STATENS VETERINÄRMEDICINSKA ANSTALT

WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2019

SVA Report 60:2020

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For the love of wildlife. E. Ågren 2019

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 2019.

Uppsala, April 2020
Erik Ågren, head of the Wildlife section

DEFINITIONS

General disease surveillance involves diagnosis of disease and cause of death through necropsy, histopathology and ancillary testing of wildlife found sick or dead.

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 are reported within Sweden or in neighbouring countries.

Targeted disease surveillance. *Many samples submitted to the Wildlife section at SVA in 2019 were moose (Alces alces) carcasses or parts. Often the entire head was submitted for screening for the prion disease CWD, Chronic Wasting Disease. CWD was found in Sweden for the first time in 2019. Three older female moose were positive for CWD and all originated from the northern County of Norrbotten. To sample for CWD, the head is placed upside-down to collect the brain stem and retropharyngeal lymph nodes. Photo: Erik Ågren, SVA*

Summary

The health status of Swedish wildlife

References: SVA annual report 2019, SVA Wildlife section and SVALA database; 2019-2020.

Monitoring the disease situation among wild animals is mainly done through post-mortem examinations and ancillary testing of wildlife found dead and through targeted collections 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 2019, 2,452 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, 560 were from large predators, many of which came from the mandatory sampling of hunted lynx and brown bear. In 2019, 233 cases of reportable diseases involving 22 wild animal species were reported to the Swedish Board of Agriculture and the OIE.

The most significant wildlife disease event in 2019 was the discovery of three cases of chronic wasting disease (CWD, a prion disease of cervids), in three older female moose in the county of Norrbotten. Two cases were detected through the ongoing national monitoring for CWD and a third was identified in local targeted surveillance.

The first case of Usutu virus in Sweden was found in 2019 in a blackbird from Öland. Surveillance for Usutu virus and West Nile virus was carried out through the summer half of the year within a citizen science project. There was a good response regarding reporting and submission of dead birds.

A major outbreak of the bacterial disease tularemia was noted during the summer and autumn, with numerous reports of dead hares and multiple confirmed positive hares submitted to SVA. Many human cases of tularemia were also diagnosed during this time period. The last time there was a major outbreak of tularemia in both hares and humans was in 2015.

Three cases of CWD were detected in older female moose in 2019. The moose in the photo, however, is healthy. Photo: Ulla Johansson.

Wildlife disease surveillance in Sweden

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 2019.

General wildlife disease surveillance 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 monitoring 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 2019, the Council consisted of Klas Allander, Per Risberg and Ola Inghe from the EPA, and Dolores Gavier-Widén, Erik Ågren, and Aleksija Neimanis from SVA. Henrik Uhlhorn, SVA serves as secretary. In 2019, the council held two meetings.

*Greenfinches (*Carduelis chloris*) on the necropsy table. Trichomoniasis is a common cause of disease in this species. Photo: Erik Ågren, SVA*

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 2019.

The annual state hunting and game management fee is 300 SEK for anyone who hunts or participates in hunting. Part of these funds goes to the Wildlife Conservation Fund, which in turn distributes grants for wildlife research. SVA's wildlife work is partly funded by this Fund.

The Swedish Environmental Protection Agency (EPA) funds the work with large predators, which amounted to 2.44 million SEK in 2019. 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 2019

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 2019

Erik Ågren. 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 Carnivore group.
Neele Doose. Veterinary Officer
Jasmine Stavenow. Biologist, MSc. Large Carnivore group.

Section of Research and Development 2019

Aleksija Neimanis. Head of Section. Veterinary Officer, BSc, MSc, MVetSci, PhD, DipACVP
Caroline Bröjer. Veterinary Officer, MSc, PhD, DipECZM (Wildlife population health)
Gete Hestvik. Veterinary Officer, PhD
Henrik Uhlhorn. Veterinary Officer, PhD
Emil Wikström. Laboratory veterinarian
Ulrika Larsson Pettersson. Biomedical analyst

Other employees involved in the wildlife work at the department and within SVA

Administrators Ewa Backman and Carina Bohlin. Necropsy assistants Hans Kanbjer, Johan Karevik, Lars Hammarsten. Technicians Marit Liljefors, Sandra Karevik, Katarina Jendelöv, Benny Eriksson, Anders Åslund. Biomedical analyst at the histological section Gudrun Andersson, Shaqe Hafstad, Mariam Kerro, Angelica Stefansdotter. Head of Department POV Dolores Gavier-Widén VMD, Associate Professor. Torsten Mörner, State Veterinarian in Wildlife Diseases, Associate Professor, Department of Disease Control and Epidemiology.

Staff at the wildlife section examine a wild boar. All dead wild boar are analyzed for African swine fever. It is important to report any found dead wild boar to be able to detect ASF as early as possible if introduced into the country. Photo: Erik Ågren, 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.

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 2019, 1,370 reports were received, compared with 357 reports the year before.

Major efforts have been made in the last two years to disseminate information about rapporteravilt.sva.se to hunters and the general public, as surveillance is based on citizen science. Ideally, everyone should know that SVA works with wildlife. They should know how to report observations, or at least be able to easily find rapporteravilt.sva.se in an online search.

In 2019, rapporteravilt.sva.se was used to generate a real-time map of the tularemia outbreak on the SVA website. It showed where and when cases of dead hares were reported, and for hares submitted, whether or not they were positive for this disease.

An improved version of the form is planned for 2020 to add additional wildlife diseases, and to use interactive data dashboards to show statistics and disease data.

2019:

1 370

reports

Wildlife cases 2019

NUMBER OF WILD ANIMALS OR PARTS OF ANIMALS RECEIVED IN 2019

A total of 2,452 wildlife cases were submitted in 2019 from the following groups: mammals (1,544), birds (888), reptiles (13) and amphibians (7). Not all animals received could be examined, and other cases were used for several different studies and analyses.

Mammals	Number
Total mammals	**1544**
Brown bear	368
Moose	212
Muskrat	152
Lynx	141
European brown hare	127
Otter	86
Roe deer	68
Grey seal	59
Wild boar	56
Mountain hare	48
Harbour seal	33
Bat	32
Wolf	28
Red fox	23
Porpoise	17
Red squirrel	16
Fallow deer	14
Wild rabbit	12
Hedgehog	11
Wolverine	11
Red deer	5
Badger	4
Hare (unknown), Dog, Ferret, Beaked Whale, Mouse	2
Arctic Fox, Chipmunk, Mole, House mouse, Raccoon Dog, Stone marten, Pig, Ringed seal	1

Amphibians	Number
Total amphibians	**7**
European green toad	5
Common toad	1
Edible frog	1

Reptiles	Number
Total reptiles	**13**
Red-eared slider	9
Yellow-bellied slider	4

Birds	Number
Total birds	**888**
Blackbird	202
White-tailed eagle	114
Jackdaw	73
Great grey owl	33
Wood pigeon	32
Song thrush	29
Greenfinch	26
Ural owl	25
Golden eagle	24
Goshawk, Sparrowhawk	20
Rock pigeon	18
Tawny owl, Buzzard, Kestrel	15
Eagle wwl, Chaffinch, Magpie	14
Redpoll	13
Bullfinch	12
Duva	11
Yellow hammer	8
House sparrow, Peregrine falcon	7
Fieldfare, Mute swan, Barn Swallow, Rook	6
Pheasant, Black-headed gull, Hawfinch, Great spotted woodpecker, Great tit	5
Herring gull, Long-eared owl, Northern hawk owl, Cormorant	4
Osprey, Mallard, Cuckoo, Kingfisher, Waxwing	3
Blue tit, Eider, European green woodpecker, Eurasian siskin, Grey heron, Crow, Eurasian hobby, Red kite, Robin, Starling, Black and White Flycatcher, Barnacle goose	2
Marsh harrier, Common sandpiper, Common gull, Common tern, Greylag goose, Grey-headed woodpecker, Canada goose, Raven, Woodcock, Tree sparrow, Tengmalms´s owl, Redwing Common moorhen, Coot, Goldfinch, Merlin, Trumpeter swan, Swift, Three-toed woodpecker, Red-backed shrike, Common whitethroat	1

Wildlife species investigated 2019

WHICH SPECIES ARE EXAMINED?

SVA investigates all wildlife species, but legislation on mandatory submission of protected species and targeted project sampling resulted in submission of some species more often than others within the wildlife disease surveillance programme.

Lynx and **brown bear** cases, just like in previous years, were numerous. This is because all animals harvested in the annual licensed hunt are sampled by inspectors in the field or by SVA. Collection of biological data such as weight, measurements and age increases our knowledge about these species. Tissue samples are collected, examined, and stored in a tissue bank freezer for future research.

Moose submissions were high in 2019 as a result of the national monitoring of chronic wasting disease (CWD). In total, 212 moose were sampled or submitted to SVA this year. An additional 400 CWD-samples were submitted from hunter harvested moose for intensified monitoring of CWD in Arvidsjaur and Arjeplog municipalities.

Muskrats were submitted in high numbers in 2019. The Swedish EPA is funding a project to eradicate the relatively small remnant population of this invasive alien species in Sweden. All culled animals have been sent to SVA for health screening and targeted disease surveillance. One culled **chipmunk** was also examined as a listed invasive alien species. **Stone marten** have begun to appear in Sweden and have been caught in marten traps. The Museum of Natural History is interested in specimens from this new, introduced species for its collections.

Grey seal and **harbour seal** samples were primarily submitted by staff at the Museum of Natural History (NRM) within collaborative projects for disease screening. The NRM work mainly with the effects of environmental contaminants on seals.

Some odd animal species were also examined. For example, the decomposed remains of two **dogs**, were submitted for species determination (dog or wolf ?). Both were dogs. Bones from a **pig** were submitted to screen for African swine fever virus.

