coronaviruses. The bats were from the general wildlife surveillance program (72 from 2020 and 28 from 2021). The mustelids were either part of the surveillance programme (10 animals) or trapped in Skåne and Blekinge where SARS-CoV-2 had been found in farmed mink (38 animals). All samples were negative for SARS-CoV-2 and all bat samples were also negative for other corona viruses.

Targeted wildlife surveillance projects 2021

The Swedish Board of Agriculture finances surveillance projects to monitor reportable contagious diseases. Early detection of introduced diseases and showing freedom from other diseases is important. Sweden has a favourable situation regarding infectious diseases and that status will hopefully be maintained. The Environmental Protection Agency finances pilot studies at SVA to study and follow up increased mortality or disease outbreaks. Projects financed in 2021 are described below.

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 2021, 62 dead or euthanised, sick wild boar were tested for ASF virus; all were negative.

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 and the earlier it is detected, the better the chance to eliminate it. Therefore, early detection is so important. Report all dead wild boar, so that they can be tested! Please use the webform

rapporteravilt.sva.se

Photo: Erik Ågren, SVA

SWEDISH WILD BOAR ARE FREE FROM SERIOUS INFECTIOUS AGENTS

In addition to surveillance of African swine fever in wild boar found as fallen game, 112 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).

TRICHINELLA 2021

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 2021, 11 positive samples were detected in wildlife. In the last five years (2017 – 2021), a total of 70 *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 results in good monitoring of *Trichinella* infection in these populations, which together cover most of the country.

SVA is one of several laboratories that offers *Trichinella* testing. If *Trichinella* is found, the sample should always also be sent to SVA for confirmation as Sweden's veterinary reference laboratory. During the previous five years, around 260 bears were harvested by hunters annually, but in 2021 the quota was 502, with 470 harvested. The number of wild boar harvested has increased annually, but the trend was broken in 2021. The figures in the table below 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, six beavers, nine badgers, one seal, one grey seal and three wolverines have also been examined for *Trichinella* in 2021. 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 analysed samples in parentheses. *For bear and wild boar, samples from hunter harvested animals are also analysed by several other laboratories. Positive results are to be reported and samples submitted to SVA, the national reference laboratory, for verification.*

Species	2017	2018	2019	2020	2021	Total
Lynx	4 (80)	6 (53)	6 (129)	6 (91)	6 (111)	**28**
Raccoon dog	-	1 (21)	0 (1)	-	-	**1**
Red fox	-	-	0 (11)	-	1 (41)	**1**
Wolf	1 (45)	3 (17)	2 (14)	0 (1)	1 (42)	**7**
Wild boar*	7 (111 845)	9 (106 055)	5 (~138 500)	9 (~161 000)	3 (130 826)	**33**
Brown bear*	0 (180)	0 (232)	0 (219)	0 (150)	0 (325)	**0**
Total	**12**	**19**	**13**	**15**	**11**	**70**

Surveillance and research projects 2021

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.

NATIONAL SURVEILLANCE OF ECHINOCOCCUS MULTILOCULARIS

In 2021, Kungsbacka municipality in southwestern Sweden became a new area where the red fox tapeworm *Echinococcus multilocularis* (*E.m.*) is confirmed to be present. A fox scat sample from that area was found positive in the new national surveillance initiated in 2021.

Collection and analysis of up to 3 000 samples from red foxes is being performed within a three-year national screening study financed by the Board of Agriculture to monitor the presence of this zoonotic parasite A few cases of alveolar echinococcosis in humans have been found in Sweden in recent years, which concerns the Public Health Agency, and increases interest in this national screening. Samples submitted for screening include faecal samples from dead foxes, or fox scats. Collaboration with field staff from the Swedish Association for Hunting and Wildlife Management and calls to the public to contribute with samples in this citizen science project enable sample submission from the entire country.

SVA found the first positive case of *E.m.* in 2011, and a first national screening was done, ending in 2014. Five hotspots were identified which consisted of small foci where positive samples were found through SVA's screening and by researchers from SLU.

Hunter-harvested red foxes are sampled for tapeworm, trichinella and antibiotic resistance. Photo: SVA

ECHINOCOCCUS MULTILOCULARIS IN KNOWN INFECTED AREAS

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! Photo: Erik Ågren, SVA*

In 2021, an intensified sampling of fox scats was done in two focal areas where *Echinococcus multilocularis* was known to be present since the 2011-2014 screening: Gnesta and Uddevalla municipalities. In 2020, positive fox scats were found in both municipalities and in 2021, additional collection of samples in a widened area was done to investigate the geographic spread from the previously known very local hots spots. A circular area up to 5 km from each of the original finding sites were sampled. Of just over 160 samples, 15 were positive: 10 from Gnesta and four from Uddevalla. Discussion and planning regarding the feasibility of deworming red foxes in these local areas with medicated baits are ongoing. This study was financed by the Environmental Protection Agency.

FACTS ON ECHINOCOCCUS MULTILOCULARIS

Echinococcus multilocularis is a 3 mm long tapeworm that in its adult stage lives primarily in the gut of red fox, but can be carried by raccoon dogs, canids such as domestic dogs and wolves, and very rarely, also cats. The microscopic eggs are released by the adult parasite and are spread in nature through scat. The intermediate host, various rodent species, eat the eggs when foraging and the larval stage of the parasite causes liver lesions, making the infected rodent easy prey for a carnivore main host. Humans are in rare cases accidental intermediate hosts and can develop serious liver lesions.

AFRICAN SWINE FEVER PATHOLOGY PHD-STUDIES

There is still no vaccine available against African swine fever (ASF) and there are knowledge gaps regarding pathogenesis and pathology of ASF in wild boar.

A PhD-project at SVA in collaboration with international colleagues is improving tools and methods 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 virus 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. Countries that do not find the disease early have not been able to eradicate the infection in 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.

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 and 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* 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 and bird feeders and reported that they also were willing to report sick and dead birds at their feeders to SVA. Over the years, many who feed birds in winter, or all year around have 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 since 2008.

In addition to reports concerning garden birds, SVA is now expanding the surveillance to include reporting of all sick or dead wildlife such as badgers, hedgehogs, bats, and foxes, as well as reptiles and amphibians in gardens. By having a large group of reporters spread throughout the country, we can continuously obtain information that contributes to wildlife disease surveillance of species that live near humans. SVA can also easily 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.

