WILDLIFE DISEASE SURVEILLANCE IN SWEDEN 2022

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Photo, cover: Northern gannet found dead on the Swedish west coast island of Öckerö. A beautiful and unusual bird for Sweden. Photo submitted to SVA from an anonymous person. A mass death of northern gannets caused by avian influenza occurred on the west coast in 2022.

Other photos: SVA, if not otherwise mentioned in the photo caption

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Introduction

The health and disease status of wildlife in Sweden is monitored through SVA's general wildlife disease surveillance program since 1948, marking its 75-year anniversary in 2023, and by targeted disease surveillance. This annual report summarizes the work and results from the program, highlighting wildlife disease events of significance in 2022, and is a report to the funding parties; specifically for the Wildlife management fund, the Swedish Environmental Protection Agency, and the Swedish Agency for Marine and Water Management.

Uppsala, 22 April 2023
Erik Ågren, Head of the Wildlife section
Aleksija Neimanis, Head of section for Research and Development

Dead blue tit, a case for the general disease surveillance program at SVA. Photo: Erik Ågren, SVA

Summary

The health status of Swedish wildlife

References: SVA Annual report 2022, SVA Wildlife section and SVALA database 2022.

Swedish wildlife populations can generally be considered as healthy, with few cases of more severe contagious 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 for monitoring of the disease status of wildlife. Diseases of wild animals that can spread to or from domestic animals or humans are prioritized, as are those affecting whole populations of wildlife or threatened species.

In 2022 SVA received 3 528 wildlife cases as carcasses, parts, or samples. In addition, we received another 200 cases from farmed wildlife, zoos, and other wildlife owned by deer farms, zoos etc, but these latter cases are not presented int this report. During the year, 274 cases of reportable diseases in 49 different wildlife species were diagnosed.

Like in 2021, avian influenza dominated the workload for the wildlife section in 2022. Handling reports and sampling found dead birds accounted for a major part of the wildlife cases.

Surveillance of CWD has since 2022 been focused on sampling moose and other cervids displaying signs of brain disease or found emaciated. No positive cases were found in the past year.

In 2022, SVA continued the second national surveillance project for *Echinococcus multilocularis* that was initiated in 2021. A hunted red fox from Borlänge municipality was positive for the parasite. Continued surveillance of areas where the parasite previously had been found revealed that *E. multilocularis* is still present in the municipalities of Uddevalla and Gnesta.

Together with other authorities, SVA works on preventing African swine fever from being introduced into the country. SVA routinely analyzes samples from any wild boar found dead in the wild, but so far, the virus has not been detected in Sweden.

In collaboration with the Swedish Museum of Natural History, 41 porpoises and 22 seal carcasses have been necropsied within the program for health and disease surveillance of marine mammals. This is to increase knowledge about these species and the program is funded by the Swedish Agency for Marine and Water Management.

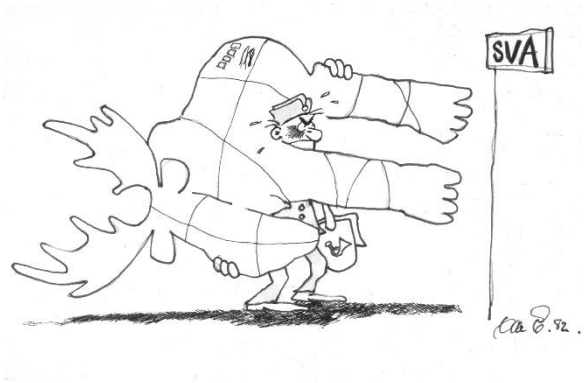
A total of 987 large carnivores have been registered at SVA in 2022. The Swedish Environmental Protection Agency finances SVA’s work with submitted bears, lynx, wolves, and wolverines that are found dead or felled during hunting or in other circumstances. The number of large carnivores examined has increased by 80% over the past five years, mainly a result of increased numbers of animals felled during licensed hunting. The results of SVA's monitoring show that large carnivores generally are in good health.

Wildlife disease surveillance at SVA

The government's instruction to SVA (2009:1394) states that the veterinary expert 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 wild animals. The work is mainly based on necropsies of dead wildlife carcasses or samples from sick euthanized animals. Reports of found dead or sick wild animals are collected from the interested public and appropriate cases are submitted for examination. This citizen science is complemented by early warning monitoring to prepare for disease outbreaks in wildlife, as well as targeted surveillance. Research projects are done to further the knowledge of diseases or to develop new diagnostic tools for wildlife species. This report presents activities and results of the wildlife work at SVA in 2022.

Wildlife disease surveillance 75 yrs!
General surveillance of wildlife diseases involves systematic examination to determine 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. The wildlife survey, as it was called in 1948, began when veterinarian Karl Borg was employed at SVA and was funded by the Swedish Hunters' Association. Since the program's start with a single employee, there are now about 15 positions at SVA working with disease surveillance in wildlife in 2023!



The targeted wildlife disease surveillance programme
was initiated in 2006 in cooperation with the Swedish Environmental Protection Agency (EPA) to finance additional wildlife studies, mainly targeted disease surveillance.

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 and jointly recommends targeted initiatives for SVA to carry out during the year. In 2022, 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 2022, the council held two meetings.

Financing

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, Government 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 received 5 million SEK in 2022. 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.

Government grants
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 Environmental Protection Agency (EPA) funds the work with large predators. In addition, the EPA funds prioritized targeted surveillance projects such as investigation of ongoing disease outbreaks or increased wildlife mortality, and establishment of specific laboratory analytic methods for wildlife samples.

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 WOAH. 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 2022, funding was given for monitoring of *Echinococcus*, avian influenza and *Trichinella*, as well as for salmonella and African swine fever in wild boar.

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 contributes to the national environmental surveillance by following health and disease trends and identifying new threats. The program shares results of necropsies and disease testing of marine mammals and collects data and samples for biobanks and research.

Wildlife staff 2022

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 the Swedish University of Agricultural Sciences (SLU) and other national or international institutes is also an important part of the work with wildlife.

Wildlife Section 2022

Erik Ågren Deputy head of Department, Head of section, Veterinary Officer, Dipl. ECVP, DipECZM (Wildlife population health). WOAH 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, Resident ECZM (Wildlife population health)
Marit Liljefors Technician

Research and Development Section 2022

Aleksija Neimanis Head of section, Veterinary Officer, BSc, MSc, MVetSci, PhD, Dipl. ACVP
Caroline Bröjer Veterinary Officer, MSc, PhD, DipECZM (Wildlife population health)
Ellinor Spörndly-Nees Veterinary Officer, PhD
Jasmine Stavenow Biologist, MSc., Marine mammals
Ulrika Larsson Pettersson Biomedical analyst
Emil Wikström-Lassa Veterinary Officer, PhD-student
Emma Höök Agronomist, Marine mammals and large carnivores

Other staff within the department and SVA

Administrators Carina Bohlin, Julia Tibell, Christina Rosander. **Necropsy assistants** Hans Kanbjer, Johan Karevik, Lars Hammarsten. **Technicians** Sandra Karevik, Katarina Jendelöv, Benny Eriksson, Anders Åslund. **Biomedical analysts** Gudrun Andersson, Shaqe Hafstad, Mariam Kerro, Angelica Stefansdotter. **Head of department** Dolores Gavier-Widén.

General wildlife disease surveillance 75 years

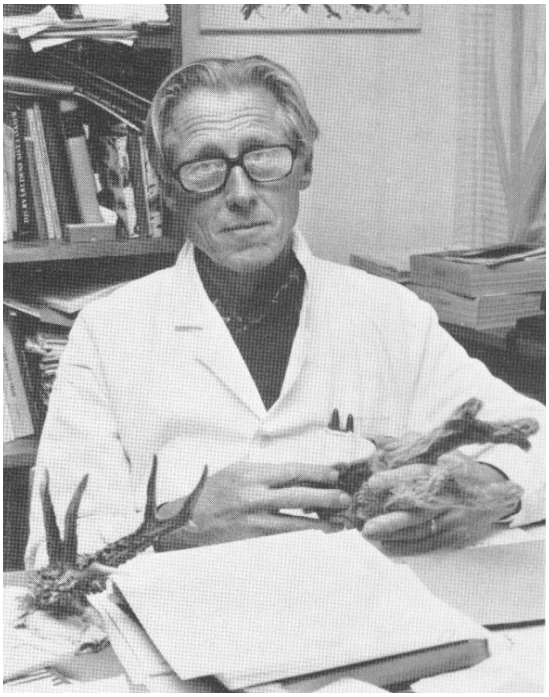
Since 1948, Sweden has monitored wildlife diseases. It is one of the oldest wildlife disease surveillance programs and has been conducted by SVA since its inception. In 2023, this 75-year jubilee will be celebrated.