Blackbirds and other thrushes were numerous in 2019 as SVA had a call out to screen cases for usutuvirus and West Nile fever virus.

White-tailed eagles and **golden eagles** are common submissions to SVA as they are State Wildlife, like large owls.

Adult white-tailed eagle on a necropsy table. Common causes of death include lead poisoning following consumption of hunting offal, and train collisions. Photo: Erik Ågren, SVA.

Wildlife diseases in focus 2019

CWD – A NEW WILDLIFE DISEASE IN SWEDEN 2019

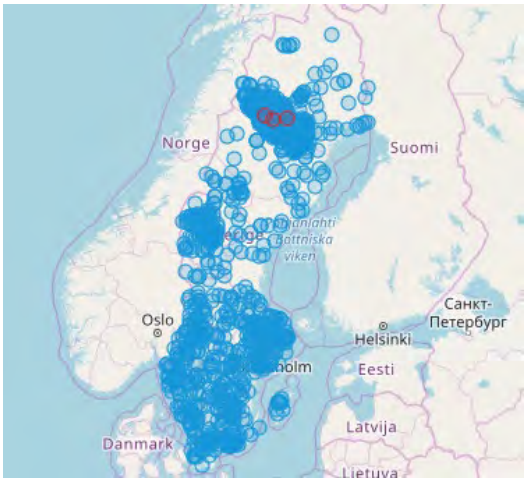
CWD - *Chronic wasting disease* is a prion disease that only affects cervids and has been present in North America for 50 years. In April 2016, CWD was found for the first time ever in Europe, in a sick wild reindeer in southern Norway. In Sweden, the first cases of CWD were detected in three moose in 2019.

CWD in Norway, the first cases in Europe. Quite unexpectedly, CWD was found in a wild reindeer in Norway in 2016. To eradicate this infectious variant of CWD in Norway, restriction zones were established for the Nordfjella wild reindeer management area where the infection was detected. Specific regulations regarding hunting and handling of carcasses and slaughterhouse waste were introduced. Within the zones, all dead or culled cervids have been tested and special restrictions apply to feeding and use of salt licks. Since CWD affected only one herd of the wild reindeer population, the entire wild reindeer herd there was culled by 2018. The area is now to be kept empty of cervids for at least five years before restocking with genetically similar wild reindeer from nearby herds. Across Norway, more than 100,000 cervids have now been examined for CWD since 2016. A total of 26 CWD-positive animals have been found in Norway until 2019; six moose, nineteen wild reindeer and one red deer. However, Norwegian researchers have shown that CWD in moose and red deer differs from the infectious variant of CWD seen in the wild reindeer and in deer in North America, and appears to be a different, possibly more spontaneous or sporadic variant of the disease. The Veterinary Institute in Norway continuously presents the results of the their CWD monitoring on their website http://apps.vetinst.no/skrantesykestatistikk/NO/.

The European Commission decided how CWD was to be monitored for the six Member States concerned (EU 2017/1972) in the autumn of 2017. Sweden, Finland, Estonia, Latvia, Lithuania and Poland have moose or reindeer, and each country shall examine at least 6 000 cervids over a three-year period, between 2018 and 2020.

In 2017, SVA developed a monitoring plan for Sweden. The plan was based on data from SLU regarding the size and geographical distribution of the populations of different cervid species, work funded by the Swedish Environmental Protection Agency.

SVA together with the Swedish Board of Agriculture carry out the monitoring of CWD in Sweden. To monitor the entire country, the 6,000 samples to be taken have been distributed by county and municipality, depending on the deer species found in the different regions and the estimated density. The priority is to sample so-called **risk animals**, i.e. animals that show signs of disease or changes that may indicate CWD. Cases that show signs of brain lesions are of greatest interest to investigate. Any found dead adult cervid is also sampled. To obtain sufficient numbers of samples from all areas, hunters within the National Wildlife Traffic Accident Council and reindeer owners can contribute with samples from road- or train-killed cervids, as these are also counted as at-risk animals.



Map of the CWD monitoring in Sweden. Three red rings are positive moose, blue are negative samples. For details see www.cwd.se

Monitoring of CWD in Sweden began after the first discovery of CWD in Norway in 2016. Only limited monitoring had been carried out since 2008 because no positive cases had been detected within the EU. From 2016, all found dead, euthanised and traffic-killed adult cervids submitted to SVA have been investigated for CWD. The EU monitoring 2018 - 2020 also includes farmed red deer and semi-domesticated reindeer.

The Swedish monitoring can be followed on SVA's website, with direct access from www.cwd.se, where the map and tables are updated continuously as samples are analyzed. Targeted CWD monitoring efforts in Sweden involved sampling hunter harvested moose in the county of Jämtland in 2017 and an increased monitoring in the county of Norrbotten in 2019 where positive cases were found.

Number of wild cervids in the category "at risk" examined for CWD at SVA in 2019 and number of positive cases. Fallow deer are not included in the EU monitoring but are sampled if there is clinical suspicion of CWD.

Species	2019	CWD positive
Moose	193	3
Roe deer	73	0
Red deer	31	0
Fallow deer	5	0
Total	**301**	**3**

A CWD sample of the brainstem is taken from the caudal aspect of the skull (from the Foramen magnum*) of a moose head. Photo: SVA*

The first two cases of CWD in Sweden were found within the CWD monitoring program. The first positive case was found in March 2019. It was a 16 year-old, very thin female moose that walked in circles on an iced-over lake and appeared to be blind, signs which also could be typical of an advanced stage of CWD. The moose was euthanized by local hunters in Arjeplog. The head was sent to SVA for analysis and the sample from the brainstem was positive for CWD, but the lymph nodes from the head were negative. In May 2019, the second case of CWD was found. It was almost identical to the first case; a 16 year-old, thin female moose with altered behavior. This moose cow was found and killed within Arvidsjaur, a neighbouring municipality with Arjeplog.

No cases of CWD have yet been detected in semi-domesticated reindeer, roedeer or red deer in Sweden up to and including 2019.

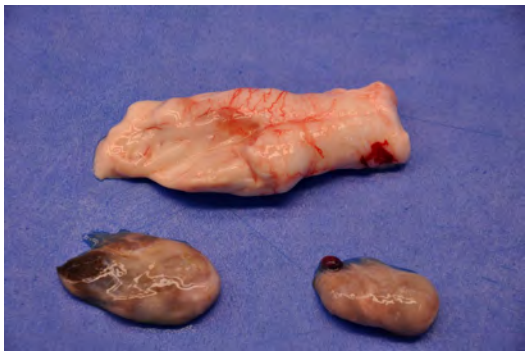
Increased surveillance in Norrbotten 2019. As a result of these two findings of CWD in moose, the Swedish Board of Agriculture (SBA) ordered increased surveillance in the municipalities of Arjeplog and Arvidsjaur during the moose hunt and reindeer slaughter in the autumn and winter of 2019. The aim was to sample as many adult hunter-harvested moose as possible to get a better picture of the CWD situation in the area. Is the disease widespread? Is it only older moose that are affected? And only females? What is the sex and age distribution of the moose population in the area? Is CWD present in reindeer or the few roe deer that share pastures with the moose? Many questions that need answers!

SVA sampling kit for CWD, with gloves, sampling spoon, tubes, envelopes, form, etc., are distributed to hunters who are willing to contribute to the surveillance of CWD.

Prior to the increased monitoring effort, SVA and the SBA informed and organized training sessions for hunters in Arvidsjaur and Arjeplog, with fantastic help from representatives of the Swedish Hunting and Wildlife Management Association in the county. There was an opportunity to practice CWD sampling (brain and lymph nodes) from animal heads, and kits for sampling were distributed.

Training opportunity in Lycksele in connection with the conference of Swedish Hunting and Wildlife Management Association chairs in Västerbotten. Photo: Anja Kjellsson.

Thanks to the effort of the hunters, a total of 420 moose from Arjeplog and 209 from Arvidsjaur were sent to SVA for analysis. This corresponds to about 65 percent of all adult harvested moose from the area in 2019, which is a fantastic result and a magnificent effort! The hunters took samples, packed and shipped the samples in padded envelopes, as did the staff at game management facilities that received harvested moose from the surveillance area.



Samples for CWD surveillance, brain stem and two lymph nodes from the oropharynx of a moose. Samples are easier to ship compared to whole heads. Photo: SVA.

For sampling of reindeer from the area, samples were mainly taken at slaughterhouses by hired staff. Taking samples from harvested moose and reindeer slaughter meant that transport of samples, analyses and test results had to be done in as short a time as possible, since the recommendation of the authorities is to not eat of the meat before there is a negative test result. As a precautionary principle, meat from an animal carrying CWD prions should not be eaten, even if CWD has not been detected in humans.

In September, the third case of CWD in Sweden was found in a 10 year-old hunter harvested female moose from Arjeplog, within the extended regional surveillance. This moose was not emaciated and had not shown any obvious signs of disease when it was harvested. None of the reindeer tested at in 2019 have been positive for CWD.

To understand more about CWD found in moose and which animals in the moose population are affected, age determination of a number of moose sampled during the hunt was done by counting the annual rings in the cement layers of tooth roots. The assessed age is then also communicated to the hunter who has submitted the sample.

Moose from the increased surveillance are aged by sectioning of a tooth root to study the age distribution. Photo: Erik Ågren, SVA.

Contagious or sporadic variant?

CWD disease is caused by prions. It occurs when normal prion proteins are misfolded and cannot be broken down, and instead accumulate in tissues, especially in the brain. With time, the accumulated prions gradually lead to increasing brain damage and symptoms such as wasting, salivation and behavioral changes. The disease always leads to death, and there is no vaccine or cure.