Hedgehog at the corner of the house. In addition to small birds at bird feeders, Wildlife Garden Health covers other urban wildlife in gardens and residential areas. Photo: Erik Ågren, SVA

Viper. Reptile cases have been very rare submissions within the wildlife disease surveillance program over the years. This project hopes to increase that number. Photo: SVA

Brown long-eared bat. Bats are often killed by cats. Opportunistic screening for bat lyssavirus and coronavirus can be done on submitted bats. Photo: SVA

Photo: SVA

CONTINUED SURVEILLANCE OF WEST NILE FEVER VIRUS AND USUTU VIRUS

No cases of West Nile Fever Virus (WNV) or Usutuvirus (USUV) were detected in 2021.

These two closely related flaviviruses are spreading in Europe. Both viruses circulate between mosquitoes and birds and can cause serious disease outbreaks and mortality in some bird species. Crows, birds of prey (especially owls) and thrushes are particularly susceptible to infections with WNV and USUV, while other bird species can be infected and spread viruses without showing symptoms.

During the 2021 mosquito season, brain, and liver samples from 253 dead birds were analysed for WNV and USUV and included 25 thrushes (blackbird, fieldfare, and song thrush), 24 corvids (crow, raven, rook, jackdaw, and magpie), 22 owls and 63 other birds of prey. The birds were mainly collected in southern Sweden: 134 birds from Götaland (southwest), 84 birds from Svealand (east) and 35 birds from Norrland (north). The study was funded by the Swedish Environmental Protection Agency.

The presence of WNV and USUV in Sweden in 2021 is considered non-existent or very limited.

Since 2020, USUV has been identified in the UK and WNV has been reported in 2021 from northern regions in Germany, Spain, Bulgaria, Greece, Italy, and the Netherlands, among others.

In a gradually warmer climate, it is most likely only a matter of time before we see our first cases of infections with WNV and before we find USUV in Sweden again. Continued monitoring of both viruses in the coming years is therefore desirable.

Photo: Erik Ågren, SVA

WHO SUBMITS FALLEN WILDLIFE TO SVA AND WHY?

An ongoing three-year interdisciplinary research project investigates factors that affect the submission of wildlife cases for wildlife disease surveillance at SVA. The aim is to improve activities that inform decision-making in wildlife management. The project, which is a collaboration with epidemiologists at SVA and environmental psychology researchers at Lund University, is funded by the Wildlife management fund and will run until 2024.

Sweden's monitoring of wildlife diseases at SVA is based on general disease monitoring with examinations of dead or euthanised sick wildlife. Data generated are dependent on voluntary reporting and the submission of animal carcasses found in nature by the public. How representative the samples are, which factors affect the submission and which group of people submit material has not been studied previously. The aim of this project is to fill these knowledge gaps to further develop and adapt the program so that relevant wildlife health issues can be prioritised, and surveillance can be more comprehensive.

Through descriptive data analysis, geographical modelling, questionnaires and interviews we are investigating:

1) What the wildlife disease data of the last ten years represent.
2) What factors facilitate or prevent the submission of reported dead wildlife.
3) Who reports and submits dead wildlife.
4) What is the personal motivation to voluntarily report and submit samples.

By identifying factors that influence the selection of samples and understanding the demographics and motivation of those who voluntarily submit samples, we can remove obstacles, facilitate submission, and increase participation to further improve the surveillance programme.

In 2021, we began investigating all submissions received over the past 10 years to see which animal species are sent in and from where they originate. Focus group discussions and surveys are planned for 2022, for in-depth studies on who reports dead wildlife and why, and which factors affect submission of cases to the surveillance programme.

Jackdaws from a mass mortality event where many birds were found dead at the same time and place. In these cases, poisoning can be suspected. Access to toxicologic screening is important to establish if a poisonous substance has caused the mortality, and to identify what substance it is. Mass mortality of jackdaws has previously been caused both by insecticides and caffeine. Photo: SVA

TOXICOLOGY ANALYSIS OF SUSPECTED POISONING CASES

After several years of limited access to laboratories for toxicological analysis of samples from wild animals, SVA began developing an in-house method based on liquid chromatography and high-resolution mass spectrometry for screening tissue samples for toxic substances in 2020.

In 2021, the Swedish Environmental Protection Agency gave funding to analyse approximately 100 samples from wild animals where suspicion of poisoning arose in connection with necropsy. The project is part of the development of the national analytical capacity and at the same time provides an overview of the scope of poisoning cases in Swedish wildlife. The work is still ongoing, and when finalized, results will be reported to EPA in 2022.

Mass mortality of waxwings following feeding on fermented berries after alternating cold spells and thaws, leading to ethanol poisoning. Photo: SVA

Interesting cases 2021

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

BONE CANCER IN A WOLF

Radiograph of an osteosarcoma in the right shoulder joint of an emaciated and weak wolf that was euthanized for animal welfare reasons. The bone tissue is partially destroyed by the tumour and restorative processes are ongoing. Photo: SVA

An old male wolf (RovbaseID M526871) was euthanized because it was thin and exhibited aberrant behaviour. A malignant tumour of the bone tissue (osteosarcoma) was detected in the right shoulder joint. This type of tumour occurs in older individuals of large dog breeds but is very unusual or rarely described in wolves.

MASS MORTALITY OF MURRES

Dead Common murre on the beach, one of many found on the west coast in 2021. All examined at SVA were emaciated young birds. Photo: Sylvia Nilsson

During the autumn, reports of many dead common murres were received from the west coast and similar events were also reported from the coasts of our neighbouring countries. Razorbills and common puffins were also found dead.

Several murres from different locations on the west coast were brought in for examination at SVA. The birds were tested for avian influenza virus, but all were negative. All of the submitted cases were emaciated young birds without other pathological changes. A few had a mild parasite burden. The reason they were emaciated was hypothesized to be food shortage. It is of interest to collect dead seabirds to SVA for examination and disease surveillance.

ROE DEER WITH STERNAL MASS

One of two roe deer with a football-sized mass bulging from the brisket area. The animals were euthanized and sent to SVA for examination. Photo: Anders Gejer.

An old, very thin female roe deer with a mass bulging from the brisket area had been observed for a whole year when foraging in gardens in the southern parts of Stockholm. During the summer of 2021, the mass increased rapidly in size and the roe deer was euthanized by wildlife officers.

The examination revealed that the mass was filled with more than one litre of bloody fluid caused by tumour tissue that had damaged the blood vessels at the base of the neck. Microscopic examination revealed that the tumour probably originated from embryonic tissue remnants of the fetal gill slits. In 2020, an old male roe deer (photo above) was necropsied at SVA, with a similar neoplasm that also gave rise to a "football-sized" tumour at the same location. Two similar odd cases in roe deer!