Over 120,000 wildlife cases have been handled at SVA over the past 75 years according to archived records and documents. The activities began with a single person, veterinarian and future professor Karl Borg, who was employed at SVA in the autumn of 1948 and was funded by the Swedish Hunters' Association, which saw the value in increasing knowledge about diseases in wildlife and how they affected game populations.

The stamp seal for wildlife meat inspection by veterinarians ceased to be used from 1 January 2006, but is the inspiration for a 75-year jubilee logo for the general wildlife disease surveillance!

Thank you!

Since its inception in 1948, SVA has been dependent on interested people contacting and reporting findings of dead and sick wildlife in order to obtain samples and animal carcasses for examination at SVA and map where and when increased wildlife mortality occurs. Citizen science as it is now called, was essential from the start and most reports and samples were submitted to SVA from hunters and the public. This is true to this day, although technical development with smart phone apps such as rapporteravilt.sva.se facilitates reporting and mapping of wildlife diseases.



Professor Karl Borg in his office at SVA, 1979. He did important work with diseases in roe deer and showed that anti-mould treatment of cereal seed led to mercury poisoning in birds.

THE WILDLIFE SECTION GROWS AND CHANGES

Wildlife veterinarian Karl Borg was alone working with wildlife at the start in 1948. The work expanded, and in 2010, the wildlife section staff was considerably larger!

Some wildlife section staff has worked most of their careers with wildlife diseases, and other have stayed a few years before taking this specific knowledge to other workplaces as veterinarians or biologists. Here is a staff photo from 2016.

The wildlife section in 2018 with new personal scrubs with wildlife prints!

Wildlife cases 2022

The wildlife section received 3,728 cases in 2022, where around 1,621 were defined as part of the general disease surveillance and were found dead or euthanised.

The wildlife cases within the general disease surveillance are listed below as number of cases per species, with 915 birds, 691 mammals, 13 reptiles, and two amphibians. Some cases also are part of other surveillance or sampling projects.

The remaining cases from 2022 are hunter-harvested large carnivores, samples from other healthy wildlife and diagnostic cases from privately owned wild animal species such as animals from deer farms or zoos.

Some wildlife samples are registered at other departments at SVA, such as samples for trichinella testing of hunter-harvested wild boar and brown bear. These are not included in the wildlife section cases.

Avian	Number
White-tailed eagle	100
Common murre	44
Mallard	37
Rock pigeon	34
Black bird	31
Jackdaw, Sandwich tern	30
Common buzzard	26
Eurasian siskin, Sparrowhawk	25
Mute swan	24
Black-headed gull	23
Northern goshawk, Tawny owl, Wood pigeon	20
Northern gannet	19
Golden eagle	18
Fieldfare, Herring gull	16
Magpie, Kestrel, Barnacle goose	15
Great cormorant	13
Canada goose, Ural owl	12
Pigeon, Great spotted woodpecker	11
Blue tit, Great grey owl	10
Eider, Whooper swan, Great tit	9
Eagle owl, Bullfinch	8
Pheasant, Common gull, Greylag goose, Yellowhammer	7
Chaffinch, Grey crow, Song thrush, Razorbill	6
Green woodpecker, Goose, Long-eared owl, Peregrine falcon, White stork	5
Greenfinch, Greater black-backed gull, Grey heron, Tengmalms´s owl, Waxwing, Caspian tern	4
Rough-legged buzzard, Puffin, Hobby, Woodcock, Red-breasted merganser, Wagtail, Swift, White-backed woodpecker	3
Brambling, Osprey, Common redpoll, Northern hawk owl, Nightjar, Nuthatch, Lesser black-backed gull, Common scoter, Black woodpecker, European goldfinch, Hawfinch, Long-tailed tit, Oyster catcher, Mediterranean gull, Common crane	2
Long-tailed duck, Blyth´s reed warbler, Marsh tit, House sparrow, Wood warbler, Short-eared owl, Hazel grouse, Lesser spotted woodpecker, Common crossbill, Jay, Eurasian tree sparrow, Partridge, Rook, Robin, Reed warbler, Stock dove, Great crested grebe, Little grebe, Eurasian pygmy owl, Starling, Merlin, Black-throated diver, Northern fulmar, Swallow, Coal tit, European pied flycatcher, Bean goose, Capercaillie, Treecreeper, Eurasian collared dove, Owl, Great grey shrike, Tufted duck, Meadow pipit, Bird unknown species.	1

Mammal	Number
Otter	87
Wild boar	77
Moose	64
Lynx	54
Bat	48
Red fox	45
Harbour porpoise	41
European brown hare	37
Roe deer	32
Brown bear	27
Hedgehog	27
Red squirrel	23
Wild rabbit	18
Grey seal	13
Harbour seal	11
Mountain hare	11
Brown rat	10
Wolf	9
Red deer	7
Wolverine	6
Fallow deer	5
American mink	5
Vole	5
Shrew	4
Grey red-backed vole	3
Wood lemming	3
Beaver, Badger, Raccoon dog, Yellow-necked mouse, Short-tailed field vole	2
Eurasian least shrew, Stoat, Lemming, Mole, Pine marten, Eurasian water shrew, European water vole, Weasel, Atlantic white-sided dolphin	1

Reptiles and amphibians	Number
Water turtle	4
Slow worm	3
Grass snake	3
Common adder	1
Common lizard	1
Loggerhead sea turtle	1
Common toad	1
Moor frog	1

Reportable diseases

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

In 2022, cases of avian influenza and salmonellosis dominated the reportable diseases. The number of reported cases in wildlife only reflects examined cases at SVA or other laboratories. The prevalence of a disease in wildlife cannot be determined, but we do get an indication if a disease is present or not, if it is introduced, and if it increases or decreases over time. 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.

Table with the number of positive cases of reportable WOAH-listed diseases detected in wildlife diagnosed in laboratories in the country in 2022. Source: SVA Laboratory Data System SVALA.

Disease	Total	Species and no. per species
Avian influenza	96	Northern goshawk 3, Eider 1, Greylag goose 2, Grey-backed gull 4, Northern gannet 12, Greater black-backed gull 2, White-tailed eagle 2, Canada goose 4, Sandwich tern 15, Mute swan 6, Buzzard 12, Peregrine falcon 2, Common murre 4, Lesser black-backed gull 1, Magpie 1, Black-headed gull 5, Rock pigeon 1, White stork 1, Northern fulmar 1, Great cormorant 2, Mediterranean gull 2, Whooper swan 1, Razorbill 4, Barnacle goose 7, Harbour porpoise 1
Avian malaria	3	Blackbird
Avian paramyxovirus	2	Rock pigeon
Avian pox	5	Magpie 2, Great tit 3
Circovirus	6	Wild boar
Echinococcus multilocularis	1	Red fox (cases in new areas. Sample submitted in 2022, analysis finalized in 2023)
Lagovirus	10	Wild rabbit (Rabbit viral haemorrhagic disease)
Listeriosis	1	European brown hare
Mycoplasma infection	3	Pheasant
Myxomatosis	3	Wild rabbit
Pox virus	2	Harbour porpoise
Pseudotuberculosis	4	European brown hare
Psittacosis	1	Great tit
Sarcoptic mange	7	Lynx 3, Red fox 3, Wild boar 1
Salmonellosis	79	Bullfinch 7, Green woodpecker 1, Siskin 14, Hedgehog 1, Roe deer 1, Black-headed gull 1, Goldfinch 1, Great tit 1, Wild boar 51
Toxoplasmosis	1	Mountain hare
Trichinosis	15	Bear 2, Lynx 5, Wolf 2, Wild boar 6 (Bear and wild boar are hunter submissions)
Trichomoniasis	24	Chaffinch 1, Greenfinch 2, Siskin 1, Yellowhammer 2, Wood pigeon 12, Stock dove 1, Rock pigeon 4, Collar-necked dove 1
Tularemia	11	Red squirrel 3, European brown hare 5, Mountain hare 3
Total	**274**	

Facts on reporting of animal diseases
Notifiable animal diseases and infectious agents are reported to the Swedish Board of Agriculture when they are diagnosed at SVA or other laboratories, as per regulations SJVFS 2021:10 (K12). The WOAH - World Organisation for Animal Health have Listed animal diseases, and also a list of other wildlife diseases and infectious diseases in wild animals that are of interest to follow, and are voluntary to report, see the link WOAH non-listed-diseases-affecting-wildlife

Hot topic diseases

CONTINUED OUTBREAKS OF AVIAN INFLUENZA

Avian influenza H5N1 virus circulated in Europe and North America throughout 2022, causing widespread mortality among wild birds and domestic poultry. Towards the end of 2022, HPAI was also detected for the first time in South America after migratory birds from North America carried H5N1 virus to wintering sites where large outbreaks occurred.