The structure of the misfolded prion proteins can vary and therefore there are different types of prion diseases and different variants of the disease. In the case of CWD, both infectious and sporadic variants are discussed, the latter also referred to as spontaneous or an atypical variant.

The three CWD positive Swedish moose were all older females and prions were only detected in brain stem and brain, but not in lymph nodes. This suggests that prions were not present outside the brain and spinal cord. This is similar to the few other cases of atypical CWD detected in moose in Norway and one case in Finland. However, both the Norwegian wild reindeer in Nordfjella and in CWD-positive cervids in North America have a contagious variant of CWD. In these cases, the diseased animal secretes prions in the saliva, faeces and urine, causing a sick animal to infect other animals by direct contact and indirectly when the environment is contaminated. Prions survive for many years in the environment as they are very resistant to degradation.

For cases with clinical suspicion of CWD, it is advantageous to receive the whole head for examination to have more material to investigate if the test is positive. Photo: Erik Ågren, SVA

It is suggested that CWD in moose in Sweden may be an atypical or sporadic variant that occurs spontaneously, possibly as an age-related and perhaps less contagious variant of the disease. The fact that all three Swedish cases in 2019 were found within about 80 km of each other is notable. To better understand CWD in moose and ascertain what variant of the disease they have, many more animals need to be analyzed. Further investigations of samples from CWD-positive moose are ongoing, in collaboration with researchers in Norway and several other countries.

CWD.SE

Communication

The SVA website www.cwd.se provides updated information about CWD and a map and tables that are continuously updated to show the ongoing CWD-surveillance in Sweden.

In collaboration with Andreas Norin (Pantheon Film & Fotografi AB), two information films were created, one on the surveillance of CWD and how to take samples, and one about CWD, the disease. The videos are available on Youtube and on the SVA website.

There are also several other short instructional videos available on Youtube, on how to take CWD tissue samples from a dead cervid.

To inform about the national CWD surveillance based on at-risk animals and to obtain reports and samples from appropriate cases from all over the country, SVA has continuously distributed information in various forms of media and through lectures and visits. SVA participated in the two major game fairs in 2019, both Tullgarn Game Fair and ELMIA Game Fair where we informed and answered questions from visitors about CWD and other wildlife diseases.

The Swedish Hunting and Wildlife Management Association invited SVA to a conference in November 2019 in Lycksele. A lecture on CWD was followed by practical training of the participants in how to take CWD samples from a moose head.

The crucial role of hunters

The CWD surveillance can only be carried out with involvement from hunters and other wildlife enthusiasts who submit samples for analysis. We would like to thank the Swedish Hunting and Wildlife Management Association, the Jägarnas Riksförbund Hunting Association and the hunters of the National Wildlife Traffic Accident Council, the County administrative boards, as well as all private efforts for all the help we have received so far and hope for continued interest and cooperation in the future to continue surveillance for CWD. The Swedish surveillance focuses primarily on at-risk animals to increase the chance of finding cases with CWD. Since we do not sample hunter-harvested animals within the national surveillance, the target number of samples has not been reached quite yet.

The CWD-moose, a USB memory stick give-away, to encourage participation of the CWD surveillance!

The Swedish Board of Agriculture and SVA held an information meeting regarding the increased monitoring of CWD during the moose hunt in Arjeplog and Arvidsjaur 2019, with training in sampling techniques for hunters and reindeer herders. The meeting was organized by the local representatives of the Swedish Association of hunting and wildlife management. Photo: Erik Ågren, SVA.

FACTS: SAMPLING FOR CWD

- Only **adult animals** are sampled, to increase the chance of finding positive cases.
- The **brain stem** and pharyngeal **lymph nodes** are needed for the analyses.
- Lymph nodes are analyzed to indicate if it is a more **contagious variant** of the disease.
- The **whole head** can be sent to SVA if you find a dead cervid or euthanize a sick cervid but cannot take samples yourself.
- **Always contact SVA** to discuss if a case is suitable to sample, what material can be submitted, and how it should be packed and shipped.
- Order **sampling kits** from SVA, see info www.cwd.se

Interesting findings in moose heads

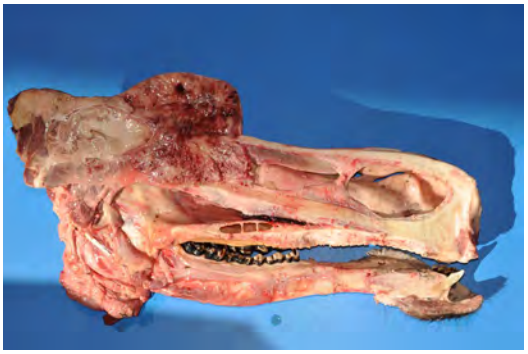
Although the majority of moose skulls from were negative for CWD, the increased number of cases investigated in 2019 contributed to the general wildlife disease surveillance program as other diseases and changes were detected.

Examples of diseases that have been detected are several cases of ethmoidal tumors in the nasal cavity, malformations, and age-related cataracts that cause opaque eye lenses leading to blindness, the presence of nasal bots (larvae of the bot fly *Cephenemyia ulrichii),* and incidental findings of small twigs in salivary gland ducts with formation of sialoliths (salivary stones).

2020

Continued national surveillance

The EU regulated CWD monitoring will continue until 31 December 2020. After this, CWD will be monitored, but the details and scope will be discussed and decided in cooperation with the Swedish Board of Agriculture.



Moose head, split midline. In the forehead, a large ethmoidal tumor is seen emanating from the nasal cavity, perforating bone. Photo:SVA.

Malformation of the maxilla of a female moose. Photo: SVA

Oral cavity, moose. The inside of the cheek with a couple of small twigs in the salivary gland duct (arrow). White mineral deposits cause widening of the duct. Photo: Erik Ågren, SVA.

Plague in Sweden?

Several diseases that affect many individuals have historically been called "plagues". These diseases can be caused by either bacteria or viruses. Here are some plague diseases that we monitor in Sweden.

AFRICAN SWINE FEVER

African swine fever (ASF) is a serious viral disease affecting only wild boar and domestic swine. The disease has **not** yet been found in Sweden but monitoring and preparedness for this disease is very important for early detection if introduced into the country. Since ASF was introduced to Europe via Georgia in 2007, the disease has spread via Russia to our immediate area and is now present in the Baltic states, Poland, and Belgium. In 2019, 37 dead or sick, euthanized wild boars have been examined for African swine fever; all were negative. Three of the animals were investigated as clinical suspicions of ASF.

Dead wild boar. To detect a possible introduction of ASF as early as possible, it is important to report any found dead wild boar so that it can be tested for the virus. Photo: Erik Ågren, SVA

There are EU regulations on how to combat ASF if it is detected. The Swedish Board of Agriculture (SBA) is responsible for coordinating the management of a ASF outbreak. SVA has an ASF expert group, which contributes with expertise to the SBA, to assess and, if necessary, propose measures to prevent the introduction and spread of ASF in Sweden. SVA has also contributed to the planning and implementation of the SBA´s collaborative exercise "Gyllenborste", (the Norse god Frej's boar), focusing on ASF in wild boar. An outbreak of ASF causes a major impact regionally as well as at a national level, which is why early detection is so important! Do report all found dead wild boar, so they can be tested! Feel free to use the web form **rapporteravilt.sva.se**

Research

Since 2017 there is a FORMAS funded research project to develop a model to simulate the spread of ASF among Swedish wild boar and to study the effect of different control methods.

A research project funded by the Swedish Foundation for Agricultural since 2018 is aiming to increase knowledge about direct and indirect contacts between domestic pigs and wild boar and how to best prevent them. Both projects are in collaboration with, among others, the Swedish University of Agricultural Sciences (SLU).

Tularemia, the great outbreak in 2019

The outbreak of tularemia in 2019 was the largest in 50 years. Also called rabbit fever, this bacterial so-called plague disease (in Swedish "hare plague") has been detected in animals and humans since 1911 and is endemic to Sweden.

OF HARES AND MEN

In the summer and autumn of 2019 there was a large outbreak of tularemia in Sweden, mainly in northern and central Sweden, but cases in hares were noted as far south as the county of Blekinge. Over the past 20 years, tularemia has spread south, both in hares and humans.

The Public Health Agency noted 1,048 humans with tularemia in 2019. 619 reports of dead hares were received to SVA and the public contributed with submissions of hare carcasses for diagnostics. A total of 172 hares (128 European brown hares and 48 mountain hares) were examined in 2019. Tularemia was confirmed in 27 brown hares and 31 mountain hares.

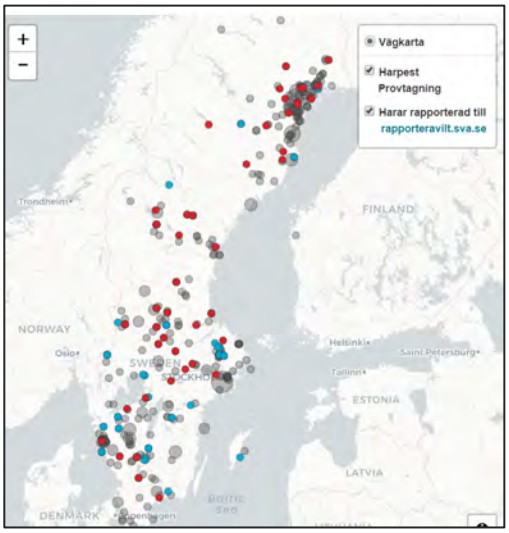
Dead mountain hare late summer 2019. Most hares examined at SVA at that time of year had died of tularemia. Photo: Stefan Vallin

Tularemia is caused by the bacterium *Francisella tularensis* and can affect many animal species, as well as humans. Outbreaks are usually characterized by finding increased numbers of dead hares, as they usually die of acutely of septicaemia. During normal years, SVA confirms single cases in hares throughout the year and in different parts of Sweden, but the disease is more common in the northern and central parts of the country.