Similar looking masses also caused by fluid accumulation have been observed in other deer species. At necropsy, the swellings in these cases consisted entirely of massive hematomas, likely the results of frontal blunt trauma to the thorax, from traffic accidents or other impact injuries. For a detailed diagnosis and pathogenesis, both necropsy and histopathology are often needed. In wildlife species, this is performed by the Wildlife Section at SVA!

ETHMOID TUMOURS IN MOOSE

Moose head with ethmoidal tumour that is a neoplastic expansive mass under the ulcerated skin over the nasal bone. Photo: Erik Ågren SVA

The number of ethmoidal tumour cases diagnosed in moose submitted to SVA has increased within the past years. The increase is probably not an increased prevalence in the moose population but a result of increased reporting and submission of cervid cases for the CWD surveillance. This surveillance was initiated in 2016 after the first finding of CWD in Europe in Norwegian wild reindeer. EU-regulated surveillance has been ongoing from 2018–2021. Communication efforts aimed at the hunting communities and the public requesting reports is also expected to have increased reporting. Between 2007–2015, an average of 2,1 cases of ethmoidal tumours were diagnosed each year. From 2016–2021, the average number of cases increased to 4,5 cases per year.

Ethmoidal tumours originate from the deepest part of the nasal cavity tissue, adjacent to the perforated ethmoidal bone where nasal nerves connect to the brain. As the tumour increases in size and breaks down bone tissue, pressure on the frontal part of the brain leads to neurologic symptoms, which also can be seen in clinical manifestations of CWD. These affected animals have aberrant behaviour and are therefore of interest to necropsy and analyse if euthanised or found dead. When the tumour has broken through the nasal bone, an obvious midline mass can be observed under the skin of the forehead, between the eyes. The overlying skin may open up with time. This form of tumour in moose has only been described in Sweden and Norway. It is probably caused by a virus, but this has yet not been confirmed and research at SVA is ongoing. The tumour is mainly seen in older animals, with an average age of 11.5 yrs. for 33 cases in 2007–2021. Of 46 cases, only eight were male moose. This reflects moose hunting management where females are often more protected during hunts and generally reach an older age than males.

Marine mammals

SURVEILLANCE PROGRAM

A total of 62 marine mammals have been examined by SVA in 2021. Of these, 44 were cetaceans and included 42 harbour porpoises, *Phocoena phocoena*, one Northern bottlenose whale, *Hyperoodon ampullatus*, and one humpback whale, *Megaptera novaegliae*. Eighteen seals were examined: 13 grey seals, *Halichoerus grypus*, and five harbour seals, *Phoca vitulina*. Additionally, SVA analysed 45 samples from hunter harvested grey seals examined by the Swedish Museum of Natural History (NRM), and samples from a stranded grey seal, for influenza A virus.

All stranded seals except one were necropsied at SVA. One grey seal was necropsied in the field, on the island of Ven. All harbour porpoises were necropsied at SVA together with staff from NRM. The Northern bottlenose whale was examined at SVA, and the humpback whale was sampled in the field, in Mörbylånga municipality on the island of Öland.

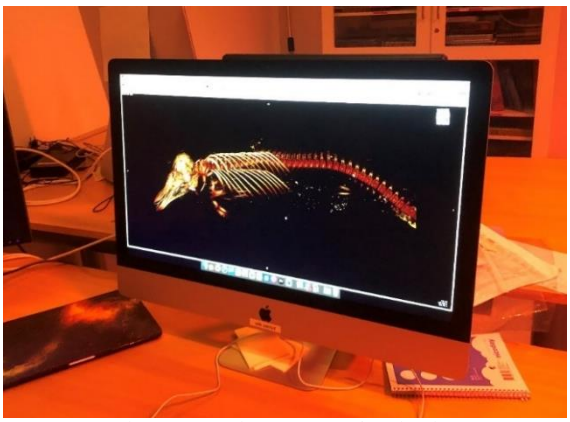
Below is a summary of the marine mammals examined during 2021. For more details and descriptions of necropsy findings, see the Annual report for marine mammals 2021 and the open data, available at dataportal.se.

CETACEANS

Harbour porpoise

The majority of the porpoises examined were juvenile/sexually immature, of which 17 were calves (yearlings), and four were newborn (neonates). All five sexually mature adult porpoises were females. Thirty-seven porpoises were found dead. Seven porpoises were accidentally caught in fishing gear and submitted by fishermen. Of 37 stranded porpoises, the most common cause of death was bycatch, which was diagnosed in 12 individuals. Two more were diagnosed as probable bycatch. Three new-born calves were deemed abandoned, and one calf had starved to death. Three porpoises had died due to infectious disease, one porpoise had injuries consistent with predation and another had drowned. The cause of death could not be determined in five animals. Another six cadavers were so decomposed that cause of death could not be established.

One of the porpoises that died of infectious disease was a large adult female from the island



A computed tomography image of a harbour porpoise found on the island of Öland, likely originated from the critically endangered Baltic Sea population. To maximize information collected from this rare animal, a CT-scan, or 'virtopsy' (virtual necropsy) was performed prior to the classic necropsy. Photo: Jasmine Stavenow, SVA

of Ven. She was emaciated and large abscesses were seen along the spine. The extensive infection compromised the porpoise's mobility. Bacterial culture and whole genome sequencing of the abscesses detected cetacean brucellosis caused by the bacterium *Brucella ceti* and this is the first time this infection could be confirmed in Sweden.

Humpback whale

On April 15, a dead whale was sighted off the coast of Gotland in the Baltic Sea. The whale was not completely beached, and within24 hours, it drifted further south-west. On April 20, it stranded in shallow waters along the southeast coast of the island of Öland, in Mörbylånga municipality. The whale was identified as a humpback whale (*Megaptera novaeangliae*), which matched with sightings of live humpback whales along the west coast of Sweden a few weeks earlier. With the help of Mörbylånga municipality and the Coast Guard, SVA was able to organize a field sampling of the humpback whale. The whale was a male, 8.9 m long and was therefore assessed to be a calf.

SVA performed a field sampling of the humpback whale that stranded on the coast of Öland in the Baltic Sea. Photo: SVA

Adult humpback whales are usually between 12-16 m long. Samples were collected for researchers at SVA, NRM, and the University of Gothenburg.

