NATIONAL VETERINARY INSTITUTE

WILDLIFE DISEASE MONITORING IN SWEDEN 2013

Jackdaw (Corvus monedula)

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Introduction

The health situation of wildlife in Sweden is monitored through SVA's work with the wildlife disease surveillance programme (VSÖP Viltsjukdomsövervakningsprogrammet), and is a continuation of a long-term systematic study of fallen wildlife, which was initiated in the 1940´s by professor Karl Borg at SVA.

This annual report presents an overview of the wildlife work SVA has performed within VSÖP 2013. The report includes the important wildlife diseases that have been noted and cases or diseases of particular interest during the year.

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Wildlife disease surveillance in Sweden

The Government's regulatory letter specifies that the veterinary expert authority, the National Veterinary Institute (SVA) should do a comprehensive assessment and analysis of the health and disease situation regarding domestic and wild animals in Sweden. This report describes the activities and results of interest concerning wild animals, during 2013.

Wildlife disease surveillance programme (VSÖP) was created in 2006 in collaboration with the environmental protection agency (EPA) and includes monitoring of diseases of wild mammals and birds in Sweden. The basic work is carried out as a general disease surveillance (fallen game), supplemented with active monitoring and investigative efforts. The basic wildlife work at SVA is financed from the EPA´s fund for of biodiversity and by funding from the State Wildlife Fund (Viltvårdsfonden).

General disease surveillance (formerly known as passive disease surveillance) involves diagnosing diseases and monitor the disease situation in the country by necropsies of fallen wildlife or slaughtered sick wild animals, as well as documenting observations of morbidity or mortality among wild animals received from the public or from involved government agencies.

Targeted disease surveillance (formerly known as active surveillance) involves performing targeted sampling, and examining sick or healthy animals for certain specific diseases or disease agents. Most often these investigations are initiated by something that has been picked up by the general surveillance, or by gathering information on current ongoing outbreaks, or reported population changes.

Wildlife Disease Council (VSR) is a group of experts and officials from the environmental protection agency and SVA who exchange information on wildlife disease surveillance and wildlife management, and discuss appropriate targeted disease surveillance studies on wildlife in Sweden. The Council has in 2013 consisted of Klas Allander, Ola Inghe and Tulikki Rooke from the environmental protection agency. SVA has been represented by Carl Hard af Segerstad, Torsten Mörner and Erik Ågren, with Henrik Uhlhorn as secretary. VSR held two meetings in 2013.

STAFF WORKING WITH WILDLIFE DISEASE INVESTIGATIONS IN 2013

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Wildlife diseases of particular interest, 2013

FOX TAPEWORM – ECHINOCOCCOS

After the first discovery of the dwarf tapeworm (*Echinococcus multilocularis*) in Sweden, in a red fox (*Vulpes vulpes*) shot in the municipality of Uddevalla on the west coast of Sweden in late 2010, a targeted surveillance has been conducted since 2011. The surveillance is done by collecting and analysing fox droppings and to a lesser extent also fecal samples from hunter-killed foxes. The surveillance has been a joint effort directed by SVA, Board of agriculture, the environmental protection agency and the Swedish Hunters ' Association, and a PhD project at the University of Agricultural Sciences (SLU) has also contributed with samples. In 2013, the parasite was detected on three occasions. In the municipality of Katrineholm the parasite was found in fox droppings, and also in a submitted fox. In the municipality of Uddevalla the parasite was found in a submitted fox.

POISONING IN JACKDAWS

Within a few days in January 2013, three groups of dead jackdaws (*Corvus monedula*) were found in two different locations some kilometers apart, in the county of Skåne. Birds from the three groups were submitted for necropsy at SVA. There were no signs of infectious disease and the large number of birds that died at the two sites within a very brief period of time led to suspected poisoning as the cause of death. Laboratory testing found ethylene glycol in organ samples from one group of birds, but not from the other.

Ethylene glycol is a common component in antifreeze products. Since ethylene glycol is tasty (sweet) but also very toxic to most animals, and even humans, manufacturers have now replaced it with propylene glycol. However, there are still ethylene glycol in some brands of motor engine antifreeze products available on the market.

Unfortunately, ethylene glycol poisoning was previously a common cause of death in dogs especially, as it causes an acute renal failure that leads to death.

Jackdaw found dead in South-West Skåne in 2013.

CAFFEINE POISONING IN JACKDAWS

In May 2013, a group of dead jackdaws was found in Helsingborg, in the county of Skåne. Necropsy results was suspected poisoning, and laboratory analysis performed in the United States demonstrated presence of caffeine in all analysed birds. Waste or garbage with caffeinated residues are suspected to be the source of poisonings.