Every few years, there are large outbreaks with increased numbers of dead hares and affected humans. Small rodents are also very sensitive and die acutely but are not observed or found as easily as dead hares.

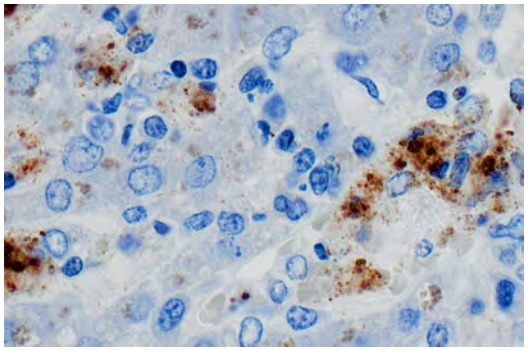
Tularemia in animals and humans is notifiable. This provides disease statistics and a good geographical and temporal overview of tularemia. In outbreaks, many dead hares are often reported, but few are submitted for diagnostics.

In early June 2019, there were several cases of tularemia in hares in southeastern Norway, near the border to Sweden. At the same time, a case was found in Gothenburg. The number of cases gradually increased during the summer to reach a peak in August and September. Most tularemia cases were found in the northern half of Sweden, but there were cases found in all counties in northern and central Sweden. Their distribution can be viewed on an online map.



Map of Sweden with reported dead hares. Grey dots are reports only, red dots are examined positive cases, blue are examined negative cases. SVA map available online: https://sva.se/djurhalsa/smittlage/karta-over-harpest/.

The statistics of the Public Health Agency show an outbreak curve in humans similar to the hare cases, with most cases in the summer and autumn, and cases were also seen in the southern counties. The highest number of cases of human cases were in Dalarna (336) and Gävleborg (231), but also many in the counties of Norrbotten, Västerbotten, Jämtland, Västernorrland, Stockholm, Örebro, Värmland and Västra Götaland. In 2019, at least one case of human harpest was confirmed in all 21 counties of Sweden. For each outbreak in the last 10 years, the number of cases observed in humans has been higher than in the previous outbreak.



Microscopic image (immunohistochemistry) of tularemia bacteria (brown stain) in liver tissue from a positive hare. Photo: G. Hestvik SVA

Myxomatosis

Myxomatosis is called rabbit plague in Swedish, and is a plague caused by a virus (*Leporipoxvirus*). Since only rabbits are affected by this disease, this myxomatosis virus historically was deliberately released in attempts to eradicate rabbit populations that have grown too large in Australia and in Europe. However, some rabbits always survive, and after a few years, the populations recover, but the disease becomes endemic with irregular outbreaks.

In Sweden, myxomatosis has been present since the 1960´s, and there are cases recorded most years, but in varying numbers. Regions are variably affected, depending on the size of the local rabbit population. Myxomatosis is strongly suspected when rabbits are observed having swollen eyelids and ophthalmitis and are apathetic. The disease causes suffering and a large proportion of affected animals die.

In 2019, SVA received many reports of suspected cases from the southernmost counties and the island of Gotland, areas where the wild rabbit is well established, but few animals were examined at SVA. The diagnosis was confirmed in 2019 only in two wild rabbits, one from Stockholm and one from the county of Halland.

Wild rabbit with myxomatosis, Torekov, Skåne. Photo: A-M. Steinmann

EBHS

In 2019, European brown hares were affected not only by tularemia, but also by a large outbreak of European brown hare syndrome (EBHS) caused by a lagovirus. This disease has been known since the 1980's and causes severe liver damage and acute death in hares. In the past 10 years, only few cases of this disease have been observed in dead hares examined at SVA. In 2019, a large number of cases (46) were found, all from the southern half of the country up to Uppsala and Värmland. The outbreak began with single cases in the spring, with increasing numbers during the summer. A significantly larger number of cases were found September-November, before decreasing slightly in December. Cases have continued to be diagnosed also in early 2020, but in declining numbers.

Infections in passerines

Birds can carry various infectious agents which sometimes cause disease with spillover to other animals or humans. This is usually associated with bird feeding.

SALMONELLOSIS

Salmonella bacteria cause inflammation of the throat and crop, and often septicemia in passerines. *Salmonella* Typhimurium is the usual cause of annual outbreaks in late winter around bird feeders. In February 2019, mortality was reported especially among siskins, bull finches and yellow hammers in central Sweden and Västernorrland. Cats that prey on sick birds can contract salmonellosis. More than 1,000 cats with salmonellosis were confirmed between January and March 2019.

Cats preying on sick passerines may also contract salmonellosis. Photo: V. Vasiliy.

From December 2018 to January 2019, between 100 - 200 jackdaws died in a local outbreak of salmonellosis in the municipality of Uddevalla. *Salmonella* Hessarek was the cause of the mortality. This is the first confirmed disease outbreak in wild birds in Sweden with this type of Salmonella, but a few outbreaks have previously been reported in thrushes and starlings in southern Europe.

*In 2019 there was an outbreak of mortality in Jackdaws (*Corvus monedula*) caused by Salmonella* Hessarek. *Photo: SVA*

FLAVIVIRUS

Usutu virus is a mosquito-borne flavivirus that mainly affects thrushes and some other species. The virus has spread north in Europe in recent years. In 2019, SVA asked the public to submit dead passerines, in particular thrushes, for targeted monitoring of Usutu virus and another flavivirus; West Nile virus, which causes disease and death in birds, horses, and sometimes also in humans. In 2019, the first and thus far only case of Usutu virus in a bird was a dead blackbird from the island of Öland, in July.

*The first bird detected with Usutu virus in Sweden was a blackbird (*Turdus merula*) in July 2019. Photo: Arenysam.*

TRICHOMONIASIS

Trichomoniasis is a disease of pigeons and passerines, especially greenfinches and other finches, and is caused by infection with single-cell *Trichonomas gallinae* parasites. In November 2019, this parasite caused a large mortality in common wood pigeons (*Columba palumbus*) in Malmö.

Common wood pigeons can carry single-cell Trichomonas *parasites in the pharynx without symptoms, but occasionally they are clinically affected. Photo: R. Christiaans.*

PSITTACOSIS

Psittacosis or ornithosis is caused by a chlamydia bacteria, *Chlamydia psittaci*. In 2019, approximately twice as many cases were seen in humans (77) as normal years. The increase may have been biased by a change in diagnostic protocols, but studies have shown a link between psittacosis in humans and contacts with passerines in connection with bird feeding. This stresses the importance of good hand hygiene when cleaning and handling bird feeders, and to avoid inhaling dust and dried bird feces from feeders or feeding sites.

How common Chlamydia infection is in Swedish garden birds is not clear, but studies in other European countries suggest that it may be more common than previously estimated. SVA received funding from the Swedish Environmental Protection Agency for the screening of presence of psittacosis within the general wildlife disease surveillance, which is reported separately in this report.

PIGEON PARAMYXOVIRUS

Pigeon paramyxovirus causes inflammation in birds. When the brain is affected, abnormal behavior with ataxia is observed. This virus is highly contagious and can cause a serious disease in poultry. Therefore, the disease is notifiable and when the infection is detected in wild pigeons, domestic birds are to be kept indoors to avoid infection. In 2019, outbreaks of pigeon paramyxovirus were recorded in rock pigeons in the county of Örebro in October. Suspected cases were reported, but could not be confirmed, from Stockholm and Gothenburg in September, Kalmar and Uppsala in October, Linköping in November and Svedala, Ljungby, and Landskrona in December. Monitoring is limited if there are only reports of single sick birds. When large numbers of affected wild birds are noted in areas where infection has not been detected before, analyses are done to confirm infection in order to protect domestic poultry in the area.

CORVIDS CARRY CAMPYLOBACTER

In a survey of corvids shot in hunts adjacent to farms with domestic animal herds, SVA looked for bacteria that can cause disease in humans. The results showed that campylobacter (*C. jejuni*) were found in the intestines in 82% of 66 corvids of different species. Occasional birds also carried Yersinia bacteria in intestinal samples, but none carried Salmonella bacteria. However, most cases of campylobacter infection in humans can be attributed to handling chicken meat for consumption. The article is available at: https://doi.org/10.1080/20008686.2019.1701399

Corvids, such as this crow, found around animal farms can carry the same types of intestinal bacteria found in domestic animals. Photo: Per Grunditz

Reported wildlife diseases 2019

Some wildlife infections are reportable when diagnosed by a laboratory. The table below lists the diseases or disease agents reported in 2019. Hares were particularly affected in 2019 with outbreaks of both the bacterial disease tularemia and the viral disease European brown hare syndrome.

Of the wildlife cases examined in 2019, the finding of chronic wasting disease (CWD) in three moose in the county of Norrbotten was the most significant. CWD is a deadly and untreatable disease and it is still unclear how widespread the disease is and what the future consequences are for the Swedish moose population.

The number of cases of reported diseases in wildlife only reflects the number of diagnoses made in cases sent to SVA or occasionally to another laboratory. The total number of wild animals affected by a disease cannot be determined. In major outbreaks, an increased number of reports and samples are usually received at SVA. By investigating suspected cases of disease, we get an indication of what diseases normally occur in the country, and if they are increasing or decreasing – if the monitoring efforts are similar from year to year. It is especially important to confirm if new diseases are introduced in the country.

The number of positive cases of OIE-listed diseases detected in wildlife diagnosed in laboratories in the country in 2019 and reported to the Swedish Board of Agriculture. Source: SVA Laboratory Data System SVALA.