Northern bottlenose whale

On June 12, a dead Northern bottlenose whale (*Hyperoodon ampullatus*) was reported from Skärhamn in Tjörn municipality, on the west coast of Sweden. The Coast Guard helped salvage the whale for transport to SVA and necropsy. The whale was severely decomposed, and the cause of death could therefore not be determined with certainty. However, heavy bleeding was seen along the back, consistent with blunt external trauma. The cause of the traumatic injuries could not be established.

Biobank samples were collected, and examination of stomach contents showed that the whale had eaten many squid shortly before it died, with large amounts of squid beaks, the hard mouth parts of squid, in the stomach. The beak is the last part of the squid to be digested, and thus remains the longest in the whale's stomach.

SEALS

The majority of the 18 seal carcasses examined 2021 were juvenile/sexually immature individuals, including eight young-of-the-year (yearlings), four new-born pups (neonates) and one premature pup. Five seal carcasses were sexually mature adults. Fourteen of the seals were found dead. Four seals were found debilitated and were euthanised for animal welfare reasons.

Grey seals

Infectious disease was the most frequent primary diagnosis in examined grey seals. Two grey seals died from non-infectious disease and another two from traumatic injuries. One newborn pup had been abandoned, and one young-of-the-year died of emaciation. In one case, the cause of death could not be determined. All four young-of-the-year examined had parasitic lesions in the liver and/or intestine.

One young-of-the-year found alive and debilitated in Östergötland County in April was euthanized by a veterinarian. The young seal was in poor nutritional condition and had a severe intestinal parasitic infestation with hookworms.

Another pup found dead in Stockholm County in May, was in poor nutritional condition and had a severe parasitic infestation with liver flukes, accompanied by inflammation in the liver and pancreas, resulting in a rupture of the gall bladder. A secondary bacterial infection was also diagnosed in the liver.

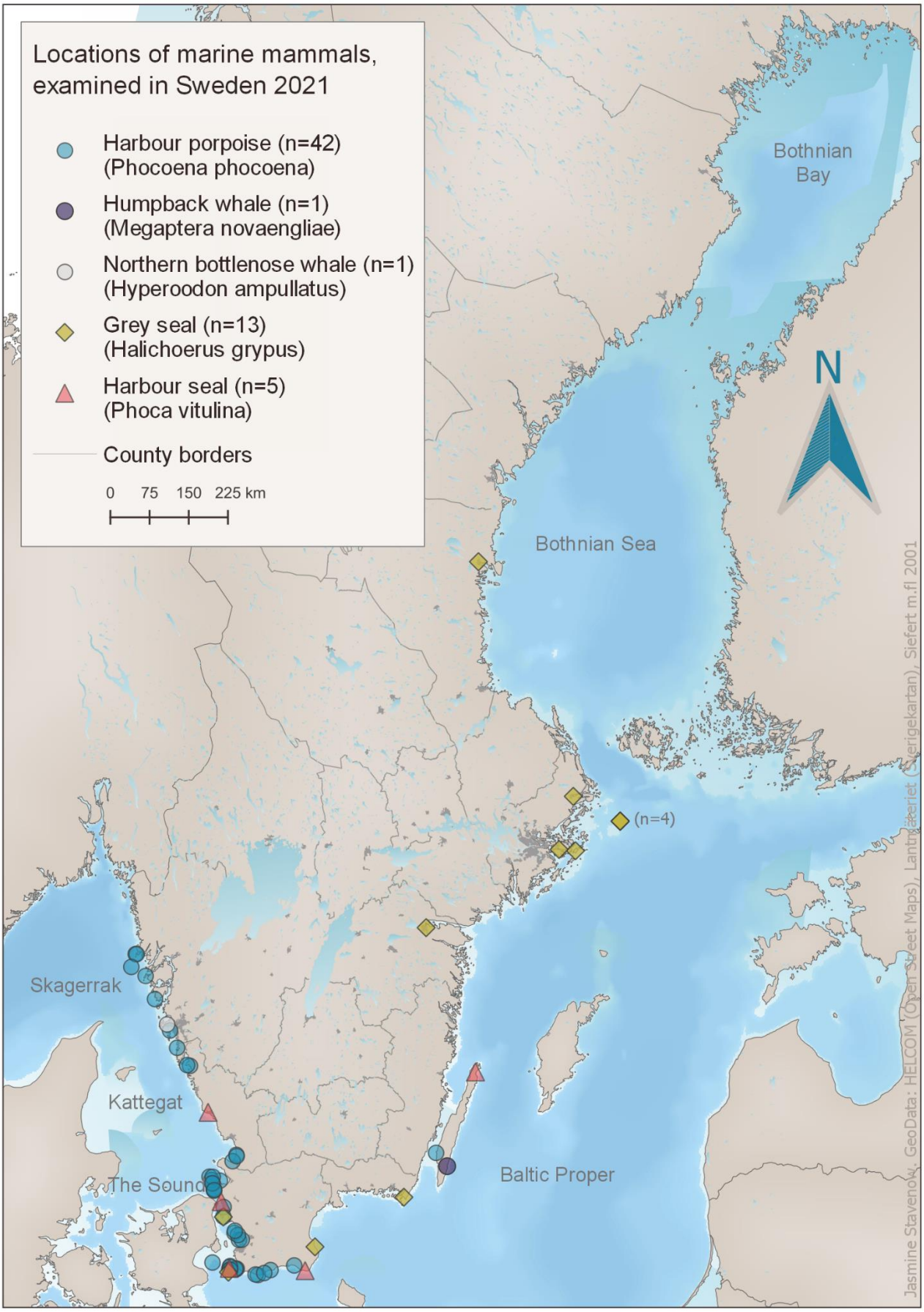
An adult male grey seal found dead in Skåne County died from infectious disease affecting the central nervous system. Inflammatory changes were found in the brain and meninges, which most likely caused motor difficulties or seizures and could explain why the seal died from drowning. This seal was field necropsied close to the finding site on the island of Ven, located in the south, in the waters between Sweden and Denmark.

Harbour seals

Two harbour seals died of traumatic injuries, one of emaciation, one due to fishery interactions, and one due to infectious disease.

In August in Skåne County, an adult seal was found alive, in poor nutritional condition, and entangled in fishing gear. The seal was brought to the local veterinarian for examination. Radiography revealed multiple fishhooks in the gastrointestinal tract. Unfortunately, surgery was not possible. The seal was euthanized and submitted to SVA. The seal had swallowed fishing tackle. Several hooks were embedded in the upper gastrointestinal tract and a fishing line with hooks and dried remnants of a mackerel extended from the mouth.