AVIAN PARAMYXOVIRUS-1 IN PIGEONS

Three outbreaks of high morbidity and mortality rates of pigeons (*Columba livia*) were reported in 2013 in the counties of Örebro (two outbreaks) and Södermanland (one outbreak). The disease is caused by a para-myxovirus, which produces inflammation in internal organs, and affects the brain so that the birds become ataxic or fly erratically. If the same virus infects poultry, it causes Newcastle disease and high biosafety is vital to avoid spread of the virus from wild birds into poultry farms. At an outbreak of the disease in pigeons, farmers are required to bring poultry indoors. No outbreaks in domestic fowl were reported in 2013.

HARE

During 2013, a total of 31 European brown hares (*Lepus europaeus*) and 6 mountain hares (*Lepus timidus*) were necropsied in the general disease surveillance. Ten European brown hares and one mountain hare had died of tularemia, as this bacterium causes a generalized infection in hares. Coccidiosis is caused by unicellular parasites in the intestines, and was diagnosed in three European brown hares. Pseudotuberculosis, caused by the bacterium *Yersinia pseudo-tuberculosis*, causes a generalized infection with abscesses in internal organs. The disease was diagnosed in two European brown hares, both from the same area. Two mountain hares had contagious mucocutaneous dermatitis, a skin infection caused by the bacterium *Treponema cuniculi*. Five further hares had died of infections, but no specific etiology could be identified.

Mountain hare with contagious mucocutaneous dermatitis.

MOOSE

In 2013, SVA did a targeted and increased effort to examine dead moose (*Alces alces*), to follow up an increase in reported mortality of moose in southern Sweden. The aim was to characterize diseases and causes of death of euthanized sick, or fallen moose in the area. A total of 52 moose were examined within this investigation. In addition, samples from an additional 43 moose, including seven complete carcasses from other areas were investigated for comparison. Disease and causes of death were variable and no single disease entity was identified. The results did not significantly differed from investigations in moose made in previous years. Diagnoses were dominated by the categories emaciation, trauma, infectious diseases (parasitic and bacterial), and a few cases of tumors.

ROE DEER

In 2013, parts or whole carcasses from 29 roe deer (*Capreolus capreolus*) were examined. No specific increased mortality was reported during the year, but investigation of dead roe deer, being a game animal as well as often being present in residential areas, is of interest for hunters and the general public. The examined deer were diagnosed with a variety of causes of death, including starvation, diarrhea, as well as mechanical (traumatic) injuries of various origins.

Roe deer, female in the wild.

BROWN BEAR

In 2013 whole carcasses, or parts of 345 brown bears (*Ursus arctos*) were examined, where 300 sets of organ samples were from bears felled in license hunting and 21 whole bodies from euthanized nuisance bears. The most common cause of death in non-hunting related mortalities were road traffic accidents (9 bears).

WOLF

In 2013, a total of 50 wolves (*Canis lupus*) were necropsied. Most wolves (27) were the skinned carcasses from the regulated hunt, where it was compulsory to submit the carcass to SVA for necropsy and tissue sampling. Road- or train-kills are common causes of death (7). Seven wolves had undetermined diagnosis due to decomposed or incomplete carcasses. The main disease noted in necropsied wolves was sarcoptic mange (6), where most were euthanized for animal welfare reasons.

WOLVERINE

In 2013, a total of 30 wolverines (*Gulo gulo*) were examined at SVA. Of these, 23 had been euthanized after decision by the County Administrative Board, as a preventive measure against predation on semi-domesticated reindeer (*Rangifer tarandus*). Diagnoses for the remaining seven wolverines included emaciation, intestinal torsion, trauma (including road-kills).

Wolverine on X-ray table, SVA.

LYNX

In 2013, a total of 181 lynx (*Lynx lynx*), where 83 were fallen lynx, 98 lynx were shot during the licensed hunt, and 13 were shot following a decision by the authorities. The most common causes of death in fallen lynx were traffic-caused mortality (37). Eleven of 12 emaciated lynx had sarcoptic mange.

Sarcoptic mange in a lynx, SVA.

RED FOX

The red fox (*Vulpes vulpes*) population in Sweden has increased (as noted by increasing hunting bags) after an extensive outbreak of sarcoptic mange (caused by *Sarcoptes scabiei*) in the 1980´s and 1990´s. The disease remains present in the fox population, with an unknown prevalence and irregular reports and finding. The disease spills over to other species, such as lynx and wolves, due to predation of foxes, as well as domestic dogs, and is a common cause of death in the most affected wildlife species. Other common causes of death noted from necropsied red foxes, is mechanical trauma and severe infections following bite wounds after intraspecific fighting.

WILD BOAR

The wild boar (*Sus scrofa*) population and the hunting bag has increased immensely the past decades, but the number of cases submitted to SVA has been low, with 22 wild boar examined at SVA in 2013. Diagnoses were emaciation (8 cases), inflammation/infection (5 cases), as well as trauma (3) and sarcoptic mange (3). Since 2009, occasional free ranging wild boar have been diagnosed with sarcoptic mange, by SVA. The parasite causes clinical signs of increased pruritis (itching), local hairlessness and sometimes skin thickening due to inflamed and secondary infections, changes similar to those seen in most foxes. Sarcoptic mite genetics has recently been studied in a pilot study at SVA, comparing mites retrieved from wild boar, red fox, raccoon dog and domestic pig. Preliminary results indicate that wild boar have their own variant of sarcoptic mites, which is closely related to the red fox mite.