Disease 2019	Cases	Species
Avian mycobacteriosis	1	Buzzard
Avian pox	1	Bullfinch
CWD	3	Moose
European brown hare syndrome	44	European brown hare
Myxomatosis	2	Wild rabbit
Pigeon paramyxomvirus	19	Pigeon
Poisoning	22	Greylag goose 1, White-tailed eagle 19, Hedgehog 1, Golden eagle 1
Rabbit viral hemorrhagic disease	4	Wild rabbit
Salmonellosis	35	Bullfinch 10, Siskin 10, Greenfinch 1, Jackdaw 14
Sarcoptic mange	11	Lynx 7, Red fox 2, Wolf 2
Toxoplasmosis	1	European brown hare
Trichinosis	14	Lynx 6, Wolf 2, Wild boar 6 (5 confirmed 2019, 1 in January 2020)
Trichomoniasis	18	Greenfinch 2, Common wood pigeon 16
Tularemia	58	European brown hare 27, Mountain hare 31
Total	**233**	

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 Swedish Board of Agriculture report annually or biannually on the number of detected cases of these diseases in both domestic animals and wild animals to the OIE - the World Health Organisation for Animal Health, an international body that monitors and annually compiles important animal diseases that have been diagnosed around the world (oie.int). In addition to diseases listed in Regulations K4, there is also a OIE list of other wildlife diseases and infectious diseases in wild animals that are of interest to follow, see link https://www.oie.int/wahis_2/public/wahidwild.php/Diseaseinformation/popup/diseaselist.

Active wildlife disease surveillance 2019

Some active studies are done to monitor whether an infection exists in the country or not.

INFECTIOUS AGENTS IN WILD BOAR

In addition to the general surveillance of African swine fever in wild boar found as fallen game, 104 samples from hunter harvested wild boar were also analysed. The samples were submitted to SVA by helpful hunters for the monitoring of important infectious agents affecting wild boars, domestic pigs and sometimes humans. All samples in 2019 were negative for the viral diseases classical swine fever and pseudorabies (Aujeszky's disease).

TRICHINELLA

Trichinosis is 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.

Testing for Trichinella must be done on all wild boar harvested to ensure a safe food. Photo: Erik Ågren

In 2015 – 2019, a total of 61 Trichinella-positive wild animals were found, relatively evenly distributed over the years. The exception is 2015, when no samples from lynx were tested.

Wild boar and brown bear are to be tested for Trichinella if the meat is to be sold. This provides good monitoring of Trichinella infection in these game species, which when combined, cover most of the country. SVA is one of several laboratories that conduct Trichinella analyses and therefore the total number of analyses in Sweden takes time to compile. However, any positive finding has to be sent to the national reference laboratory SVA. The table below therefore shows the number of positive Trichinella findings for bears and wild boars, but not the number of samples examined. All Trichinella findings in bears and wild boar were in hunter harvested animals. During these five years, around 250-300 bears per year and around 100,000 wild boar were shot annually. The figures give an idea of how rare Trichinella is in Swedish wildlife.

Other species. In addition to the species listed in the table below, one wolverine, one raccoon dog, one stone marten, four badgers, two seals and 61 birds of prey have also been examined for Trichinella in 2019. All of these were negative.

Table. Compilation of positive Trichinella wildlife cases in Sweden 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 are analysed in different laboratories. Positive results should always be reported and submitted to SVA, the national reference laboratory.*
***6 wild boar harvested in 2019 were positive for Trichinella, but a reference sample for the sixth case was not received by SVA until January 2020.*

Species	2015	2016	2017	2018	2019	Total
Lynx	0 (0)	7 (103)	4 (80)	6 (53)	6 (129)	**23**
Raccoon dog	0 (0)	0 (0)	0 (0)	1 (21)	0 (1)	**1**
Red fox	0 (2)	1 (55)	0 (0)	0 (0)	0 (11)	**1**
Wolf	0 (46)	3 (43)	1 (45)	3 (17)	2 (14)	**9**
Wild boar*	1 (89 497)	3 (91 289)	7 (111 845)	9 (106 055)	5** (~138 500)	**25**
Brown bear*	1 (180)	1 (225)	0 (180)	0 (232)	0 (219)	**2**
Total	**2**	**15**	**12**	**19**	**13**	**61**

AVIAN FLU

Wild birds necropsied at SVA are routinely examined whenever possible for the presence of avian influenza viruses. This is funded by the Swedish Board of Agriculture, which then reports the results to the EU. In 2019, 454 wild birds of 65 different species were examined. No case of highly pathogenic avian influenza was detected among these birds. Low pathogenic avian influenza that was not further typed was found in a Herring gull from Skåne, a Rock pigeon from Västra Götaland, and also a White tailed eagle that was examined in 2019, but which had been stored frozen since 2018.

Table. Birds investigated for avian influenza in 2019 (all negative for highly pathogenic influenza).

Avian	Number tested
Passerines	180
Raptors	237
Ducks	20
Gulls	11
Waders	5
Field birds	1
Total	**454**

Eagles are always sampled for avian flu before the necropsy at SVA. No highly pathogenic influenza was found in 2019. Photo: Erik Ågren, SVA.

ALVEOLAR ECHINOCCOCOSIS

Wolves examined at SVA are routinely analyzed for the fox tapeworm, *Echinococcus multilocularis (E.m.)*. None of the 22 wolves examined in 2019 carried this tapeworm. There was no targeted surveillance of *E.m.* in red foxes in 2019, but two single submitted fox scats tested negative.

The red fox is the normal main host for the fox tapeworm Echinococcus multilocularis. *Even dogs, wolves, and raccoon dogs can carry this 3 mm long intestinal parasite. The microscopic eggs of the tapeworm are deposited with the feces of the fox into the environment. Intermediate hosts are usually small rodents that eat the eggs during foraging and when infected they suffer from the larval stage that usually destroys the liver of the rodent. Accidental ingestion of eggs by humans may cause infection and serious disease Photo: B. Balestri*

Surveillance & research projects in 2019

The Swedish Environmental Protection Agency has allocated funds that SVA can apply for for 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 bodies for examination as soon as possible. Below are the research and "acute" projects that have been ongoing during 2019.

PSITTACOSIS IN PASSERINES

Psittacosis is caused by the bacteria *Chlamydia psittaci*. Birds are the main reservoir, but also mammals, including humans, can be infected. The presence of this infection in wild birds in Sweden has not been extensively studied. Data from international studies suggest that psittacosis may be common in passerines. The number of cases of psittacosis in humans has increased in recent years in Sweden and there is often a link between infection and contact with bird feeders.

Chlamydia was found in six (2.2%) of 275 necropsied garden birds. Three great tits (*Parus major*), two rock pigeons and a common wood pigeon were positive, and psittacosis was assessed as the cause of death in three of the birds. The results were comparable to previous studies of droppings from wild Swedish birds.
Sick, wild garden birds, such as great tits and pigeons, pose a risk to humans and the results underline the importance of ensuring good hygiene when feeding birds.

*The common pigeon, or rock pigeon (*Columba livia*), can carry chlamydia. Wash your hands after handling bird feeders and bird tables! Photo: SVA*

WEST NILE FEVER VIRUS AND USUTU VIRUS

West Nile virus (WNV) and Usutu virus (USUV) are two closely related, mosquito-borne Flaviviruses that have birds as reservoirs and are spreading north throughout Europe. Both viruses cause serious disease and mortality in birds, in particular crows, birds of prey (mainly owls) and thrushes, while other species are infected without showing symptoms. Both viruses can infect humans, (i.e. they are zoonoses) and WNV can also infect other animal species, including horses.

Examining dead birds is an effective way to detect WNV and USUV. A public appeal resulted in 219 returned dead birds being examined for both viruses during the 2019 mosquito season. A blackbird that died on Öland at the end of July carried Usutu virus. This was the first finding of this virus in Sweden. Swabs from 171 live thrushes sampled during autumn migration were negative for USUV and WNV, as well as a few mosquitoes collected from the site of the blackbird. The USUV incidence in Sweden in 2019 was therefore interpreted as very limited and no cases of WNV were found.

The first positive case of usutuvirus was a blackbird found dead on Öland in July 2019. Photo: SVA

SEALS AS SENTINEL ANIMALS FOR ANTIBIOTIC RESISTENCE IN MARINE ENVIRONMENTS

*Harbour seal (*Phoca vitulina*). Photo: Karin Bernodt, SVA*

Antibiotics is one of the most important tools we have to combat infections in both animals and humans, but the presence of antibiotic-resistant bacteria is increasing globally. There are still large knowledge gaps regarding the spread of antibiotic-resistant bacteria in the environment. Seals have been used as sentinel animals for marine environments in various monitoring programs and are also suitable for studies of antibiotic resistance.

A 2009 study of intestines from 30 seals showed no signs of resistance in the indicator bacteria used for this form of monitoring: coliform bacteria and enterococci. In 2019, SVA together with the Swedish Museum of Natural History conducted a follow-up study on samples from 90 seals to assess the status of antibiotic resistance 10 years later. The result was reassuring in that for the most part, seals do not carry resistant bacteria in Sweden. However, two single cases of resistance were found in indicator bacteria in seals for the first time in Sweden, including the first finding of ESBL-binding *E. coli.* The two positive seals were both found in proximity to human settlements, which may have increased the risk of contact with antibiotic-resistant bacteria.

HEALTH MONITORING OF MUSKRATS - HAS TULAREMIA DECIMATED THE POPULATION?