A harbour seal found entangled in fishing gear was euthanized by veterinarian. Fishing hooks were embedded in the upper gastrointestinal tract. Photo: SVA



Map showing the finding places of the marine mammals, examined by SVA during 2021.

Large carnivores

All carcasses or parts of the large carnivore species bear, lynx, wolf, or wolverine that are found dead, euthanised, or felled in hunts are sent to SVA for examination and sampling.

SVA received carcasses or parts of 837 large carnivores in 2021. The majority of cases are from the licensed hunts or other management activities. Fallen wildlife, that is animals found dead or put down due to disease or injuries, are as in previous years dominated by traffic accidents on road or rail, and sarcoptic mange that usually leads to emaciation. Forensic pathology examination is done on cases that are part of a criminal investigation.

The handling of large carnivore carcasses and samples is done through commission of the Swedish EPA, as part of the management of these species. The EPA regulation NFS 2002:18 42§ reads that carcasses or parts of these species are to be reported to the Police, who then hand over the material to SVA for examination. The work with these samples at SVA is an important part of the health and disease screening and management of these populations. With a continuous screening over time, variations in disease diagnoses and causes of death can be followed over the years.

Below are brief summaries of causes of death and the health status for the animals examined at SVA in 2021. More details can be found in the *Large carnivore report 2021*, and in reports on the licenced hunts 2021 for wolf, lynx, and bear.

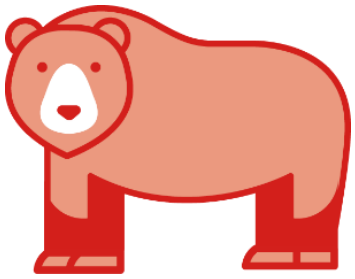
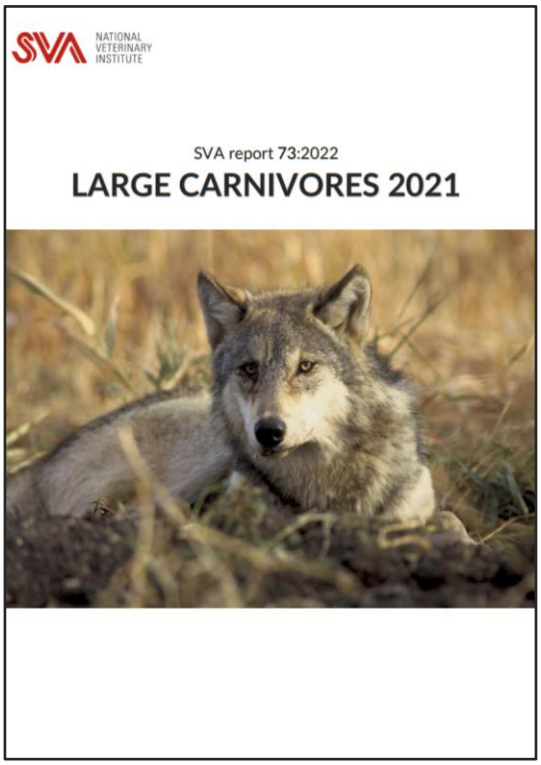


Table with number of predators received by SVA per year for the period of 2017-2021. Ref: SVALA, Annual Reports

Species	2017	2018	2019	2020	2021
Bear	310	360	377	444	596
Lynx	158	136	144	168	168
Wolf	67	37	28	31	57
Wolverine	12	7	11	30	16
Total	**547**	**540**	**560**	**673**	**837**



A more detailed report on large carnivores examined at SVA is found online at www.sva.se, SVA-report 73:2022, also in English.

WOLVERINE

In 2021, 13 of 16 wolverines were culled through protective hunts, two died in vehicular collisions and one case was a forensic investigation. Necropsy findings included old injuries and dental attrition. Wolverines appear to have a good health status in general, but few animals are examined so conclusions regarding the whole population are not well grounded.

BEAR

In 2021, 463 of 596 brown bears were hunter harvested in the licensed hunt and only tissue samples were submitted to SVA. This year, the routines for sampling of culled bears were changed to optimise staff resources and working time, as the hunting quota was increased from 300 to 500 bears. All culled bears were sampled according to a minimum sampling protocol, and only every third bear was fully sampled, as well as any tagged research animal. SVA received 111 bears as entire carcasses from protective hunt culls, four bears were shot in self-defence situations, 10 bears were killed in traffic: six by railroad and four on roads. For one submitted bear cub, the cause of death could not be established. Five bears were forensic cases.

The health status of the bear population is assessed as good and there was no specific serious disease noted in 2021. As minor findings, a small umbilical hernia, a scarred local pleuritis lesion, old bite and claw wounds and broken claws and attrition of paw pads and teeth were noted in some animals. The presence of both nematodes (*Baylisascaris transfuga*) and tapeworms were noted, a normal finding in bears in some areas of the bear population.

Lynx, in a zoo. Photo: Karin Bernodt, SVA

LYNX

In 2021, 168 lynx were examined. Eighty-one were culled in the licensed hunt, 26 in protective hunts and 42 were killed in traffic. Twelve submitted lynx were emaciated. One lynx had been bitten to death, and one lynx cub was euthanised after the mother had been hit by a car. Six lynx had injuries or diseases that led to euthanasia or death. One lynx had a deformed hind leg of uncertain origin, one had septicaemia following bite wounds, and one an old gunshot wound. There was one case of cryptorchism and one case with hypoplasia of a testicle. Eight lynx had sarcoptic mange, three had otic mites, six had trichinellosis, and 78 carried intestinal tapeworms and/or nematodes. The health status in the population can be considered good except for sarcoptic mange as the most serious infectious disease present.

WOLF

In all, 57 wolves were examined in 2021, with 27 from the licensed hunt, 16 from protective culling, and two killed by owners protecting domestic livestock (JF 28§). Four wolved died in traffic. For three wolves, the cause of death could not be established at necropsy due to decomposition. An old male euthanised for animal welfare reasons had age-related changes and a malignant bone tumour in the right shoulder joint (osteosarcoma), see note on page 24. A one-day old cub was found alone and weak and was euthanised. She had empty stomach and gut, which probably explained the weak condition. Necropsy findings noted included old trauma, with one case of an old gunshot wound. Ten cases of cryptorchism were found, which is a higher percentage than in previous years. Two cases with dental anomalies were noted. A minor malformation of fused cartilage rings in the trachea was seen in one case with a dental anomaly. A single case each of sarcoptic mange and trichinellosis was found. No cases of *Echinococcus* tapeworms were found after routine screening of all incoming wolves. The health status of examined wolves was good, but the high prevalence of cryptorchism this year (28%) has led to further genetic studies of the wolf population in collaboration with SLU.