Wild boar with sarcoptic mange, SVA 2013.

General wildlife disease surveillance

GENERAL SURVEILLANCE

General wildlife disease surveillance at SVA (previously referred to as passive surveillance) is based on necropsies and ancillary testing of opportunistically submitted carcasses or body parts of wildlife. Both fresh and fixed (for histopathology) samples may be submitted, as well as samples for microbiology.

From all necropsied wildlife where the tissues are not too decomposed, up to seven different organ samples are stored in the bio-bank freezers at SVA, a collection of samples from over 10 000 wild animals.

Geographical origin of submitted wildlife material

In 2013, material from a total of 1,246 wild animals were submitted to SVA for the general wildlife disease surveillance. The samples came from all 21 counties in Sweden. As in previous years, the highest number of animals or animal parts came from the counties closest to SVA in the county of Uppsala, while some counties with large populations of large predators (for which regulations enforce submission of all carcasses to SVA) tend to be high in this list (see Figure 1 below).

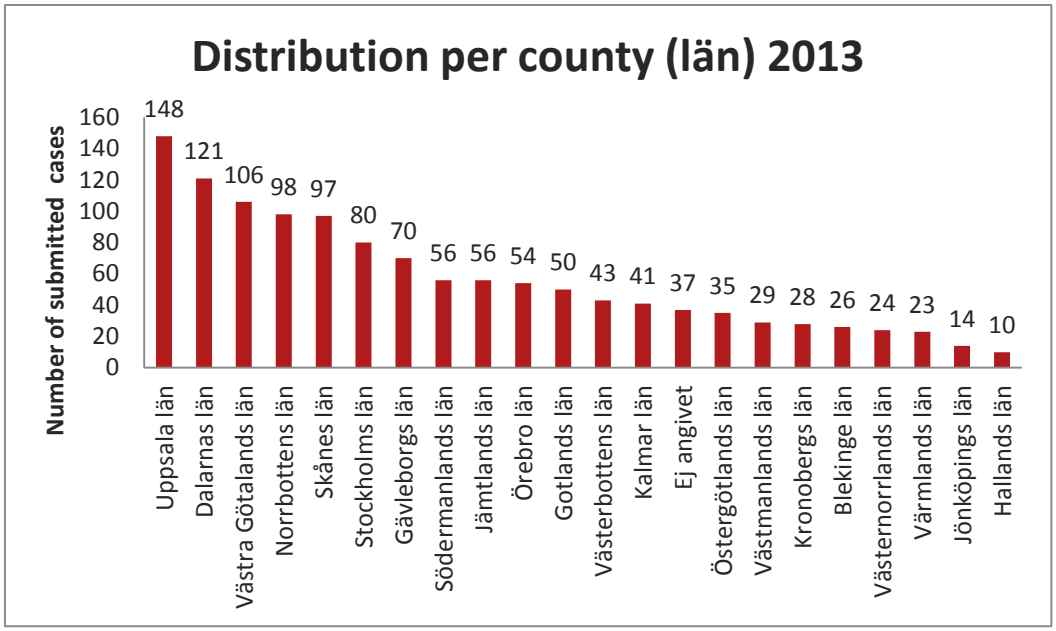

Figure 1. Distribution by county, number of animals or parts of animals submitted in 2013.

Animal species, distribution within the general surveillance

Most of the incoming 1,246 animals were mammals (789), and the remainders were distributed as birds (440) and frogs and reptiles (17). An overview of animal categories can be seen in the figures below. The cases consisted of whole carcasses (1,127), the remainder being parts of animals. Of the analysed wildlife samples, 1,115 have been submitted as fallen or diseased animals, where cause of death or disease is asked. Samples collected from (apparently healthy) animals shot during licensed hunting (such as hunted brown bear, lynx and wolf) are archived for present and future research. These samples are also used to screen for signs of contagious diseases (antibody screening), or presence of carrier-state for diseases (screening for disease agents), where wildlife can carry and potentially spread diseases without signs of clinical disease. Not included in these numbers are muscle samples from hunted wild boar and hunted brown bear, submitted from the hunters directly to the parasitology lab at SVA, for *Trichinella* screening.