In Sweden, highly pathogenic avian influenza (HPAI) of the H5N1 variant was detected in 90 birds of 24 species in 2022 (see table below). Only a few positive birds were detected in the spring, but during the summer of 2022 bird flu caused extensive mortality among aquatic colony-breeding bird species such as the northern gannet, guillemot, razorbill, cormorant, and gulls mainly along the west coast, in Skåne, Blekinge, and on Gotland.

In 2022, SVA received over 4,100 reports of sick and dead birds via SVA's online form **rappporteravilt.sva.se**, email, and phone calls. 3,680 were reported in June and August alone, which can be compared to 298 reports during the same period in 2021. The large number of reports included, among others, 768 gannets, 726 auks (guillemots and razorbills) and 324 geese and swans. One report may represent one or more dead birds. Also, the reports of course include birds that did not die from avian influenza, but the large number of reports of the same species in a limited geographical area gives an indication of the extent of mortality.

Only subsets of reported dead birds were examined at SVA due to practical and financial constraints. The number of birds that died from avian influenza therefore is much higher than number of cases submitted and reported as positive after analysis.

Avian influenza outbreaks are most notable when affecting dense populations of water-associated birds. Central Stockholm, feeding site for birds. Photo: Erik Ågren, SVA.

In some bird colonies, avian influenza had a major impact on the population. Between 50 – 95% mortality was seen, for example, in Sandwich tern chicks.

The number of reports of dead birds began to decline in September 2022 and birds sampled in August and September were negative. Only eight examined birds were positive from October to December. Avian influenza was also detected in a porpoise in 2022.

Microscopic examination showed that the virus was present in large quantities in the brain, which explains the neurological symptoms that were often observed in live infected birds.

Table of the number of wild birds sampled for avian influenza, and number of positive birds in 2022.

Species	AIV-pos	AIV-neg
Goshawk	3	14
Eider	1	7
Greylag goose	2	4
Grey-backed gull	4	10
Northern gannet	12	5
Greater black-backed gull	2	1
White tailed eagle	2	80
Canada goose	4	5
Sandwich tern	15	1
Mute swan	6	18
Buzzard	12	12
Peregrine falcon	2	3
Common murre	4	41
Lesser black-backed gull	1	0
Magpie	1	12
Black-headed gull	5	3
Rock pigeon	1	37
Stork	1	1
Northern fulmar	1	0
Cormorant	2	6
Mediterranean gull	2	0
Whooper swasn	1	7
Razorbill	4	1
Barnacle goose	7	6
Total	**90**	**274**

Photo: Johan Eltes

Multiple reports on sick, immobile, and dead Northern gannets were sent to SVA due to an avian influenza mass mortality event on the west coast of Sweden in the summer of 2022. Many reports included images from the public, some examples are seen above. Ringed birds give information on where the bird has been sighted or died. Photos: unknown if not given.

CWD SURVEILLANCE

SVA and the Board of Agriculture continued the surveillance of Chronic wasting disease (CWD) in cervids. No new cases were found in 2022.

Monitoring continues, in revised form

National surveillance continues, however from 2022, it focuses solely on suspected clinical cases. Adult cervids with two or more of the following symptoms that may indicate CWD are analysed: emaciation, neurological symptoms, behavioural changes, increased salivation, and increased urination. If suspected cases are seen, observers are to contact the wildlife section for further instructions.

Surveillance 2022

28 suspected CWD cases in moose and three red deer, were all negative. In Norway, more than 3,085 moose were screened in 2022 and two of those were positive for CWD. 3,103 wild reindeer were also examined, with one positive reindeer from Hardangervidda. Of 2,133 red deer, one was positive. In Finland, one case of CWD was detected in a moose in Kyyjärvi in 2022.

ABOUT CWD

Chronic wasting disease is caused by prions, which are infectious proteins. The normal prion protein changes into undegradable prions that then accumulate in the brain. This leads to brain damage and ultimately to death. In North America and in wild reindeer in Norway, CWD is contagious, and the disease is spreading in cervid populations. The variant of sporadic CWD found in old moose in the Nordic countries is different and is not expected to be contagious or is less contagious.

EC monitoring of CWD 2018 – 2021

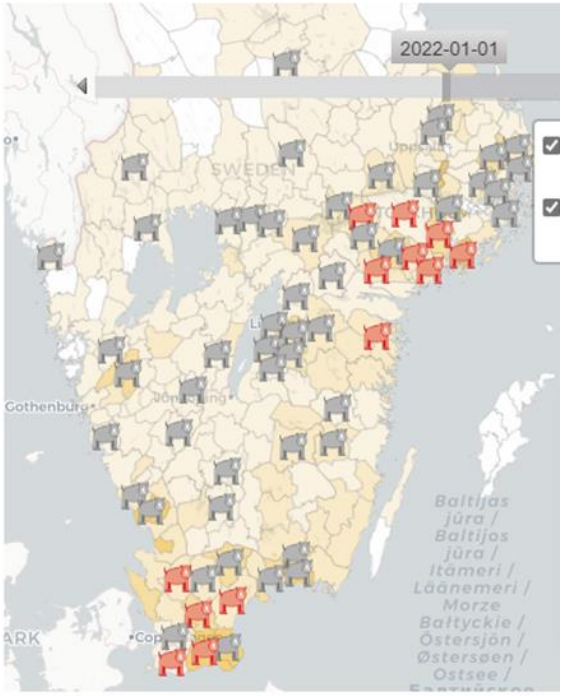
In 2017, the European Commission regulated the monitoring of CWD for the six Member States that have moose or reindeer. Each country had to examine at least 6,000 cervids between 2018 and 2021. Since 2018, four positive moose have been detected in Sweden, three older moose cows in Norrbotten and one old moose cow in Västerbotten.

For more information about CWD, see **cwd.se**

Female moose. Photo: Karin Bernodt, SVA

SALMONELLA CHOLERAESUIS IN WILD BOAR

Wild boar were investigated for salmonella in 2022 and surveillance will continue in 2023.



Screening of salmonella in wild boar, www.sva.se

Wild boar necropsied at SVA are sampled for salmonella to screen for, and map *Salmonella* Choleraesuis in the wild boar population.

In 2020, *Salmonella* Choleraesuis was found in domestic pigs in Skåne, in southern Sweden. This bacterium can cause sepsis and sudden death in domestic pigs and wild boar. This type of salmonella had not been detected in Sweden for over 40 years, so *S.* Choleraesuis was a surprising and unwanted finding, as Sweden has a very low incidence of salmonella in production animals.

The finding led to surveillance of wild boar in southern Sweden where this pig-adapted bacterium was found. Cases in both sick, euthanised wild boar and in apparently healthy, hunter-harvested wild boar were detected. In 2020, the bacterium was also found in sick, captive wild boar in Södermanland.

In 2022, continued surveillance was carried out on found dead wild boar and on samples submitted from hunters around the country. Results showed that 51 out of 200 sampled wild boar were positive for salmonella bacteria, of which 46 were *S.* Choleraesuis. Out of 82 wild boar found sick or dead, *S.* Choleraesuis was detected in 32 cases, and other types of salmonella in four other cases. From 117 samples from hunter harvested wild boar, 14 were positive for *S.* Choleraesuis, and only one case was positive for another type of salmonella.

Our findings show that this bacterium is found more often among fallen wild boar, i.e. those found dead or sick, euthanised wild boar. Most positive cases were found in Skåne and Södermanland counties, but occasional positive cases were found in other counties. Blekinge was added as a new positive county this year, and probably other counties will find cases over time as the surveillance continues. See www.sva.se for a map of the surveillance.

The Food Safety Agency advises that careful handling and food hygiene during evisceration and slaughter is important, and that it is safe to eat healthy wild boar even if they could carry *Salmonella* in the intestines. However, sick animals should not be eaten!

Targeted wildlife disease surveillance

The Swedish Board of Agriculture (SBA) funds surveillance projects to monitor reportable contagious diseases. Early detection of introduced diseases and showing freedom of others is important. The Environmental Protection Agency funds pilot studies at SVA to study and follow up increased mortality or disease outbreaks. Projects 2022 are listed here.