The muskrat *(Ondatra zibethicus)* is a large rodent that lives in lakes, streams, and coastal areas. In Sweden, the population has decreased in recent decades and now only exists in Västernorrland. There has been speculation over whether the decline has been caused by a disease. In North America, where the muskrat is spread over large geographical areas, tularemia is not uncommon. This disease is caused by the bacterium *Francisella tularensis*. Tularemia is relatively common in the muskrat range in Sweden so in 2019, SVA investigated whether this disease could be the cause of the population decrease here.

In August 2017, the muskrat was listed by the EU as an alien invasive species. In 2018 and 2019, many muskrats were culled in Sweden. The carcasses were then used for disease surveillance resulting a veterinary Masters thesis by a veterinary student from Porto, Portugal. The presence of antibodies to tularemia bacteria was investigated with an agglutination method. When antibodies were detected, further analysis to find the bacteria was done. Pharyngeal lymph nodes were tested by PCR analysis and microscopic examination was done on internal organs to search for tissue lesions and to identify which organs contained tularemia bacteria.

In all, 216 muskrats were examined at SVA. Antibodies against tularemia were found in 31 muskrats (14%). Tularemia bacteria were detected in eight out of 22 lymph nodes analyzed by PCR, and in one lung. This shows that muskrats are infected by *F. tularensis*, that they can survive an infection and do produce antibodies, indicating that muskrats may be a reservoir for the bacterium.

There are several different routes of infection for the tularemia bacterium. These include vectors such as mosquitoes and ticks, via infected food and water or by inhalation. It has been shown that the bacterium is present in water sources and in sediments. The fact that the bacterium was found in the pharyngeal lymph nodes suggests that ingestion by mouth is a common route of infection.

It is difficult to determine from these initial results whether and to what extent tularemia has impacted the decline of the population. The euthanized muskrats appeared healthy, but it may be that the most sensitive individuals had already died of the disease and only those that remained were more resistant.

An additional finding in the microscopic examination of muskrat lungs was 46 cases (22%) of a yeast infection with *Emmonsia parvum*, the causal agent of the disease adiaspiromycosis. The fungus causes only mild inflammatory lung changes and has been found in several species, mainly rodents and raccoons. The fungus is present as filaments in the environment that are inhaled by the animal. In the lungs, filaments develop into large round spores and cause local inflammatory nodules that usually don't impact animal health.

*The muskrat (*Ondatra zibethicus*) was introduced for fur trade purposes but is now to be eradicated in the EU as it is listed as an alien invasive species. The population in Sweden has dwindled, maybe by tularemia? Photo: S. Uriadnikov*

Marine mammals 2019

The hunting regulation NFS 1987:905 states that anyone who finds the carcass of an animal belonging to a species in the list of "wildlife of the state" must report the finding to the Police. The listed species include large predators, whales, several species of birds of prey and a number of endangered birds and mammals. The Police ensure that findings are sent to the Museum of Natural History (NRM) in Stockholm or to SVA.

MARINE MAMMALS

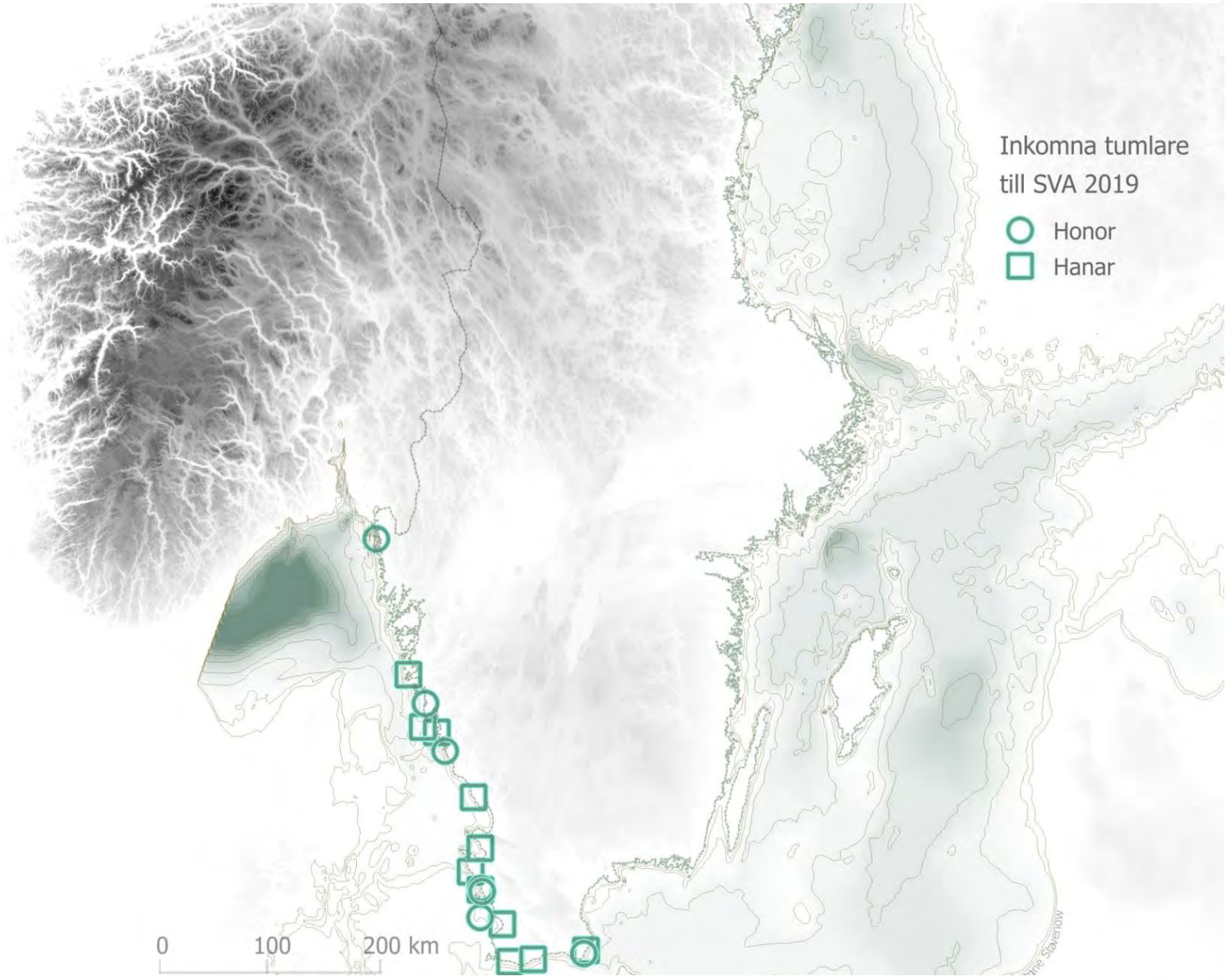
Seals that have been hunted or incidentally caught in fishing gear are regularly examined at NRM for health monitoring of populations, especially regarding the effects of environmental contaminants. Porpoises (*Phocoena phocoena*) and other whales that are found stranded or dead are jointly examined by SVA and NRM to determine the cause of death, document lesions and diseases and collect samples and data. This increases our knowledge about environmental toxins, food habits, health and disease status and genetics of these species.

PORPOISES

In 2019, SVA and NRM received funding from the Swedish Agency for Marine and Water Management (SwAM)to collect and necropsy dead porpoises to increase our knowledge of these animals. Eighteen porpoises were examined in 2019 at SVA. Seven were found in Kattegat, one from Skagerrak, four from the Baltic Sea and six from the Öresund (sites are mapped on the next page). Four of five adult porpoises were males. The only adult female had active mammary glands and had recently mated but was emaciated. Ten animals were subadults and three were calves. Examination showed that three animals had pneumonia caused by parasites and bacteria. Most of the porpoises were analyzed for salmonella and brucella bacteria, but no bacteria were found. One porpoise was bycaught in fishing gear, and bycatch could not be ruled out in three other animals. The cause of death could not be definitely determined for five other cases, as several carcasses were too decomposed. Four porpoises died of trauma, one of which had wounds consistent with grey seal predation. Seal predation has been frequently documented in other porpoise populations. A young calf was assumed to have been abandoned, as it lacked food in its stomachs and had died of starvation.

SwAM also provided funding to summarize ten years of post-mortem examinations of porpoises between 2009 - 2019 (n=109). The report presents a compilation of causes of death, diseases and health status.

Necropsy of porpoises at SVA with staff both from SVA and the Museum of Natural History in Stockholm. The cause of death and any diseases are noted. Samples for screening of environmental contaminants, for genetics, and tissue biobanks are collected. Photo: Andreas Bardell



Finding sites for porpoises necropsied in 2019. Circles are females, boxes are males. Map: Jasmine Stavenow, GeoData: HELCOM (Open Street Map), Daniel och Gesch 2011, and Siefert m fl. 2001.

BEAKED WHALES, RARE CASES AT SVA

Large whales rarely strand on Swedish coasts, but in August 2019 three Sowerby's beaked whales (*Mesoplodon bidens*) stranded in Bohuslän, along the west coast. Despite attempts to save the whales, all three died. One was examined on site by staff from the Swedish Museum of Natural History, but two were transported to SVA in a refrigerated transport. The two whales weighed 730 and 830 kg respectively. Despite refrigeration, the bodies had severely decomposed. No sign of disease could be detected and decomposition made it impossible to determine if the whales had suffered from decompression sickness. Why these deep-sea whales were in shallow waters is not known. However, we had the opportunity to collect samples and data for our collections and for future research on these unusual visitors to Swedish waters. The only other beaked whale examined in recent history was a lone beaked whale found dead on a beach near Karlshamn in Blekinge in 2015. It died of starvation. More information on sightings of whales along Swedish coasts is found at valar.se.

The four large predators 2019

A significant number of the wild animal carcasses or parts submitted to SVA for examination are the four large predators: bear, lynx, wolf, and wolverine.