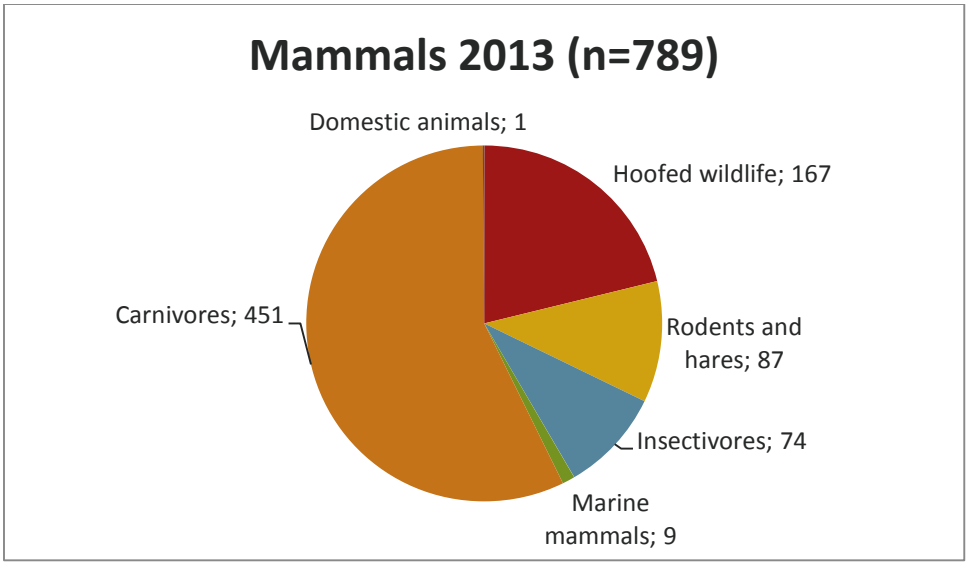

Figure 2. Categories of wild mammals submitted to the wildlife section SVA during 2013.

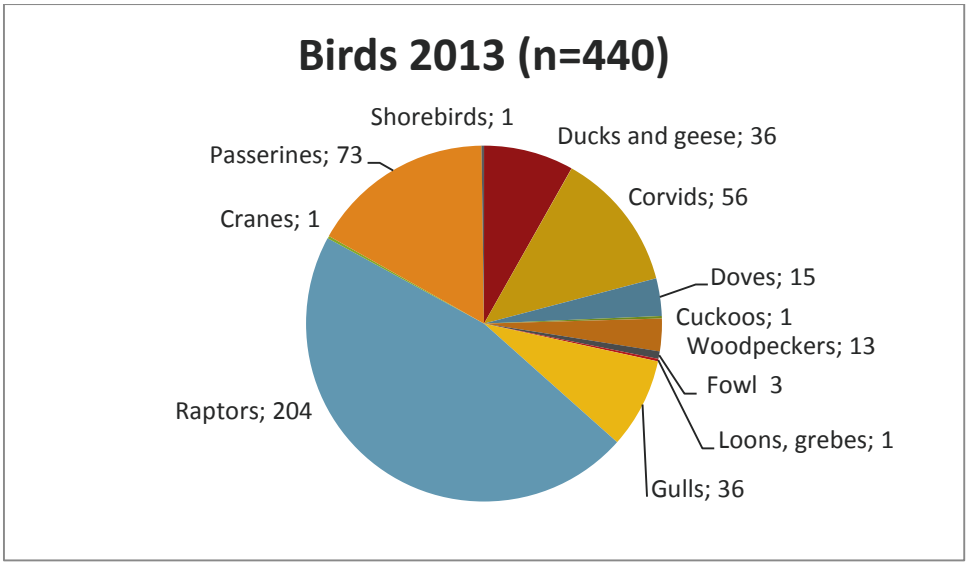

Figure 3. Categories of wild birds submitted to the wildlife section SVA during 2013.

Distribution of diagnoses from general surveillance cases

The most common main diagnosis in fallen wildlife is mechanical external trauma, in about 30% of the examined animals. Underlying causes include traffic, predation or gunshot wounds. About 19% of the cases were inconclusive, which to some extent can be explained by the fact that only selected parts of dead animals were submitted, and apparent cause of death or illness could not be established.

Inflammation and infection was noted as cause of death in about 16% of the cases, and this includes diseases caused by bacteria, viruses, parasites and fungi. Emaciation is also a very common diagnosis at necropsies of wild animals. Emaciation is caused not only by direct lack of food, but is also the end stage following underlying causes such as worn down teeth (dental attrition), parasitic or bacterial infections that weaken the animals so that they cannot forage or assimilate nutrition from their feed. An overview of diagnoses recorded in 2013 can be seen in the figure below.