AFRICAN SWINE FEVER – NOT IN SWEDEN

In 2022, 77 wild boar have been examined for African swine fever (ASF). All were negative. African swine fever is a serious viral disease that only affect Suids. The disease has **not** yet been found in Sweden, but surveillance and preparedness for this disease is very important in order to detect any introduction as early as possible for the best chance for eradication. The Swedish Board of Agriculture (SBA) finances the analyses of suspected ASF cases and is responsible for and coordinates the disease control efforts if ASF ever is detected in the country.

SVA has a standing expert group on ASF, contributing with knowledge and participation in regular SBA coordination meetings with authorities, industries, and stakeholders such as hunters, forest owners, farmers, and others, to prepare as much as possible, to prevent disease introduction, and have a rapid response management plan ready should this virus be found in the country at some point in the future.

Report dead wild boar!

Managing an African swine fever outbreak will have a huge impact on everyone in the geographical areas concerned, as well as on several different businesses. That is why early detection of an introduced infection is so important. Please report any found dead wild boar, so they can be sampled and tested! Please use the online form:

rapporteravilt.sva.se

SVA and the Board of Agriculture want to sample any found dead wild boar for African swine fever, thankfully, a disease not yet found in Sweden.

1 IN 19 000 WILD BOAR HAS TRICHINOSIS

Trichinella analyses for 2022 are reported here for both SVA and at various private laboratories. A total of 15 wildlife cases of trichinella were detected in 2022; Six out of 113,803 wild boars tested, five out of 110 lynx tested, two out of 32 wolves tested, and two out of 476 brown bears tested. None of 162 tested red foxes carried trichinella, which is a bit unusual, as foxes is a species where the parasite is found most years. Other tested species with negative results in 2022 were 11 beavers, six badgers, and eight seals.

The results show that *Trichinella* is still only very sporadically detected in wildlife in Sweden, but a game animal that carries *Trichinella* can cause serious disease in humans if the meat is handled incorrectly. All animals that eat small rodents or other *Trichinella*-infected meat can become infected with the larvae, and themselves become carriers of the parasite. Humans can become infected if they eat meat with *Trichinella* if the meat has not been heated enough. Close to 70 degrees Celsius core temperature is needed. There are also some species of *Trichinella* that can survive deep-freezer temperatures.

SWEDISH WILD BOAR FREE FROM OTHER SERIOUS INFECTIOUS SUID DISEASES

In addition to wild boar that are brought in for necropsy at SVA to screen for African swine fever and salmonella, SVA receives wild boar blood samples taken by helpful hunters. The blood samples are examined for important infectious pig disease agents.

In 2022, 112 samples were examined for classical swine fever virus, for Aujeszky's disease (pseudorabies), and 102 for brucella bacteria (*Brucella suis*). All samples and analyses were negative.

Wild boar and brown bear meat from hunting must be examined for *Trichinella* if the meat is to be sold. This gives a good monitoring of *Trichinella* infection in these populations, which combined, cover most of the country. However, there are different species of *Trichinella*, and not all of them are found in all wildlife species. SVA is one of several laboratories that offers *Trichinella* testing. If any lab finds *Trichinella*, a sample must be sent to SVA, as it is the National reference laboratory. Further typing of any found parasite is then done at the EU reference laboratory in Italy.

Hunter harvested wild boar are sampled for Trichinella *screening, as it is a zoonotic muscle parasite. Blood samples from hunted wild boar are also sent in by some helpful hunters to monitor serious infections in wild boar. Photo: Erik Ågren, SVA.*

ECHINOCOCCUS MULTILOCULARIS NATIONAL SURVEILLANCE

***Echinococcus multilocularis* is present only very sporadically in small foci in Sweden and is therefore difficult to monitor. A red fox harvested by a hunter in Borlänge municipality in 2022 was positive for this parasite. This was the only finding in 2022 outside of previously known, recently positive areas. Borlänge has had a single positive case before, in 2011.**

The second national surveillance of *Echinococcus multilocularis* was initiated in 2021 and continued in 2022. The target is to collect 3,000 red fox samples to map the presence of the parasite. The study is financed by the Board of Agriculture. A few cases of alveolar echinococcosis, the human disease caused by the parasite, have been found in Sweden the past years. This has made the Public Health Agency interested in having the parasite monitored and mapped.

SVA found the parasite in 2011 after ten years of surveillance of hunter harvested red foxes. The first intensified national surveillance of the parasite was done in 2011 - 2014. Five geographic areas with positive findings were identified in this period, in the municipalities of Uddevalla, Katrineholm, Gnesta, Borlänge, and Växjö. Repeated local sampling since 2011 has shown that the parasite has been continually present in at least Uddevalla och Gnesta.

Samples for the ongoing second national screening include fecal samples from dead red foxes or fox scats. Staff from the Swedish Association for Hunting and Wildlife Management help to collect samples, but samples from the general public are also welcome. The results of the analysis of submitted samples can be seen on a map on the SVA website www.sva.se. The single positive red fox from Borlänge shot in 2022 was confirmed positive in 2023.

Read more on the website sva.se regarding how to identify fox scats if you want to help find and submit samples for the surveillance of Echinococcus multilocularis *parasites.*

CONTINUED SURVEILLANCE OF WEST NILE FEVER VIRUS AND USUTU VIRUS

No cases of West Nile fever virus or Usutu virus were detected in 2022. These viruses seem to be absent in Sweden, or present only very rarely.

During the 2022 mosquito season, brain and liver samples from 158 found dead wild birds were analysed for West Nile fever virus (WNV) and Usutu virus (USUV); 43 thrushes, 11 corvids, 27 raptors and 5 owls. The birds came mainly from southern Sweden, with 90 birds from southern, 42 birds from middle and 26 birds from northern Sweden. The study was funded by the Swedish Environmental Protection Agency.

In 2022, 314 outbreaks of WNV in birds were reported from Europe, from Spain, Italy, Croatia, Hungary, Austria, and closest to Sweden, in northern Germany. USUV has only been diagnosed once in Sweden, in a blackbird found dead on Öland in 2019. In parts of Europe, such as in Germany, USUV is endemic and has been circulating among wild birds for a long time, with recurrent outbreaks, especially blackbirds and owls.

The closely related WNV and USUV are spreading in Europe. Both circulate between mosquitoes and birds and can cause serious disease outbreaks and mortality in some bird species.

Corvids, raptors, and thrushes are very susceptible to infections with WNV and/or USUV, while other bird species can become infected and shed virus without showing symptoms. Infected mosquitoes can transmit these viruses to humans when they feed, and human cases of WNV with encephalitis and some mortality has been seen regularly in parts of southern Europe for several years.

In a gradually warmer climate, it is probably only a matter of time before Sweden has the first case of WNV and further findings of USUV. Continued surveillance of both these viruses are warranted. The 2022 surveillance project was funded by the Swedish Environmental Protection Agency.

Blackbird. Photo: iStock

TRICHOMONIASIS CONTINUES TO AFFECT PASSERINES

Summertime mortality in passerines, especially in greenfinches, is largely caused by trichomoniasis, as this parasite causes a serious pharyngeal inflammation leading to starvation.

The single cell trichomoniasis parasite causes extensive avian mortality, mainly in greenfinches. Since the disease was discovered in Sweden in 2008, the greenfinch population is estimated to have decreased by as much as 40%. In 2020, and even more so in 2021, many dead greenfinches were reported to SVA.

Unlike previous years, many of the birds submitted for necropsy the past few years did not exhibit the typical yellowish, dry inflammation of the pharynx and crop seen previously with trichomoniasis infection, despite the birds being emaciated and showing dried feed on the beaks. This could indicate a new presentation of the disease, or that there was another disease affecting greenfinches.

Retrospective PCR analysis of samples from birds necropsied in 2019 – 2022 with suspected trichomoniasis, but where this had not been verified, showed that the majority of these cases truly were infected with trichomonas. Only about half of the necropsied greenfinches had obvious yellow necrosis in the pharynx, but microscopic examination of less obvious cases showed a profound inflammation of the pharyngeal mucosa, which would have made it difficult for these birds to eat and therefore led to starvation.

The study also highlights that the recommendation to stop any bird feeding and offering water for bathing for a period of a few weeks in connection with increased mortality in passerines still is valid, to attempt to limit the spread of this infection. The study was funded by the Swedish Environmental Protection Agency.

Greenfinch with trichomoniasis, a serious pharyngeal inflammation due to Trichomonas parasites. The soiled beak with dried feed is typical of these cases, as the birds cannot swallow feed, and therefore starve to death. Photo: SVA

MASS MORTALITY OF COMMON MURRE

During the winter of 2021–2022, reports were received of large numbers of dead and weak murres, along the Swedish west coast. Necropsies showed they had died of emaciation.