In total, SVA has handled 548* large predators in 2019. The majority of submissions of entire carcasses come from licenced hunting or other management-related measures. Diagnoses for fallen game (i.e. animals found dead or euthanized sick animals) are dominated by road or train-kills, and sarcoptic mange which leads to starvation. Some cases are submitted for forensic investigation.

SVA manages carcasses and samples from large predators for the Swedish Environmental Protection Agency (EPA) as part of the management of large predators. The EPA regulation NFS 2019:5 8§, states that any found carcasses or parts of these protected species shall be reported to the Police, who then ship the findings to SVA for examination.

Wolf carcasses submitted to SVA are often from a protective hunt or have been killed in traffic. Photo: Wolf in a zoo, Karin Bernodt, SVA

Large carnivores killed during protection hunting or in licensed hunting are to be examined at SVA. They are submitted as skinned carcasses or samples of collected tissues. Submissions are regulated by the relevant authorities for these species.

The work on large predator samples at SVA is an important part of investigating and monitoring the health and disease status of these populations. Through long-term monitoring, trends and variations in disease, health, and causes of death can be followed over time and give valuable information for management decisions.

Below are summaries of the examined bears, wolverines, lynx, and wolves at SVA in 2019. A more detailed report is published separately by SVA: Report on Large Predators 2019 (in Swedish).

*Number of carcasses or parts of large carnivores received at SVA, per year. Ref: SVA. *The number is slightly lower than reported in the SVA Annual report 2019, due to some double registrations of individuals, that now have been corrected (3 lynx and 9 bears).*

Species	2015	2016	2017	2018	2019*
Bear	312	314	310	359	368
Wolverine	37	14	12	7	11
Lynx	57	116	158	133	141
Wolf	73	47	62	36	28
Total	**479**	**441**	**547**	**535**	**548**

BROWN BEAR

In total, carcasses or parts of 368 bears were received in 2019. Of these, 297 were samples from licenced hunting, where only tissue samples are sent to SVA. Thirty-nine whole bears were received from protective hunting and two further carcasses came from bears shot during attacks on domestic animals (§28 JF). Eight bears were shot in self-defence situations (Chapter 24. BrB). Eleven bears were killed in traffic: five in road accidents and six were killed by train. In addition, carcasses or parts of 11 bears were received as fallen game or as part of a forensic investigation. No specific diseases were noted in the examined bears. In general the bear population appears to be in good health.

WOLVERINE

Eleven wolverine carcasses were examined 2019, 10 of which were from protective hunting. One animal had been killed by a motor vehicle. There were no findings of diseases in 2019.

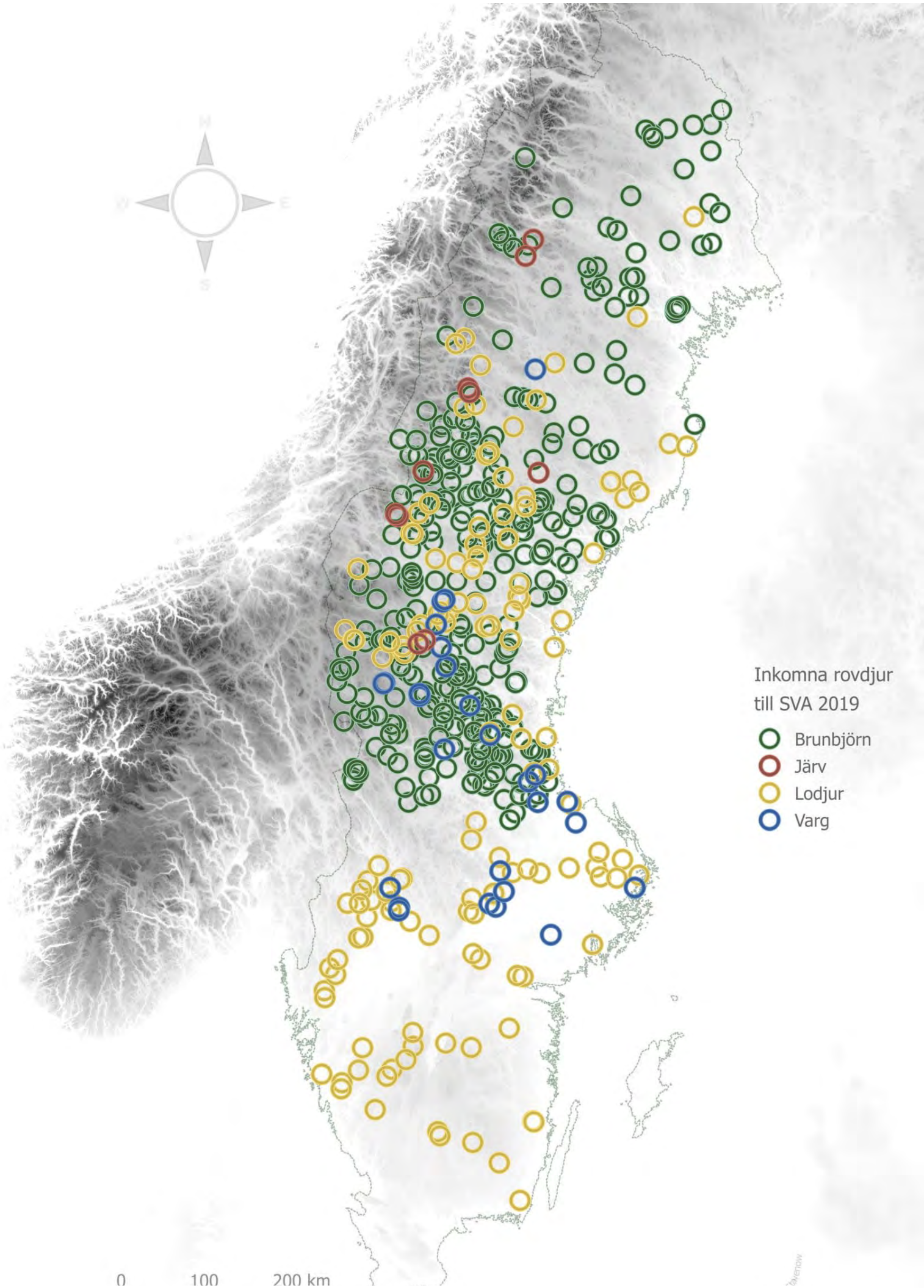
LYNX

In 2019, 141 lynx were examined at SVA. Of these, 68 animals were harvested in licensed hunting and 19 in protective hunting. Thirty-four lynx had perished in traffic during the year, most of them were killed in road accidents. The health status of the lynx population is generally good, but sarcoptic mange is not uncommon, causing serious skin infections and starvation. In 2019, nine investigated lynx were affected by mange.

WOLF

A total of 28 wolves were examined at SVA in 2019. Fourteen wolves were shot in management protective hunts. One wolf was shot during an attack on domestic animals (§28 JF). Eight wolves were killed in traffic. Five wolves were fallen wildlife cases, of which three cases were mange. Two males were cryptorchid, there were two cases of trichinosis, and a few wolves had minor dental defects.

The brown bear is the most common large predator at SVA. Most bear cases are sets of tissue samples taken during the official inspection of license hunt-harvested carcasses. This bear was killed in traffic and the entire body was submitted to SVA. Photo: Jasmine Stavenow, SVA



Map of find locations of dead large carnivores 2019: Bear (green), Wolverine (red), Lynx (yellow), Wolf (blue). Map: Jasmine Stavenow. Map and GeoData from HELCOM (Open Street Maps, and Daniel och Gesch 2011)

International focus 2019

AVIAN INFLUENZA

In 2019, several highly pathogenic avian influenza strains have continued to circulate, particularly in Asia and Africa. Except for the occasional wild bird positive for H5N6 in Denmark at the beginning of the year, the avian influenza situation in the region around Sweden has been relatively calm.

CWD

As part of the management of the outbreak of CWD in Norway since 2016, all wild reindeer in the Nordfjella area where the infection was detected have now been culled. The area will be kept empty from cervids for at least five years before the reintroduction of genetically related wild reindeer from nearby wild reindeer herds. In the Norwegian CWD surveillance, two more positive old moose have been detected. In total, more than 100,000 cervids have now been sampled in Norway. Of these, 26 have been positive.

AFRICAN SWINE FEVER

African swine fever (ASF) has continued to spread west in the EU during 2019. The spread occurs mainly among wild boar, but many outbreaks among domestic pigs have been reported, particularly in south-eastern Europe. In Latvia, 370 cases in domestic and wild boar were reported in 2019. In 2019, ASF has been reported for the first time in Hungary, Slovenia, and Serbia. In November
the infection was detected in western Poland near the border to Germany, about 300 km west of Warsaw, which was the previous westernmost occurrence. Attempts to limit the spread through fencing have not been successful in Poland.

The local outbreak of ASF in southern Belgium peaked in February and has since been managed by zoning, fencing and culling of all wild boar in the area. However, the surveillance zone had to be extended twice due to the findings of infected wild boar outside the infected zone. A total of 854 ASF-infected wild boar have been found, the most recent in October 2019. SVA and the Swedish Board of Agriculture participated in a visit to the area in November 2019 to study the management of the ASF outbreak.

In Asia, there has been a large spread of ASF outside China and Vietnam in 2019, including North and South Korea, Cambodia, Indonesia and the Philippines. The infection is now found in countries that combined have 2/3 of the world's domestic pig population and this has a severe impact on food production. There is also a concern that the disease may threaten endemic wild suid species, especially in Indonesia.