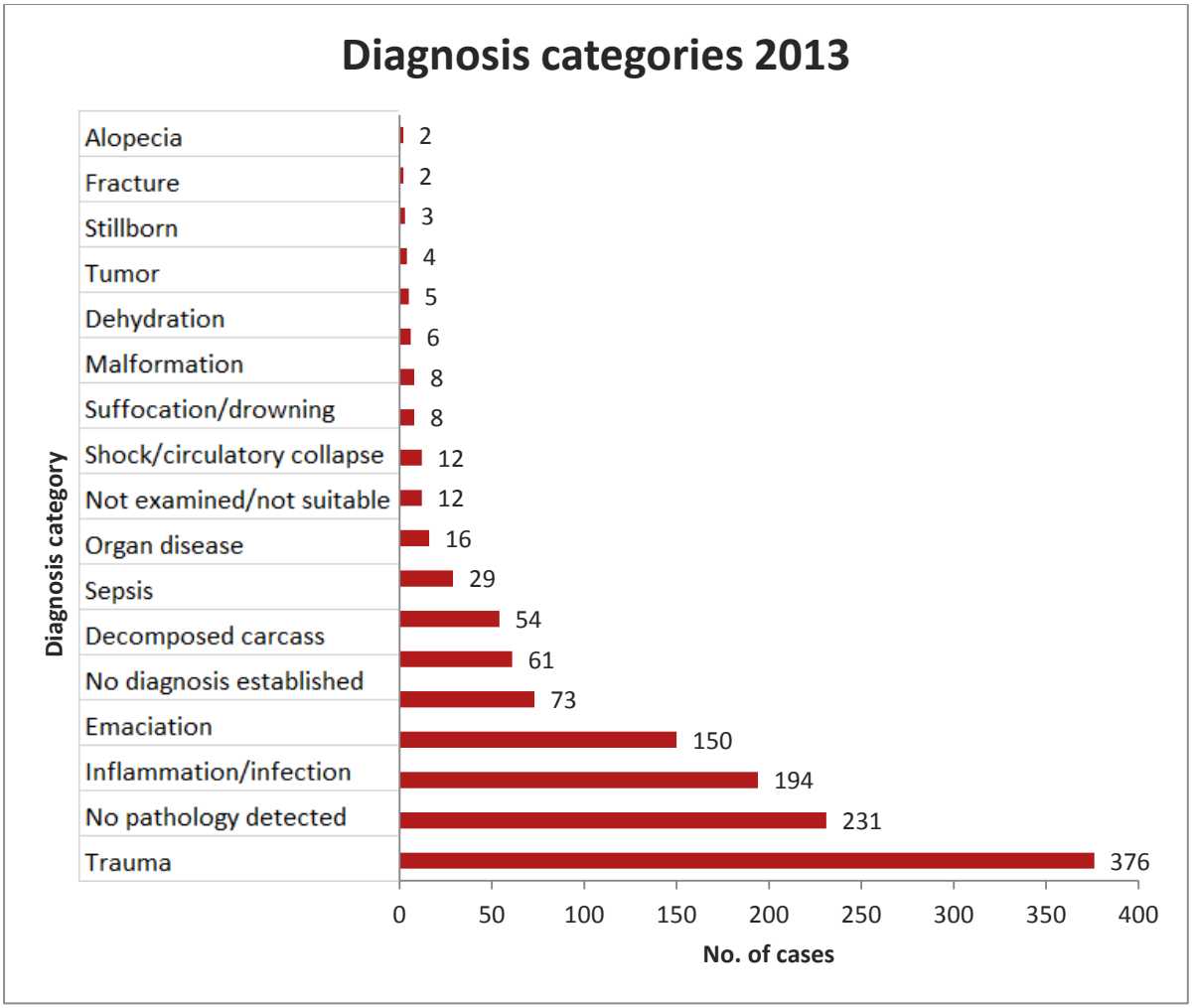

Figure 4. Distribution of diagnoses of wild animals or animal parts submitted to SVA in 2013.

TARGETED DISEASE SCREENING OF FALLEN WILDLIFE

Salmonella monitoring

Part of the sampling and screening of fallen wildlife is for monitoring presence of salmonella bacteria in wildlife. In 2013, intestinal samples from 708 cases were tested; 417 mammal and 291 birds.

Salmonella spp. was found in 53 cases in various species; 31 birds, 15 hedgehogs, five red foxes, one moose, one Lynx and one brown bear. As shown in previous years, salmonella is most commonly found in passerines such as the bullfinch, common redpoll and greenfinch, but salmonella was also found in various species of woodpeckers, as well as in greater black-backed gull, great gray owl (*Strix nebulosa*) and white-tailed eagle (*Haliaeetus albicilla*). The most common type was *Salmonella Typhimurium* (29).

Hedgehog (Erinaceus europaeus).

Tularemia monitoring

Tularemia is a bacterial disease that can affect humans and many animal species. SVA has a continuous monitoring of animals submitted for necropsy, with a priority to test rodents and hares. Of 37 necropsied hares in 2013, 10 European brown hares and one mountain hare tested positive for tularemia. Liver samples from 192 trapped small rodents collected for another project were examined for tularemia, to investigate if they could be possible healthy carriers of the bacterium *Francisella tularensis*. All 192 tested rodents were negative.

Greatly enlarged and inflamed spleen (splenomegaly, splenitis) of a European brown hare diagnosed with tularemia in 2013.

Trichinella monitoring

The large predators, brown bear, wolf, lynx and wolverine are continuously tested for the muscle parasite Trichinella at necropsy, as well as a number of red foxes, badgers, otters and birds of prey. Trichinella screening is funded in part by the Board of Agriculture as part of the surveillance of diseases that may affect public health. Trichinella are small parasitic round worms, whose larvae migrate from the intestine, and encapsulate in the musculature of animals that have fed on infected prey. People can be infected if meat with parasites is not cooked properly. All hunted wild boar and bear meat to be sold and used for human consumption must be checked for Trichinella parasites.