A total of 60 murres (a.k.a. guillemots) from different coastal sites on the west coast were brought in for examination at SVA. The birds were tested for avian influenza, but all were negative. Necropsies to find the cause of the mass mortality was done on 51 birds in suitable condition. Most of the birds were emaciated juveniles with empty gastrointestinal tracts. 73% of the birds had gastric ulcers in the transition between the gizzard and glandular stomachs, a lesion that may occur due to starvation. In several birds, there was needle-like chitinous material, which possibly may have been remnants of such organisms as sea stars or sea urchins, although these are not part of usual diet of murres. This sharp and pointy material may have contributed to lesions and ulceration of the gastric mucosa. A few of the murres had a mild parasitic burden and four birds had fungal pneumonia (*Aspergillus*). Five of the birds were investigated for other viral infections, and toxicology.

One of these five birds had elevated levels of a commonly used antibiotic, otherwise nothing abnormal was found.

During the summer of 2022, hundreds of murres died of avian influenza on the island of Gotland. This was a separate mortality event, not part of this project that was funded by the Swedish Environmental Protection Agency.

Dead murre on a sandy beach, Frösakull, Halland county. Photo: Angelica Ahlefeldt-Laurvig

TOXICOLOGY OF SUSPECTED POISONING CASES

Few laboratories offer toxicological analyses of tissues from wildlife, which limits the possibility of diagnosing suspected cases of poisoning.

Therefore, SVA set up a new diagnostic method in 2020, using liquid chromatography and high-resolution mass spectrometry for screening of toxic substances in tissue samples.

In 2021 and 2022, analyses were made of 102 samples from wild animals where poisoning was suspected at necropsy. This study was part of developing the national analytic capacity and at the same time obtaining results on the presence and extent of poisoning of Swedish wildlife. The investigated cases were dominated by corvids (about 60%), as these predominate the findings of unexpected mortality events happening in a brief time frame and in a limited geographical area.

Suspected but not confirmed findings of toxic and foreign substances were indicated in 59 individuals. The most found substance was caffeine, present in 39 cases, mainly in corvids. In addition, the results indicated presence of various rodenticides, plant and fungal toxins, and pharmaceutical residues in a few animals.

The frequent indication of caffeine poisoning associated with local mass mortality among jackdaws is noteworthy. The study also gave strong indications of both intentional poisoning of birds and accidental secondary poisoning of predators that feed on rodents. The study was funded by the Swedish Environmental Protection Agency.

Jackdaw. Photo: Karin Bernodt, SVA

ANTIBODIES AGAINST TULAREMIA IN HARES

A new analytic method showed that hares and muskrats had been exposed to the bacterium causing tularemia.

The zoonotic disease tularemia is caused by the bacterium *Francisella tularensis* subsp. *holartica*. The disease is seen in recurrent outbreaks during the summer months in both animals and humans. The infection can be transmitted between hosts in different ways, but mosquitoes are considered to play an important role. In Sweden, the disease has previously been diagnosed primarily in mountain hares (*Lepus timidus*) in northern Sweden, where affected hares usually died of acute septicaemia.

More recently we have seen a change in the epidemiology of tularemia. Hare carcasses found positive for the disease have been found also in southern Sweden and we are receiving a lot of European brown hares that died of tularemia, often with a more chronic course of disease and some with only minor tissue lesions. This, combined with the southern spread of the disease, forms the basis of this study.

To investigate if hares and muskrats had been exposed to the bacterium *F. tularensis* subs. *holartica*, 721 blood samples were analysed for presence of tularemia-specific antibodies. The blood samples were collected at necropsy from hares submitted to SVA within the national general wildlife disease surveillance program from 2015 to 2021. The samples were therefore not representative for the entire populations of hares in Sweden. The muskrats had been culled as invasive species along the north-eastern coast of Sweden.

The analysis was done with a cELISA (competitive enzyme-linked immunosorbent assay) method. One aim of the study was to evaluate whether this cELISA was useful for investigating exposure of the tularemia bacterium in wildlife.

The incidence of positive cases in the study was higher than expected, with 53.5% of the examined hares and 68.9% of the muskrats positive for tularemia antibodies.

Positive cases were from animals both with or without lesions typical of tularaemia. The results indicate that hares more often have time to form antibodies against the infection than we previously thought, and that more animals survive the infection. Hares with antibodies against the tularemia bacterium were found in all counties in Sweden, including counties where tularemia had not previously been found in hares. There was no difference in exposure rates between European brown hares and mountain hares. The project was funded by the Swedish Environmental Protection Agency.

Dead European brown hare found in Uppsala County. The hare was examined for tularaemia, as this disease now is present throughout the whole country. Photo: Henrik Uhlhorn, SVA.

INVASIVE SPECIES AND SURVEILLANCE OF CONTAGIOUS DIESASES

Stone martens have appeared in southern Sweden as a new invasive species.

Stone martens (*Martes foina*) have been found in southern Sweden in the past couple of years. The Invasive species task force has the mission from the Environmental Protection Agency to find and cull invasive mammals and birds. They have submitted 23 culled stone martens to SVA in 2022. Some of the ten culled adult females may have already reproduced in Sweden. The stone marten causes damages and economic impact by chewing on electric wiring in the engine compartment of cars!

The stone marten can be distinguished from the pine marten (*Martes martes*) by a white instead of a yellow throat patch, and it has naked paw pads and a pale instead of a black nose.

Each member state of EU is to have a plan for how to quickly find and then to manage any introduction of invasive species in the country. Invasive species are non-endemic species that have been introduced by human activities and may cause extensive damage to biodiversity, to society, or to the economy.

SVA screens culled or found dead animals of invasive species for relevant infectious agents. Mustelids are susceptive to SARS-CoV-2 and influenza viruses. Raccoon dogs can carry Echinococcus multilocularis and rabies virus. Muskrats are screened for tularemia, Egyptian geese for avian influenza virus, and water turtles for salmonella bacteria.

Stone marten (Martes foina) *culled in southern Sweden. The bright white throat patch and visible paw pads distinguishes it from the pine marten* (Martes martes). *Photo: Invasive species task force.*

Research & Development

GARDEN WILDLIFE HEALTH GROWS

The Swedish Garden Wildlife Health programme *Vilthälsa inpå knuten* is part of the general wildlife disease surveillance.

In 2022, over 300 new members were registered in the Swedish Garden Wildlife Health network, a citizen science approach on surveillance of health and disease in urban wildlife, i.e. those that live in the vicinity of humans.

During 2022, information about targeted surveillance projects was mailed as newsletters to registered members, including projects for surveillance of West Nile fever virus, Usutu virus, and avian influenza in birds. The newsletters also informed members that SVA is searching for more reptile and amphibian cases for necropsy, as knowledge on health and diseases in these animals is quite limited.

Vilthälsa inpå knuten currently has over 800 members made up of people who feed garden birds and other interested members of the public, in all Swedish counties. One aim is to expand the network and improve reporting and surveillance of all wildlife present in the urban environment. In an increasingly urbanised world, gardens are also becoming increasingly important for biodiversity.

Another aim is to have good coverage, with reports and wildlife samples for examination from the whole country. With a large reporting network in all counties and preferably in all municipalities, we will improve knowledge on health and diseases, as well as more efficiently receive indications of when and where increased wildlife mortality or disease outbreaks occur. Incoming data and results from submitted samples can be compiled and processed to use to better target wildlife surveillance and sampling, as well as inform the public of ongoing events.

Common lizard with a female Ixodes ricinus *tick on the chin, on a compost container in a garden. Photo: Erik Ågren, SVA.*

WHO SUBMITS FALLEN WILDLIFE, AND WHY?