Collection centers for wild boar carcasses from the African swine fever infected zone in southern Belgium. During a study visit in November 2019, sampling, handling, and disinfection procedures were shown. Photo: Erik Ågren, SVA

WEST NILE VIRUS

In 2019, about 400 human cases of WNV disease have been reported in the EU, half of them in Greece. This is about twice as many as in 2017. The mortality rate has been around 10%. The disease occurs in wild birds and is spread by mosquitoes to other birds but also to humans and horses. WNV has in 2019 been reported for the first time in Germany and Slovakia. In Germany, it is believed that hundreds of people may have been infected. WNV has been detected in about 50 birds in Germany, including owls in zoos. A warmer climate may lead to spread of WNV to Sweden.

USUTU VIRUS

In 2019, mortality of blackbirds caused by Usutu virus (USUV) was reported in France, Belgium, the Netherlands, Switzerland, and Italy. An Italian study of blood donors showed that infections with USUV in some cases may be linked to disease symptoms in humans. Outbreaks caused by USUV have been seen further and further north in Europe in recent years and the first case in Sweden was found 2019.

SEABIRD MORTALITY

In 2019, thousands of shearwaters in the Pacific Ocean off Alaska and thousands of common murres in the North Sea off the Dutch coast have been found dead due to starvation. Climate change with impacts on water temperature and currents affecting food sources as well as storms have been presented as possible causes.

RAT POISON IN FOXES AND OWLS

Norwegian studies have shown widespread but low levels of rat poison in fecal samples from red fox and in owl liver samples. More than half of the red foxes studied and more than 2/3 of the great horned owls examined had detectable levels of rat poisons. Previous studies have shown traces of rat poison in wolves in Norway. This is worrying as it shows a secondary transfer of poison into the environment, in predators and raptors that have rodents as an important part of their diet.

The use of mouse and rat poison leads to secondary exposure in species that eat small rodents, as Norwegian studies have shown. It is not uncommon to find the poison in foxes and owls. Photo: Erik Ågren, SVA

Publications from SVA 2019

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. Below is a selection of publications from 2019 related to wildlife, where the names of authors from the Wildlife Section or other departments at SVA are written in **bold**.

SCIENTIFIC PUBLICATIONS

Hestvik, G; Uhlhorn, H; Koene, M; Åkerström, S; Malmsten, A; Dahl, F; Åhlén, P-A; Dalin, A-M; **Gavier-Widén, D**. *Francisella tularensis* in Swedish predators and scavengers. Epidemiol Infect ; 147: e293, 2019 Oct 22.

Sánchez-Cordón, P.J., Nunez, A., **Neimanis, A., Wikström-Lassa, E.,** Montoya, M., Crooke, H., **Gavier-Widén, D**. African swine fever: disease dynamics in wild boar experimentally infected with ASFV isolates belonging to genotype I and II. Viruses, 2019; 11(9), 852.

Söderlund Robert, Jernberg Cecilia, Trönnberg Linda, Pääjärvi Anna, **Ågren Erik**, **Lahti Elina**. Linked seasonal outbreaks of *Salmonella* Typhimurium among passerine birds, domestic cats and humans, Sweden, 2009 to 2016. Euro Surveill. 2019;24(34):pii=1900074.

Ågren, E. Stavenow, J. Förekomst av tarmnematoden *Baylisascaris transfuga* hos svenska brunbjörnar (*Ursus arctos*), Jul 10, 2019, Svensk Veterinärtidning.

Jenny Knapp, Gérald Umhang, **HeleneWahlström**, Mohammad Nafi SolaimanAl-Sabi, **Erik O. Ågren**, Heidi Larsen Enemark. Genetic diversity of *Echinococcus multilocularis* in red foxes from two Scandinavian countries: Denmark and Sweden. Food and Waterborne Parasitology. Available online 27 February 2019, e00045, https://doi.org/10.1016/j.fawpar.2019.e00045

Yon L, Duff JP, **Ågren EO**, Erdélyi K, Ferroglio E, Godfroid J, Hars J, **Hestvik G,** Horton D, Kuiken T, Lavazza A, Markowska-Daniel I, Martel A, **Neimanis A**, Pasmans F, Price SJ, Ruiz-Fons F, Ryser-Degiorgis MP, **Widén F, Gavier-Widén D**. RECENT CHANGES IN INFECTIOUS DISEASES IN EUROPEAN WILDLIFE. J Wildl Dis. 2019 Jan;55(1):3-43.

Marlene Cavaleiro Pinto, **Veronica Rondahl**, Mikael Berg, **Erik Ågren**, Júlio Carvalheira, Gertrude Thompson & Jonas Johansson Wensman (2019) Detection and phylogenetic analysis of parrot bornavirus 4 identified from a Swedish Blue-winged macaw (*Primolius maracana*) with unusual nonsuppurative myositis, Infection Ecology & Epidemiology, 9:1.

SCIENTIFIC PRESENTATIONS

Nordic section of WDA (Wildlife Disease Association)
24th biennial meeting of the NWDA, Luvia, Finland, 3-6 June 2019.
Presentations: **Uhlhorn, H., Neimanis, A**. Wildlife disease surveillance in Sweden 2017-2019. **Neimanis, A.** Recognizing African Swine Fever in wild boar- a primer. **Uhlhorn, H.** 10 years of corvid mortalities.

Workshop on Lagoviruses: **Neimanis, A**. Invited speaker "Lagovirus e lagomorfi, un rapporto in continua evoluzione" training workshop, Istituto Zooprofilattico Sperimentale della Lombardia e Dell'Emilia Romagna (IZSLER), Brescia, Italy. 20 november 2019. Pathology and pathogenesis of lagoviruses.

Latvian Agricultural University 100 anniversary and veterinary meeting. **Aleksija Neimanis** invited speaker: *Latvian Veterinary Faculty 100 year anniversary and biennial veterinary conference*, Jelgava, Latvia, 23 November. One Health within one ecosystem: Current wildlife disease issues and their threats

European Association of Zoos and Aquariums EAZA, *EAZA Education Conference* 25-28 March 2019, Stockholm. **Stavenow. J., Ågren. E.O.** 2019. Large carnivore health and disease surveillance at SVA and zoos: collaboration and mutual benefits.

2019 Nordic Zoo Veterinary Group, meeting, Eskilstuna, Sweden, 31 Jan – 1 Feb 2019. Invited speakers: Necropsy techniques for exotic species. **Erik Ågren, Erika Karlstam**

Joint Leibniz-IZW/EAZWV/*ECZM* Zoo and Wildlife Health Conference *2019*. June 12 - 15, *2019*. *Kolmården*, Sweden. ECZM meeting 11-12 June. ECZM strategy planning meeting 10-122 June. **Erik Ågren**

2019-08-13 –14 Meeting on Chytridiomycosis in the Nordic countries. Norwegian Environment Agency (Miljødirektoratet), Oslo. **Erik Ågren**

Davis Thomson Foundation, European Division, Wildlife and Zoo Animal Pathology Symposium, 24-25 September 2019, Arnhem, the Netherlands. **Erik Ågren.**

Joint congress of ESVP, ECVP and ECVCP, 25-28 September 2019, Burgers´ Zoo Arnhem, the Netherlands. Poster presentation: **Ågren, E.O.** Subcutaneous ticks (*Ixodes ricinus*) in red foxes (*Vulpes vulpes*).

REPORTS

Museum of Natural History report 2019:1. Tumlare 2018. Hälsostatus och dödsorsaker hos insamlade djur, av A. Roos, A. Neimanis, E. Wikström, och E. Ågren. (Porpoises 2018. Health status and causes of death).

Stavenow. J., Ågren. E.O. Large Carnivore report 2018. SVA report 54:2019

Stavenow. J., Ågren. E.O. Licenced hunt lynx 2019. SVA report 55:2019

Stavenow. J., Ågren. E.O. Licenced hunt bear 2019. SVA report 58:2019

Communication

VISITS

The wildlife section regularly receives visitors for lectures on wildlife diseases and on the work at the wildlife section and its ongoing projects: Visits usually include the necropsy room to see the activities there. Lectures on current wildlife diseases are held continuously at various meetings and workshops, where the audience consists of one of the hunter organizations.

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, learned the practical and administrative parts in inspecting large predators that are shot during the licensed hunts, as well as the routines and regulations involved.

INFORMATION ON DISEASE SURVEILLANCE AT SVA

Major efforts were made during 2019 to inform on the ongoing surveillance of African swine fever and CWD. Reaching out to all hunters and others active in outdoor life, advertising and information about reporting any found dead wild boar, dead moose or other cervid, as well as other fallen wildlife, have been carried out continuously in hunting media and during lectures and visits. A major effort was made at the two largest hunting fairs this year, with a pavillion at and participation in both the Tullgarn Game Fair and Elmia Game Fair in May 2019.

SVA was represented at the Tullgarn Game Fair and Elmia Game Fair in 2019 to inform about monitoring of CWD and African Swine Fever in collaboration with the Swedish Board of Agriculture. General information about wildlife diseases and trichinella analysis was also provided. Photo: Erik Ågren, SVA

Working groups

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

Wildlife disease council Swedish Environmental Protection Agency/SVA: 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

SVA zoonosis committee: Henrik Uhlhorn.

SVA R&D coordination group: Aleksija Neimanis

SVA Poultry forum: Aleksija Neimanis

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 the Wildlife Disease Association, board. Henrik Uhlhorn, Caroline Bröjer

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

Journal of Wildlife Diseases, assistant editor: Erik Ågren

OIE Focal point Wildlife Diseases: Torsten Mörner (Jan-Feb), then Erik Ågren

References

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HELCOM Open Street Maps, Available at: metadata.helcom.fi/

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.

Screening of diseases in Swedish muskrats. Mastersarbete av Mariana Reis Macieira, Universidado do Porto, Portugal 2019.

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