In 2013, *Trichinella* spp. were found in 1.7% of examined brown bears, 2.7% of red foxes, 4.6% of lynx, 4.7% of wolves, and 11.1% of the wolverines examined at SVA. Five brown bears were positive for Trichinella in 2013, which was the highest number yet recorded in Sweden, in one year. Trichinella testing of hunted wild boar is a diagnostic service at SVA that hunters use. In 2013 a total of 66,312 wild boar samples were tested for Trichinella. Three wild boar (0.0045%) were infected with Trichinella. Fifty-four wild birds of prey were investigated in 2013, but no *Trichinella* spp. were found. An overview of Trichinella tested wild animals can be seen in table 1 (from SVA's report "Surveillance of infectious diseases in animals and humans in 2013").

Table 1. Number and results of Trichinella (T) monitoring in wild animals at SVA in 2013.

Animal species	**Number of samples**	**Number of positive**	**% Positive**	***T. britovi***	***T. nativa***	***T. pseudo-spiralis***	***T.* spp.**
Badger	4	0	0				
Beaver	1	0	0				
Arctic fox	4	0	0				
Pine Marten	2	0	0				
Seal	2	0	0				
Raccoon	1	0	0				
Wild bird	54	0	0				
Red Fox *	149	4	2.68	2	3		
Lynx *	173	8	4.62	1	7		1
Otter	23	0	0				
Raccoon dog	1	0	0				
Wild boar	66,312	3	0,0045	3			
Wolf	43	2	4.65	1	1		
Wolverine	27	3	11.11	1	1		1
Brown bear	289	5	1.7		5		
Total		**25**					

*Two *Trichinella* species, *T. britovi* and *T. nativa* were found in the same individual host (double infection).

Targeted wildlife disease surveillance 2013

The targeted (formerly *active*) disease surveillance consists of studies of selected animal species or diseases, to get a better understanding of a noted or suspected disease outbreak that can affect wildlife, domesticated animals or people. These projects are usually initiated to follow up findings within the general wildlife disease surveillance, from necropsy findings or with information collected from hunters and the general public indicating an emerging disease situation. The pilot projects are initiated to get multiple samples or whole dead animals for investigation and analysis of the relevant disease.

FOX DWARF TAPEWORM MONITORING

The dwarf fox tapeworm *Echinococcus multilocularis* is, for the fox a harmless, approximately 3 mm long intestinal parasite, but the larval stage can cause severe disease in intermediate hosts, such as small rodents and in occasionally also in humans. All Canidae, including wolf and raccoon dog (*Nyctereutes procyonoides*) are possible main hosts of the adult parasite. Monitoring of hunted red foxes was done by SVA between 2000 and 2010, in a surveillance program commissioned by the Board of Agriculture. Annually, about 300 red foxes were submitted to SVA by hunters in different parts of Sweden. A fox shot in December 2010 in the municipality of Uddevalla on the west coast of Sweden, was the first finding of the fox dwarf tapeworm in Sweden. An intensified collection and screening of hunted foxes was done in 2011, and two further positive areas with infected foxes were found, in the municipalities of Katrineholm and Borlänge. In 2012 and 2013, a nationwide monitoring has been ongoing, based on screening of collected fox scats. In the same period, a PhD research project at SLU also collected samples from rodents and fox scats, of which some samples could be used for the national screening. By 2013, a total of 1,537 fox scats were analysed, and a single positive sample was found in the municipality of Katrineholm. Sixty-three whole fox carcasses were examined for *E. multilocularis* from the three identified positive regions, and two of these foxes were positive – one in Katrineholm and one in Uddevalla. In 2013, all 41 necropsied wolves were tested, as well as 46 examined raccoon dogs, but all were negative for the *E. multilocularis* tapeworm.

Red fox.

RABIES SURVEILLANCE IN BATS

Bats can carry a rabies virus, European Bat Lyssa Viruses, EBLV, which on rare occasions has infected and caused death in humans. In 2009, EBLV antibodies was demonstrated for the first time in bats in Sweden, but virus was not isolated, in eight Swedish Daubenton´s bats (*Myotis daubentonii*). In 2013, 43 found dead bats were analysed, and all were negative for rabies virus.

Bat submitted to SVA for EBLV surveillance.

WILD BOAR AS CARRIERS OF PATHOGENS

Blood samples from hunted wild boar are sent to SVA for serological testing of a number of important pathogens affecting wild boars, domestic swine or human. In all, 411 wild boar blood samples were tested for pathogens such as classical swine fever virus, pseudorabies virus, PRRS virus, etc. Two samples gave a positive result on antibodies against PRRS (porcine reproductive and respiratory syndrome) virus, but an extended survey of wild boar in the area where the samples had been collected, was negative. These two cases were classified as "individual animals with reaction", and were not considered to be carrying the PRRS virus. As Russia reported cases of African swine fever (ASF) in 2013, all wild boar necropsied within the general surveillance were also tested for this virus. All 14 necropsied wild boars were negative for ASFV.