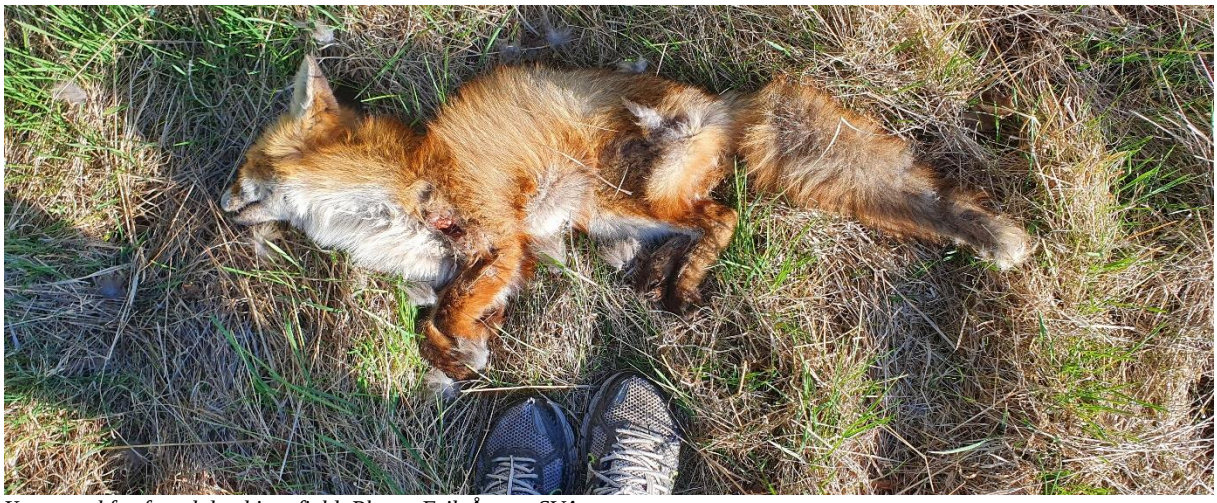
How can we improve the general wildlife disease surveillance? This interdisciplinary research project is funded by the Wildlife Management Fund and the Swedish Association for Hunting and Wildlife Management.

Focus group discussions and questionnaire studies were done in 2022 to better understand who reports dead or sick wildlife and what factors affect the submission of cases or samples to SVA. We also continued the work done in 2021, where we mapped the previous 10 years of wildlife cases to better understand the samples and data that we receive.

The aim of the study is to improve Sweden's wildlife disease surveillance and thereby contribute with better knowledge for decision-making in wildlife management. The project runs until 2024 and is done in collaboration with epidemiologists at SVA and social scientists at Lund University.

The Swedish wildlife disease surveillance programme at SVA is based on general disease surveillance of dead or killed sick wildlife. The data relies on citizen science with voluntary reporting and submission of animal carcasses or samples from the field.

The study uses descriptive data analysis, geographic modeling, a questionnaire study, and focus group interviews to understand what is submitted and who contributes to the program and why. By identifying factors that influence the selection of samples and understanding the demographics and motivation of those who voluntarily report and submit samples, we will gain knowledge to help find strategies to facilitate the submission of samples and increase public involvement and motivation so that relevant wildlife health issues can be prioritized.



Young red fox found dead in a field. Photo: Erik Ågren, SVA

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Interesting cases

Here are some of the cases examined during the year that were out of the ordinary. It could be a new or unusual disease or just an odd case with unexpected findings.

RED FOX WITH TWO PREGNANCIES

A red fox (*Vulpes vulpes)* shot during hunting had two pregnancies from two separate matings, a heterotropic pregnancy with superfetation.

The fox was sent to SVA as part of the *Echinococcus* surveillance and was an old female in good body condition. At the postmortem examination, three ~5 cm in diameter, round structures were noted in the abdomen. Each structure was composed of a fetus in its fetal membranes, with the fetus being fully developed but partly mummified. Additionally, the uterus had a focal enlargement, consisting of again a fetus in its fetal membranes, but only a few cm in length (early in the gestation). No other significant findings were seen in the uterus or other organs.

Abdomen of a pregnant female fox, with three round structures in the abdominal cavity. The structures were fully developed, partly mummified fetuses in their membranes.

Ectopic pregnancies, with fetuses free in the abdomen are rare, but can occur in both animals and humans. The fertilized eggs end up in the abdominal cavity instead of traveling down the ovarian duct to the uterus. Trauma or disease in the genital tract can predispose of this event. Intraabdominal pregnancies are dangerous for the mother as the fetuses cannot be delivered without surgery and die, as in the present case. If the fetal death is early in the pregnancy the fetuses can also be resorbed. The fox also had a seemingly normal, more recent pregnancy which could indicate that the cause for the ectopic pregnancies had been resolved and that the fox was generally doing well. No previous case in foxes is described, but it has occurred in rabbits and chinchillas.

Top: three mummified fetuses from the abdomen. Below, the uterus with a red arrow pointing to the more recent, intrauterine pregnancy is seen.

SEA TURTLE IN SWEDISH WATERS!

In January 2022, an unusual Swedish wildlife case arrived, a loggerhead turtle (*Caretta caretta*) that had stranded on the west coast island of Smögen.

The sea turtle carcass was submitted to the Gothenburg Museum of Natural History and sent for necropsy to SVA within the general wildlife disease surveillance. The museum informed us that a turtle of this species had only been found one time previously on the Swedish west coast, more than 100 years ago, in Marstrand in 1890. This species usually lives in warm water coastal areas and the nearest site where they reproduce is on the Canary Islands. Young loggerhead turtles live in the Atlantic Ocean and can be found as far north as the UK. When females reach sexual maturity, they return to the same beach where they were born, to lay their eggs.

The sea turtle was a female in good nutritional condition and was determined to be at least 13 years old according to annulations in a finger bone.

The cause of death could not be determined with certainty, but it is possible that low water temperature led to hypothermia. At necropsy, swelling and acute haemorrhage in the forelimbs were seen, which indicates that accidental bycatch in fishing gear could not be ruled out as a cause of death. Parasite-caused inflammation was also seen in large blood vessels near the heart, which was considered to maybe have affected the animal and contributed to reduced endurance. Healed traumatic lesions were seen on the carapace and some scarring of membranes was observed in the abdominal cavity.

An old, healed lesion in the carapace of the stranded sea turtle from the Swedish west coast is seen. Photo: SVA

Marine mammals

HEALTH AND DISEASE

Whole carcasses of 41 porpoises and 22 seals were examined in 2022. The number of marine mammals examined annually is limited and long-term surveillance is needed to identify trends regarding health, disease, and causes of death for these species.

SVA, together with the Swedish Museum of Natural History (NRM), has been running a health and disease surveillance programme for marine mammals since 2020, with funding from the Swedish Agency for Marine and Water Management (HaV). The programme includes cetaceans found stranded (dead with unknown cause of death) and bycaught (accidentally caught in fishing gear), and stranded seals. SVA and NRM collect data to monitor where, when, and how marine mammals die. Additionally, suitable carcasses are brought in for necropsy and tissue sampling to investigate health, disease, and causes of death.

Below is a summary of the marine mammals studied at SVA in 2022. In total, carcasses of 63 marine mammals were examined at SVA in 2022, including 41 porpoises, 11 grey seals, and 11 harbour seals. In addition, tissue samples from 75 hunter harvested seals were analysed for presence of influenza virus. For more details, and description of interesting necropsy findings, see the report "Health, diseases and causes of death in marine mammals 2022", available on the SVA website sva.se.

WHALES

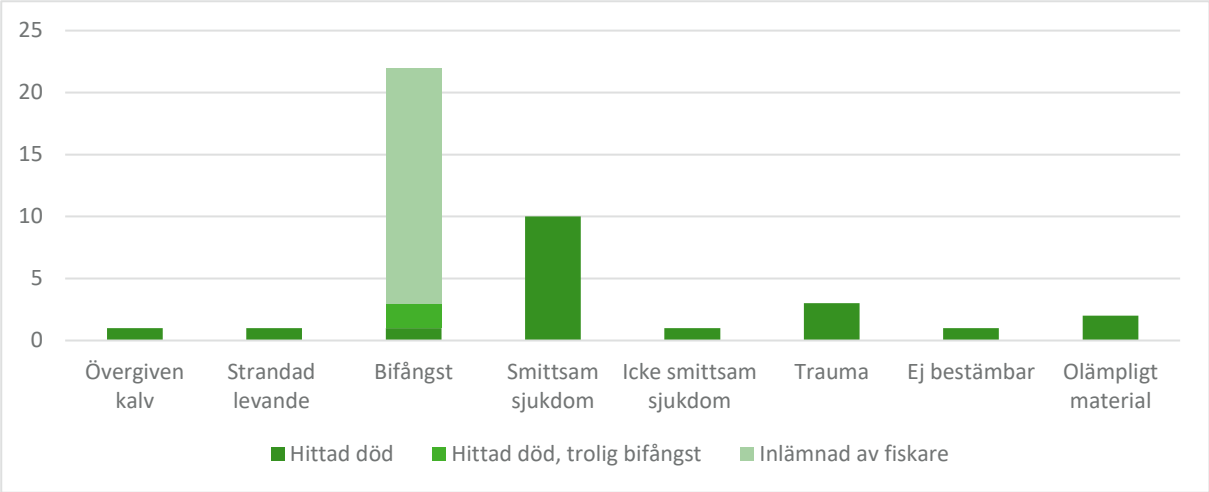
Porpoises

Of 22 examined stranded porpoises, the most common cause of death was infectious disease (n=10, see figure below) such as pneumonia caused by parasites and/or bacteria.