Publications 2021

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 also participate in various international and national conferences where research results are presented. Due to the pandemic restricting travel, conferences or webinars have mainly been online. Below is a selection of publications from 2021 related to wildlife, where the names of authors from the Wildlife Section or other departments at SVA are written in **bold**.

SCIENTIFIC PUBLICATIONS, SELECTED

Lawson B, **Neimanis A**, Lavazza A, Ramón López-Olvera J, Tavernier, P, Billinis C, Duff P, Mladenov DT, Riijks JM, Savić S, Wibbelt G, Ryser-Degiorgis M-P, Kuiken T. How to start up a national wildlife health surveillance programme. Animals. 11, no. 9: 2543. https://doi.org/10.3390/ani11092543

McDevitt, Allan D., Ilaria Coscia, Samuel S. Browett, Aritz Ruiz-González, Mark J. Statham, Iwona Ruczyńska, Liam Roberts, Joanna Stojak, Alain C. Frantz, Karin Norén, **Erik O. Ågren**, et al.

Next-generation phylogeography resolves post-glacial colonization patterns in a widespread carnivore, the red fox (*Vulpes vulpes*), in Europe. Molecular Ecology. Online version published 14 Nov 2021. https://doi.org/10.1111/mec.16276

Meurling, Sara: Maria Cortazar-Chinarro, Mattias Siljestam, David Åhlen, **Erik Ågren**, Jacob Höglund, Anssi Laurila. 2021. Body size mediates latitudinal population differences in response to *Bd* infection in two amphibian species. Preprint BioRxiv 2021.0.16. doi: https://doi.org/10.1101/2021.07.16.452656

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

Sánchez-Cordón PJ, Floyd T, Hicks D, Crooke HR, McCleary S, McCarthy RR, Strong R, Dixon LK, **Neimanis A**, **Wikström-Lassa E**, **Gavier-Widén D**, Núñez A. 2021. Evaluation of Lesions and Viral Antigen Distribution in Domestic Pigs Inoculated Intranasally with African Swine Fever Virus Ken05/Tk1 (Genotype X). Pathogens. 10(6):768. https://doi.org/10.3390/pathogens10060768

Sánchez-Cordón PJ, Vidaña, B, **Neimanis A**, Núñez A, **Wikström E**, **Gavier-Widén D**. Chapter 4. Pathology of African Swine Fever. In Iacolina L. et al. (eds) Understanding and combating African swine fever. https://doi.org/10.3920/978-90-8686-910-7_4

Sandholt AK, **Neimanis A**, Roos A, **Eriksson J**, **Söderlund R**. Genomic signatures of host adaptation in group B Salmonella enterica ST416/ST417 from harbour porpoises. Veterinary research. 52(1):1-1. https://doi.org/10.1186/s13567-021-01001-0

Sannö, Axel; **Erik Ågren**; Mats Ander; Karin Troell. 2021. Sarcoptic mange in the wild boar, *Sus scrofa*, in Sweden. Current Research in Parasitology & Vector-Borne Diseases. Axel Sannö, Mats Ander, Erik Ågren, Karin Troell, ISSN 2667-114X, https://doi.org/10.1016/j.crpvbd.2021.100060.

Ågren, **Erik O.**, **Kaisa Sören**, **Dolores Gavier-Widén**, Sylvie L. Benestad, Linh Tran, Karolina Wall, **Gustav Averhed**, **Neele Doose**, Jørn Våge, and **Maria Nöremark**. 2021. First Detection of Chronic Wasting Disease in Moose (*Alces alces*) in Sweden. Journal of Wildlife Diseases, 57(2), pp. 461–463.

REPORTS AND POPULAR SCIENCE

SVA annual report 2020. Wildlife. Erik Ågren

Surveillance of infectious diseases in animals and humans in Sweden 2020. Postmortem examinations in wildlife. Erik Ågren.

Health, disease and causes of death in marine mammals 2020, in Swedish. [Hälsa, sjukdomar och dödsorsaker hos marina däggdjur 2020]. SVA rapport 61/2021. **Neimanis A., J. Stavenow, E. Ågren,** A. Roos, J. Kallunki Nyström

Licensed wolf hunt 2021. SVA rapport 65:2021. Erik Ågren, Jasmine Stavenow.

Wildlife disease surveillance in Sweden 2020. SVA report 66:2021. Editors: Erik Ågren & Henrik Uhlhorn

Licensed lynx hunt 2021. SVA report 67:2021. Linda Thelin, Erik Ågren.

Licensed bear hunt 2021. SVA report 71:2022. Linda Thelin, Erik Ågren.

Large predators 2021. SVA report 73:2022. Minerva Löwgren, Erik Ågren, Linda Thelin.

Dead porpoises tell vital stories. In Swedish: Döda tumlare ger livsviktig kunskap. Havsutsikt 2/2021. **Stavenow, J.**, A. Roos, **A. Neimanis**, **E. Thorsson.**

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 2021.

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. A digital teaching tool was used, and films also can be used after the course. The course goes through the practical and administrative aspects of inspecting hunter harvested large carnivores.

Continuing education

SVA APPROVED AS TRAINING CENTRE FOR WILDLIFE SPECIALISTS

SVA was in 2021 approved as a training centre for the specialist training programme for ECZM, the European College of Zoological Medicine specialty Wildlife Population Health.

A residency normally takes three years and after passing a board examination the candidate becomes a board-certified diplomate of the specialty, and can be titled European specialist, which is the highest level of veterinary continuing education.

At the SVA Wildlife section there are two ECZM diplomates, now programme director and supervisor respectively for the first ECZM resident that started a residency during 2021. The residency is partly finance from the Marie-Claire Cronstedts foundation. Also, within the SVA Wildlife group there are two board certified veterinarians within other colleges, the ECVP and ACVP, as European and American specialist in veterinary pathology, respectively.