BIRD FLU MONITORING

Wild birds necropsied at SVA are examined for the presence of avian influenza virus (AIV), which is done on behalf of the Board of Agriculture, which then reports the results to the EU. In 2013, 329 wild birds of 66 different species were examined, without findings of AIV.

ACUTE PROJECTS, TARGETED MONITORING

Study on the thiamine levels and reproductive problems in common eider

Since 2009, a project has, in cooperation with Stockholm University, investigated the reproductive success of the Common eider (*Somateria mollissima*) in an area on the south-east coast of Sweden. Low levels of thiamine (Vitamin B1) was noted in adult ducks, eggs and chicks. Over a five-year period, an extremely high mortality rate (about 95%) of eider chicks during the first week of life, was noted. In addition, an interesting behavior of eider, mallard, greylag goose, barnacle goose, and herring gull was recorded on one island, as up to 15% of the eggs in nests were from other bird species than that of the nesting female.

Investigation of reported high mortality of moose in southeastern Sweden

During 2013, high mortality among moose (*Alces alces*) in the county of Blekinge was reported, with more than 40 dead moose encountered during the winter of 2012-2013. In the autumn of 2013, a study to investigate the health situation of the moose in the area was initiated. Data was collected from hunted moose, noting slaughter weights and reproductive status. Also, field necropsies and sampling was done on all moose found dead. A few dead moose were transported to SVA for a more complete necropsy. The project results are to be presented in 2014.

Moose found dead in the forest.

Investigation of moose calf mortality on Öland

On the island of Öland on the south-east coast of Sweden, a project studying an abnormal high calf mortality continued in 2013. After fitting 26 moose (20 females, six males) with GPS/GSM-transmitters in 2012, perinatal mortality and summer mortality of calves was followed in 2013. The results showed that the calf mortality rate remained high, as 16 of 19 born calves had died by the end of the summer. Necropsies of five neonatal calves born 2013 revealed that they had died of starvation, which was similar to the results of examined dead calves in 2012. Half of the moose calf mortalities occurred within the first week of life, and the second half was late in summer. Field observers noted that the female moose were in poor body condition at the time of, and after calving. This indicates that poor female moose health and fitness may have contributed to the mortality of calves. An extension of the study is planned, to follow the

health condition of females in connection with and after calving.

Moose calf in early summer.

Grazing fallow deer.

Fallow deer mortalities

During the late summer of 2013 an increased mortality of wild fallow deer (*Dama dama*) was reported from parts of the counties of Södermanland and Örebro. At the same time a fallow deer farm owner in southern Sweden experienced extensive mortality in one of the enclosures. Samples and deer carcasses examined at SVA showed an acute, severe pneumonia caused by the toxin-producing bacterium *Pasteurella multocida*. It is commonly found in wild and domestic mammals and birds, and it is well known that healthy deer can carry the bacterium in the nasal cavity or pharynx. Stress or underlying diseases that impairs the immune system can be triggers that allow these bacteria to grow and start forming toxins, which often results in acute death. High population densities together with limited water access in some areas, due to drought during a hot spell, is believed to be possible contributing factors to the outbreaks of pasteurellosis. A few of the fallow deer were also positive for the tick-borne bacterium *Anaplasma phagocytophilum*. Anaplasmosis in wild deer in Sweden is a fairly recent discovery, and the significance of the infection in deer is still unclear. A targeted sampling was conducted in the fall of 2013, from healthy fallow deer shot during regular hunting in the affected area of the county of Örebro. Bacterial culturing did not show presence of the pathogenic *Pasteurella* bacterium in these animals. Further investigations of the fallow deer is done in 2014.

Invasive raccoon dogs

In cooperation with a project led by the Swedish Association for Hunting and Wildlife Management, and the Swedish University of Agricultural Sciences, necropsies of euthanized invasive raccoon dogs (*Nyctereutes procyonoides*) has been performed at SVA since 2010, for tissue sampling and disease surveillance.

Raccoon dogs originate from Asia and have been bred for fur production. Due to both released and unintentional escapes of raccoon dogs, the species has established and is spreading westward through Europe. From a very dense population in Finland, the raccoon dog has begun to invade Norway and Sweden from the northern part of the Nordic countries. From Germany, the raccoon dog is also spreading north into Denmark, and introductions into Sweden is conceivable in the future.

The raccoon dog is not a native species, it can cause devastation in ground-nesting bird populations, red-listed frog species and cray-fish stocks. In Sweden, the raccoon dog project uses various tools to prevent establishment and spread of this invasive species, by camera trapping, hunting and trapping, and using sterilized animals with transmitters to track their migration patterns and to locate groups of animals.