One porpoise that died from infectious disease was a young male with encephalitis caused by highly pathogenic avian influenza virus H5N1, (published by Thorsson *et al*, *Emerging Infectious Diseases*, April 2023). This is the first case where avian influenza virus was documented to cause disease in a porpoise.

Only one of the stranded porpoises was diagnosed as bycatch, and two as probable bycatch. A newborn calf was abandoned by its mother. Three porpoises had

Photo, left: Young male porpoise stranded alive in Kämpersvik was diagnosed with highly pathogenic avian influenza virus. The picture shows the attempt to support and give the exhausted porpoise a chance to recover. The QR-code links to a video of the porpoise.
Photo: Fabian Sanchez

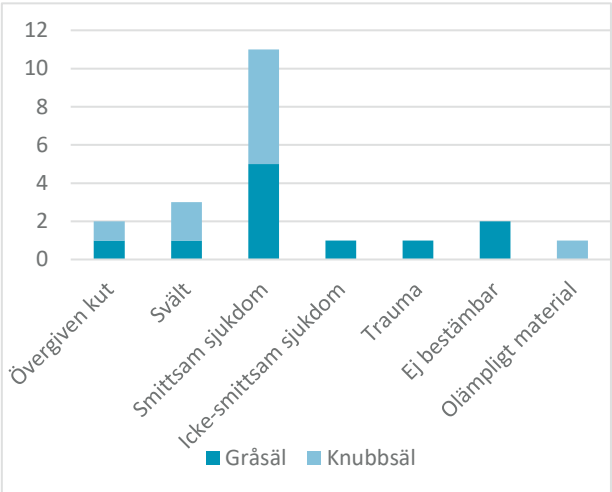


Overview of the primary diagnosis (cause of death) for porpoises examined in 2022.

injuries consistent with trauma, two of which were probably caused by predators.

The cause of death could not be determined in four animals, two of which were so greatly decomposed that it was not possible to establish cause of death. However, some samples and data could still be collected from these animals.

In the 19 porpoises submitted as bycatch, typical injuries were seen; linear pressure marks and thin skin cuts from gill nets on the head and appendages. The lungs often were fluid filled with stable foam in the trachea, which is seen in drowning. In some cases, bruises, effusions, and internal injuries could also be seen. In addition to this, pathologic lesions were also found in some animals. Six porpoises had abundant parasites in the lungs, with pneumonia in three cases.



Overview of the primary diagnosis (cause of death) for seals examined in 2022.

SEALS

The most common cause of death in seals was infectious disease such as parasitic infestation and bacterial infection (n=11, six harbour seals and five grey seals, see diagram on the left). Two grey seals died of non-infectious causes. Two newborn seals (one grey seal and one harbour seal) died after being abandoned early in life, and three young-of-the-year (one grey seal and two harbour seals) died of emaciation. For three others, the cause of death could not be determined, the body in one case being severely decomposed.

The first case of avian influenza in grey seals in Sweden was detected in 2021. Widespread outbreaks of avian influenza were seen in seabirds in the summer of 2022. Influenza virus was not detected in stranded seals or in seal samples from bycatch or hunting in 2022.

However, antibodies against influenza virus were found in 10 grey seals shot during the 2022 licence hunt. This means that these seals had previously been in contact with the influenza virus and coped with the infection. Further analyses are ongoing, but at least two grey seals had antibodies against the same type of influenza that affected seabirds the same year.

Large carnivores

The number of large carnivores examined at SVA has increased by 80% in five years, mainly because of increased licensed hunts. Any bear, lynx, wolf, or wolverine found dead, killed, or felled during hunting must be sent to SVA for examination.

In total, SVA handled entire carcasses or parts of 987 large carnivores in 2022. Most cases arrived as skinned carcasses from licensed hunting or other management-related measures. Traffic-related death was the second most common cause of death. The most important disease in some large carnivores is sarcoptic mange, which usually leads to emaciation in affected animals. Forensic pathology is done as part of the investigation of suspected crime cases.

SVA has the task of handling large carnivore carcasses under the directive of the Swedish Environmental Protection Agency, as part of the management of these species. The EPA regulations NFS 2002:18 42 § state that if you find dead animals or animal parts of these species, this must be reported to the police, for transport to and examination at SVA.

When large carnivores are culled, the carcass nowadays becomes the property of the hunting rights holder or landowner. However, decisions on the conditions of the hunt usually state that certain parts or samples are handed over to SVA. The work with large carnivores at SVA is an important part of investigating the health situation in these populations. With similar monitoring over many years, trends in health and disease can be followed.

Below, we summarise the causes of death and health status of bears, wolverines, lynx, and wolves examined at SVA in 2022. More details are published in SVA's report on Large Carnivores 2022, as well as in the reports published after each licensed hunt, in 2022 for wolves, lynx, wolverines, and bears. These can be found on SVA's website sva.se.

Table with number of large carnivore cases registered at SVA per year, for 2013–2022. Cases can be entire carcasses, parts of animals or just sets of tissue samples. Ref. SVALA och SVA Annual report 2022.

Species	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Bear	345	337	312	264	310	360	377	444	596	737
Lynx	181	84	57	116	158	136	144	168	168	186
Wolf	50	36	73	47	67	37	28	31	57	49
Wolverine	30	26	37	14	12	7	11	30	16	15
Total	**606**	**483**	**479**	**441**	**547**	**540**	**560**	**673**	**837**	**987**

BEAR

In total, 737 bear cases were received in 2022. 623 were from licensed hunting, where only tissue sample sets are sent to SVA. This sampling of felled bears was carried out with new routines introduced in 2021. Minimum sampling is done from all bears but for every third bear, as well as for bears tagged by the Scandinavian Brown Bear Project, an extended sampling protocol is done. Of 87 bears from protective culling, 68 came as entire carcasses to SVA and the rest as tissue sample sets. Two bears had been shot in self-defense situations. Fifteen bears were killed in traffic. Other cases included two bear-killed juvenile bears, one bear that was euthanized due to lameness and two cases were decomposed bear bodies where cause of death could not be determined. Four bears were submitted as forensic cases.

The health status of the brown bear population is assessed as good and no severe diseases were noted in the examined bears. As minor findings, some cryptorchid males and some minor fresh or older injuries were noted, as well as a few bears with damaged or worn-down teeth. Intestinal parasites, both nematodes and tapeworms, were noted in parts of the bear population areas. This has been noted regularly in recent decades. Fur lice was noted in a single bear.

WOLVERINE

In 2022, 15 wolverines were received, nine of which were culled, one animal was killed in traffic and one was euthanized due to a head injury, possibly due to traffic. Severe tooth wear was noted in a wolverine, which, however, was in normal body condition. Only parts were found from our wolverines and they were submitted for species determination by genetic analysis.

The 15 wolverines that were felled during the licensed hunt in 2022 in Jämtland County were not received by SVA until the beginning of 2023 and are therefore not included in this report for 2022. However, no pathological changes were found during the examinations of these animals. Wolverines seem to have a good health situation, without findings of serious diseases most years, but the number of animals examined each year is low.

LYNX

During 2022, 186 lynx were examined, with 107 from licensed hunting and 25 culled. 35 lynx were killed in traffic, most on roads, but six were killed on railroads. Two lynx were submitted as forensic cases. Five lynx carried trichinella. One lynx had a congenital absence of a kidney, and one male was unilaterally cryptorchid. Twelve lynx had sarcoptic mange and nine of these had starved to death. Sarcoptic mange is the most common infectious disease in this population.

WOLF

A total of 49 wolves were examined in 2022, with 28 wolves from licensed hunting, 13 from protective culling, and one wolf was killed to protect domestic animals (JF 28§). Seven wolves died in traffic accidents.

Necropsy findings included old, healed injuries. One wolf had shotgun pellets from a previous shooting. Four of 25 males were cryptorchid. Some animals had dental misalignments or tooth defects of minor importance. Two cases of trichinella were detected, while *Echinococcus* parasites were not detected in any wolf.

Wolf in zoo. Photo: Karin Bernodt, SVA

Publications 2022

Here we list selected wildlife publications with authors from the Wildlife section or other departments at SVA, these names are in bold.

SCIENTIFIC PUBLICATIONS, SELECTED

Stavenow J, Roos AM, **Ågren EO**, Kinze C, Englund WF & **Neimanis A**. 2022. Sowerby's Beaked Whales (*Mesoplodon bidens*) in the Skagerrak and Adjacent Waters: Historical Records and Recent Post-Mortem Findings. *Oceans 3*(3), 250–267.