ECZM
EUROPEAN COLLEGE
OF ZOOLOGICAL MEDICINE

LECTURES AND PRESENTATIONS 2021, SELECTED

Intermyndighets-EPI-samverkan SVA-SJV 2021-03-01. Digital presentation on Wildlife disease surveillance. **Erik Ågren**

EWDA student chapter virtual workshop 2021-04-22. Working with Wildlife health from a governmental agency perspective: unique opportunities and challenges. **Erik Ågren**
News from the North- current wildlife health issues in Sweden. **Henrik Uhlhorn**
Beyond disease: setting up an integrated health and disease surveillance program for marine mammals in Sweden. **Aleksija Neimanis**
Networks and outreach: improving wildlife health surveillance in Sweden. **Jasmine Stavenow** and **Aleksija Neimanis**

Swedish Centre for Animal Welfare (SCAW) och SLU Future One Health seminar "One Welfare, we are all connected" 2021-06-10. Digital lecture "Wildlife Health within a One welfare context", **Aleksija Neimanis**

Web education for inspection of large carnivores. Organizers: Viltskadecentrum and SVA, digital course. SVA: **Erik Ågren**, 16 - 17 June 2021

EWDA Network Meeting: Expanding the field network of wildlife health surveillance. Virtual Conference, Cuenca, Spain, 31 August 2021. Using technology to improve wildlife health surveillance. **Erik Ågren**

69th WDA /14th EWDA Joint virtual Conference, Cuenca, Spain, Aug 31 - Sep 2, 2021.

Oral presentations at EWDA:

Occurrence and significance of psittacosis caused by *Chlamydia psittaci* in garden birds in Sweden. **Ellinor Spörndly-Nees, Henrik Uhlhorn, Tomas Jinnerot, Aleksija Neimanis**

Impact of the genomic architecture of Lagovirus europaeus/GI.2 recombinants in the clinical course of rabbit hemorrhagic disease. Lopes AM, Machado Marques R, Costa M, Teixeira L, Pinto A, Vasco Côrte-Real J, Magalhães MJ, Esteves PJ, Costa Silva A, **Neimanis A**, **Gavier-Widén D**, Gomes Ferreira P, Abrantes J.

Syphilis seropositivity and *Treponema paraluisleporidarum* strain diversity in European brown hares. Linda Hisgen, Lena Abel, **Erik Ågren,** Alexander Barlow, Marcus Fähndrich, Linda Grillová, Miklós Gyuranecz, Luisa Hallmaier-Wacker, Antonio Lavazza, Simone Lüert, Markéta Nováková, Carlo Pacioni, Christian Roos, Egbert Strauß, Tiziana Trogu, Roser Velarde, Ulrich Voigt, David Šmajs, Sascha Knauf

Poster-presentations at EWDA:

Surveillance of Chronic Wasting Disease in Sweden. **Gustav Averhed, Maria Nöremark, Kaisa Sörén**, Maria Cedersmyg, Karolina Wall, **Dolores Gavier-Widén, Erik Ågren**.

Moose (*Alces alces*) with suggested spontaneous Chronic Wasting Disease in Sweden. **Erik Olof Ågren, Gustav Averhed, Dolores Gavier-Widén, Kaisa Sörén**, Karolina Wall, Sylvie L. Benestad, Linh Tran, **Neele Doose**, Jørn Våge, **Maria Nöremark**

Finding elusive Echinococcus tapeworms in Sweden. **Erik Olof Ågren**, **Eva Osterman Lind, Jenny Frössling**

First known outbreak of *Salmonella* serovar Choleraesuis in Swedish wild boar. **Karin M. Olofsson, Linda Ernholm, Caroline Bröjer, Gustav Averhed, Erik Ågren**

First report of suggested septicaemia in a European otter (*Lutra lutra*) caused by the fish pathogen *Yersinia ruckeri*. **Karin M Olofsson, Minerva Löwgren**, Paulina Hysing, **Norbert Van De Velde**, **Erik Ågren**, **Charlotte Axén**

The worst avian influenza (HPAI-H5N8 and H5N5) season ever in wild birds and poultry in Sweden. **Caroline Bröjer**, **Henrik Uhlhorn**, **Siamak Zohari, Malin Grant, Maria Nöremark, Elina Thorsson, Elisabeth Bagge, Gustav Averhed, Helena Eriksson, Karin Olofsson-Sannö, Minerva Löwgren, Pernille Engelsen-Etterlin, Désirée S Jansson**

Tick-borne encephalitis in the Swedish moose (*Alces alces*). **Elina Thorsson**, Tomas Bergström, Kristina Nyström, Peter Norberg, Anette Roth, **Gustav Averhed**

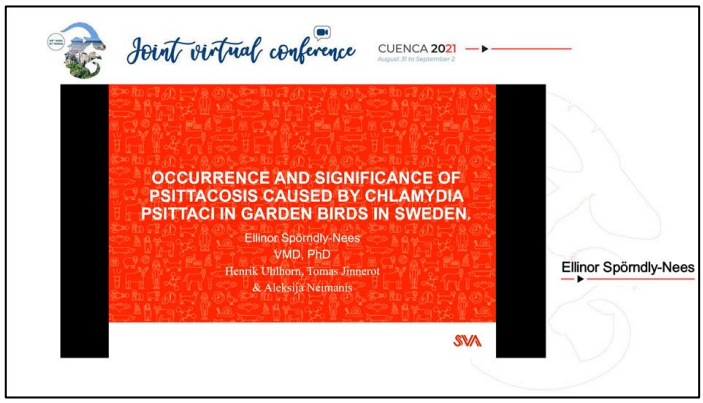
25th NWDA meeting, virtual conference, Uppsala 16 sep 2021. Report from Sweden: Wildlife disease surveillance highlights 2019-2021. **Erik Ågren**

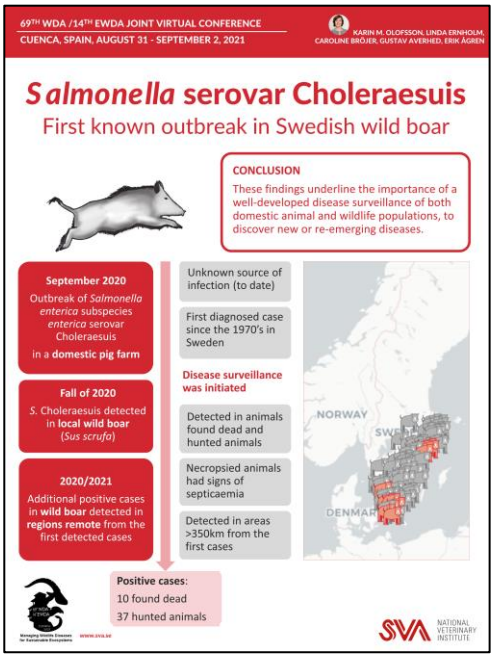
Infektionsveckan och mikrobiologiskt höstmöte online. Seminar on *Echinococcus multilocularis*, Uppsala 17 sep 2021. Rävens dvärgbandmask, veterinärens vinkel. **Erik Ågren**