Neimanis, A., Stavenow, J., Ågren, E. O., Wikström-Lassa, E., & Roos, A. M. 2022. Causes of Death and Pathological Findings in Stranded Harbour Porpoises (*Phocoena phocoena*) from Swedish Waters. *Animals*, *12*(3), 369.

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Pereira, P., Esteruelas, N. F., Nakamura, M., Rio-Maior, H., Krofel, M., Di Blasio, A., Zoppi, S., Robetto, S., Llaneza, L., Garcia, E., Oleaga, A., Lopez-Bao, J. V., Martinez, M. F., **Stavenow, J., Agren, E. O**., Alvares, F., & Santos, N. (2022). Hair cortisol concentration reflects the life cycle and management of grey wolves across four European populations. *Scientific Reports*, *12*(1), 10, Article 5697.

McDevitt, A. D., Coscia, I., Browett, S. S., Ruiz-González, A., Statham, M. J., Ruczyńska, I., Roberts, L., Stojak, J., Frantz, A. C., Norén, K., **Ågren, E. O**., Learmount, J., Basto, M., Fernandes, C., Stuart, P., Tosh, D. G., Sindicic, M., Andreanszky, T., Isomursu, M., . . . Wójcik, J. M. (2022). Next-generation phylogeography resolves post-glacial colonization patterns in a widespread carnivore, the red fox (*Vulpes vulpes*), in Europe. *Molecular Ecology*, *31*(3), 993–1006.

Grant M, **Bröjer C**, Zohari S, Nöremark M, **Uhlhorn H**, Jansson DS. Highly Pathogenic Avian Influenza (HPAI H5Nx, Clade 2.3.4.4.b) in Poultry and Wild Birds in Sweden: Synopsis of the 2020–2021 Season. Vet Sci. 2022 Jul 8;9(7):344.

REPORTS

SVA annual report 2021. Wildlife. **Erik Ågren** (SWE)

Surveillance of infectious diseases in animals and humans in Sweden 2021. Postmortem examinations in wildlife, **Erik Ågren**. Tularaemia, **Henrik Uhlhorn**. (in English)

Health, disease, and causes of death in marine mammals 2021. SVA report 72:2022. **Aleksija Neimanis, Elina Thorsson, Jasmine Stavenow**, Anna Roos (SWE)

Licensed wolf hunt 2022. SVA report 74:2022. **Erik Ågren, Minerva Löwgren**. (SWE)

Wildife disease surveillance in Sweden 2022. SVA report 76:2022. Editor: **Erik Ågren** (SWE and in English)

Licensed lynx hunt 2022. SVA report 80:2022**. Erik Ågren, Minerva Löwgren**. (SWE)

PRESENTATIONS 2022, SELECTED

Norén K., Nordengrahn A., **Neimanis A.**, **Uhlhorn H.**, Tällberg G., Rosendal T. and **Spörndly-Nees E.** Tularemia, more frequent in Swedish hares than previously thought? Poster, SVA research days. 2022-11-29

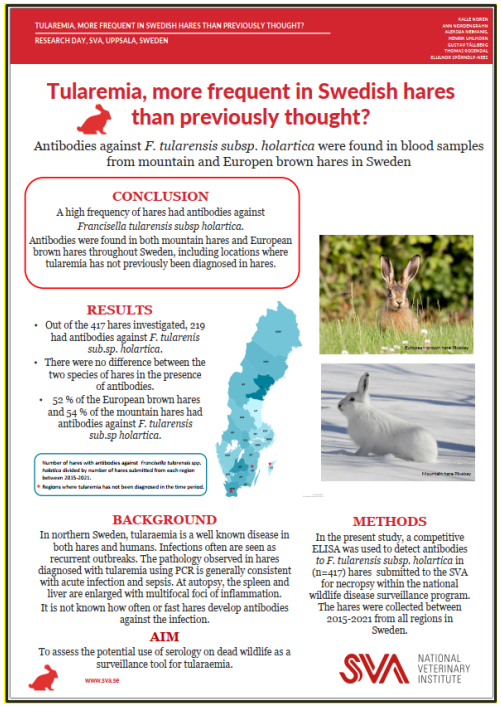
Averhed G., Olofsson-Sannö K., Spörndly-Nees E. Cause of mass mortality in Guillemots (*Uria aalge*) during winter 2021–2022. Poster, SVA research days.

Skandulv meeting 7–9 mars. Presentation: Wolves at SVA. **Erik Ågren, Minerva Löwgren**.

Viltmästareförbundets annual meeting 21–22 March. Kosta. Wildlife diseases**. Erik Ågren**.

Wikström-Lassa, E., Sanchez-Cordon, P.J, Núnez, A., Lean F.Z.X., Crooke, H., **Neimanis A**., **Gavier-Widén, D**. Implementation of standardized macroscopic, histopathological and immunohistochemical scoring systems as useful tools to evaluate disease pathogenesis in domestic pigs and wild boar infected with African swine fever virus. Poster presentation at GARA-meeting, Dominican Republic, 24–27 May.

Invasive species task force reference group, 1 June, Umeå. SVA work with invasive species. **Erik Ågren**.



Josep Estruch Morente, Carlos Rouco, Joana Abrantes, Ana M. Lopes, Tereza Almeida, **Aleksija Neimanis**, Santiago Lavín, Jordi Ruiz-Olmo, Roser Velarde. Emerging European brown hare syndrome virus in *Lepus europaeus* in Spain. Oral presentation at the 6th World Lagomorph Conference, Montpellier, France. 4-8 July.

Caroline Bröjer, Henrik Uhlhorn, Siamak Zohari**, Malin Grant, Elina Thorsson, Gustav Averhed, Karin Olofsson-Sannö, Minerva Löwgren**. Monitoring highly pathogenic avian influenza (HPAI) and the role of citizen science. Oral presentation at NKV (Nordic Congress of Wildlife Research), Sep 2022, Uppsala.

Caroline Bröjer, Patrik Olofsson, Mikael Kristersson, Rolf Larsson. Avian influenza in Sandwich terns in Sweden. Oral presentation, symposium Development and consequences of the recent bird flu outbreak among sandwich terns in the Wadden Sea and adjacent areas, Oct 2022.

VISITORS TO THE WILDLIFE SECTION

Jägarnas riksförbund board, 26 April.

Ministry of Economics, 25 August

Outreach

COURSE ON INSPECTION OF LARGE CARNIVORE CARCASSES

In June, the annual course for County Administrative Board inspectors was held at SVA together with the Wildlife Damage Centre (SLU), with hands-on training and teaching the administrative aspects of inspecting and sampling hunter harvested large carnivores.

EXPERT OPINIONS 2022

The Environmental Protection Agency (EPA) suggested regulation regarding methods of euthanasia for vehicle injured game.

The EPA, National management plan for bear, wolf, wolverine, and lynx 2022–2027.

GOVERNMENT ASSIGNMENTS 2022

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

The Government assignment ”The wild boar package” **Vildsvinspaketet** was reported back to the government in January 2022. The report is available on **sva.se.** SVA continues to participate in the project group and communications group.

Continuing education

TRAINING CENTRE FOR WILDLIFE SPECIALISTS

The wildlife section presently has one resident training for the board examination of the ECZM (European College of Zoological Medicine), within the Wildlife Population Health specialty. In 2021, SVA was approved as a training centre for this specialist training programme. The section has two ECZM diplomates, functioning as programme director and supervisor, respectively. The residency is partly funded by a grant from the Marie-Claire Cronstedt foundation. In addition, there are two board certified veterinarians within other colleges, the ECVP and ACVP, as European and American specialists in veterinary pathology, respectively, in the Wildlife section.

ECZM
EUROPEAN COLLEGE
OF ZOOLOGICAL MEDICINE

Expert groups

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

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

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

SVA Scientific council: Aleksija Neimanis

SVA Environmental and Climate committee: Emma Höök

SVA Zoonosis centre working group: Henrik Uhlhorn for POV.

SVA R&D coordination group: Ellinor Spörndly-Nees

SVA Poultry forum: Caroline Bröjer

SVA Animal welfare organ: Henrik Uhlhorn

Board of Agriculture wildlife reference group, SVA representant: 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 (no activity in 2022)

ECZM, European College of Zoological Medicine, Wildlife Population Health specialty: Caroline Bröjer examination committee, resident programme director, Erik Ågren resident supervisor

Journal of Wildlife Diseases, associate editors: Erik Ågren, Aleksija Neimanis

WOAH Focal point for wildlife: Erik Ågren

HEALTHY WILDLIFE – SAFE HUMANS

NATIONAL VETERINARY INSTITUTE

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