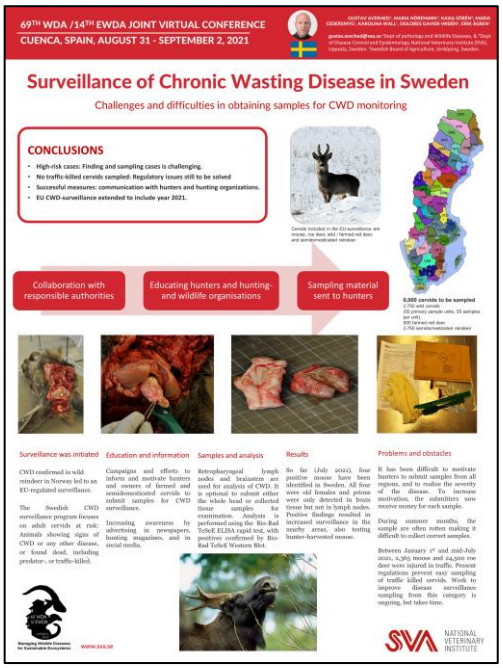
State of the Art Covid-19 möte, 24–25 November 2021, Svenska Läkaresällskapet. Digital poster presentation: SARS-CoV-2 in a zoo tiger. **Erika Karlstam, Siamak Zohari**, **Karl Ståhl** och **Aleksija Neimanis**

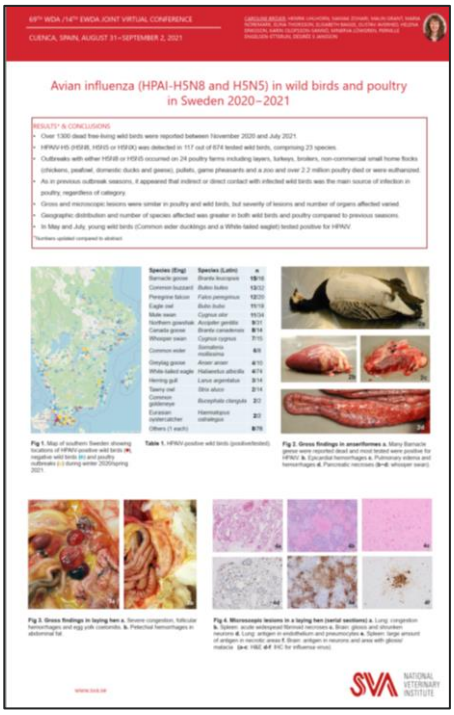
Mammal Trapping Video Summit, 26–29 November 2021 Alpha wildlife summits. Presentation: Approval of restraining and killing trap models in Sweden and suggested improvements through behavioral and physiological evaluation. **Erik Ågren**, Johan Lindsjö, Ulrika Alm Bergvall, Åsa Fahlman, Odd Höglund, Therese Arvén Norling, Petter Kjellander

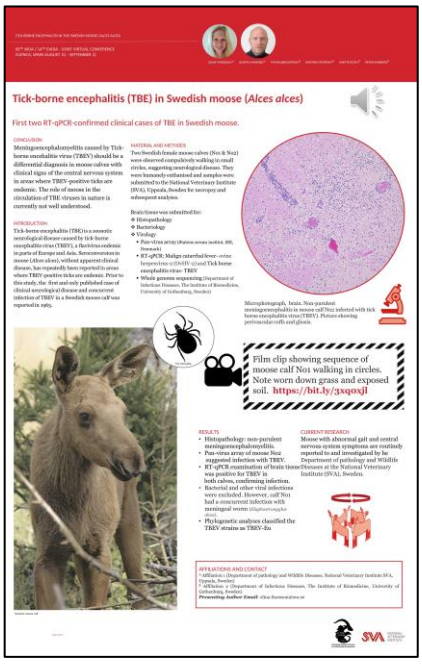
At the *European Wildlife Disease Association* virtual meeting in 2021 SVA had several presentations











EXPERT OPINIONS 2020

SVA 2020/1066 Yttrande om förslag till Livsmedelsverkets nya föreskrifter om jägares leveranser av små mängder vildsvin och kött av vildsvin. Dnr 2020/04701. [On new regulations for hunter delivered small quantities of wild boar and meat of wild boar]

SVA 2021/241 Yttrande på remiss om Naturvårdsverkets förslag till nya föreskrifter om vapen, vapentillbehör och ammunition för jakt. NV-04496-18. [On the EPA suggestions for new regulations on arms, arms material, and ammunition for hunting]

SVA 2021/761 Yttrande på förslag till strategi för svensk viltförvaltning. NV-07785-21. [On suggestion for strategy for Swedish wildlife management]

SVA 2021/850 Yttrande rörande enkät gällande användning av NSAID-preparat inom veterinärmedicin i Sverige. NV-08163-21. [On the questionnaire on the use of veterinary NSAID-medication in Sweden]

GOVERNMENTAL TASKS 2021

Viltvårdsfonden, the Wildlife management fund finances part of the SVA work with wildlife. Report submitted annually on 1 October och 1 April.

The Governmental task ”Wild boar package” **Vildsvinspaketet** for SVA; Prerequisites for digital trackning of wild boar meat. *Förutsättningar för digitaliserad spårbarhet för vildsvinskött* continued in 2021 and the final report was submitted in January 2022. Report available on **sva.se**

Title page image of the SVA report ***Prerequisites for digital tracking of wild boar meat.*** *Anna Malmsten.*

Working groups and networks

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, Maria Nöremark, Dolores Gavier-Widén, Erik Ågren, Aleksija Neimanis.

SVA Scientific council: Dolores Gavier-Widén, Aleksija Neimanis

SVA Environmental and Climate committee: Jasmine Stavenow

SVA Zoonosis centre working group: Henrik Uhlhorn for POV.

SVA R&D coordination group: Aleksija Neimanis, Ellinor Spörndly-Nees

SVA Poultry forum: Caroline Bröjer

SVA Animal welfare organ: Henrik Uhlhorn

Board of Agriculture wildlife reference group, SVA representative: Erik Ågren

Swedish Environmental Protection Agency´s Hoofed wildlife council, SVA representative: Gustav Averhed

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

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

Information central for the Gulf of Bottnia, SVA representative: Caroline Bröjer

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, associate editors: Erik Ågren, Aleksija Neimanis

OIE Focal point for wildlife: Erik Ågren

Healthy Wildlife – Safe Humans

…but wash your hands – hedgehogs **may** carry salmonella!

STATENS VETERINÄRMEDICINSKA ANSTALT

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