At SVA, 46 euthanized or road-killed raccoon dogs were examined in 2013. Necropsy,

parasitologic examination of the skin, lungs, stomach and intestinal tract was done, as well as *Trichinella* testing of muscle, intestinal bacterial culturing, and rabies screening of brain tissue.

As in previous years, the only disease noted in the investigated raccoon dogs was sarcoptic mange in two animals. Eight different parasite species were identified in the lungs, stomach and intestines. There was no evidence of serious transmissible diseases, and specifically no evidence of rabies or *Echinococcus multilocularis*.

Necropsy of a raccoon dog, at SVA.

Sarcoptic mange in arctic foxes

During the winter of 2013 sarcoptic mange was suspected when images from camera traps showed arctic foxes (Vulpes lagopus) with patchy alopecia typical of mange. Two affected foxes were submitted to SVA, and sarcoptic mange was confirmed. As the arctic fox is a critically endangered species in Sweden, an intervention with anti-parasitic treatment using prepared baits were placed around the affected permanent dens. The intervention was administrated by the County Administrative Boards of Jämtland and Västerbotten, in cooperation with Stockholm University, with funding from the Wildlife Disease Council grant. A follow-up of the effect of treatment is being done by analysing photos from permanent camera traps around the dens. The sarcoptic mange infections in arctic foxes are considered to have been spread by infected red fox. A similar event in the 1980´s was successfully managed by live-trapping arctic foxes and treating them against mange. Red fox range has over time expanded into the mountain areas, and arctic foxes have become prey to the larger red fox. Official rangers are presently permitted to lethally remove red foxes in the vicinity of arctic fox dens.

Wildlife sampler organization

An organization of "Wildlife samplers" within the Swedish Association of Hunting and Wildlife Management (SAHWM), with a contact person in each Swedish County, was established in 2011. SVA collaborates with this network of hunters to receive from them reports of abnormal morbidity and mortality in the Swedish fauna. This volunteer-based network also assists in collecting and shipping samples to SVA, for various research projects and surveillance programs. The contact persons in the counties receive information on current wildlife diseases, and get some basic training in sampling and sample handling, at SVA.

The Big Four: work on large predators

The four large predators; brown bear (*Ursus arctos*), wolf (*Canis lupus*), lynx (*Lynx lynx*) and wolverine (*Gulo gulo*), make up a substantial proportion of the wild animals or animal parts submitted to SVA. These species are all listed as Wildlife of the State, and according to the regulations of the Environmental protection agency (EPA), all dead animals or animal parts of these species found in nature must be submitted for examination at SVA. After examination and tissue sampling, skeleton and skins are in most cases sent to the collections of the Museum of Natural History, in Stockholm. This applies for large predators put down as nuisance animals, as well as sampling from licensed hunting. During licensed hunting for brown bear, an official inspector in the field collects tissue samples for research and bio-banking, and a small premolar tooth for age determination, from each shot animal. These samples are then submitted to SVA for sample archiving and data logging. An important part of the large predator work is forensic necropsies and examinations, in cases of suspected wildlife or hunting crimes. In 2013, 42 wildlife forensic examinations were done at SVA, with 13 cases concerning brown bear, 8 lynx cases, 10 cases involving wolves and 10 golden eagles (*Aquila chrysaetos*).

In addition, the work involving large predators includes compilation and communication of information to public authorities, the general public and specific interest groups, as well as giving expert opinions and information to other authorities. Questionnaires are sent to all Swedish hunters that have bagged a large predator, for a research study led by Norwegian scientists, to collect data on the practical part of how large predators are hunted. Collaboration and sharing of samples and data with other scientists and institutions promotes the disseminating of knowledge about these, often iconic as well as hotly debated, animals.

Multiple measurements of a dead brown bear are taken and logged into a database, before the necropsy and sampling that follows.

Collaboration with the Museum of Natural History

SVA has a standing collaboration with the Museum of Natural History (NRM) in Stockholm. All mammal and bird species on the list Wildlife of the State are sent to NRM after the necropsy and sampling at SVA. Large predators, marine mammals, and several threatened bird species or species of special interest, are included in this list. Cooperation between the SVA and NRM is an excellent exchange of knowledge and skills between different disciplines, such as biology, ecology and veterinary medicine. Especially, collaboration is done regarding marine mammals, otters (*Lutra lutra*), and the two species of eagles in Sweden, white-tailed eagle (*Haliaeetus albicilla*) and golden eagle (*Aquila chrysaetos*).

MARINE MAMMALS

Of the marine mammals, most cases submitted to NRM for necropsy and sampling are grey seals (*Halichoerus grypus*), with fewer harbour seals (*Phocoena vitulina*), and more rarely ringed seal (*Pusa hispida*) and harbour porpoise (*Phocoena Phocoena*). They are all marine living top predators, at the top of the food chain and can serve as excellent markers of the health status in this environment. In 2013, a wildlife pathologist from SVA has worked part time with necropsies of seals, together with the staff of the NRM doing environmental toxin and pollutant monitoring. In December 2013, nine porpoises found dead throughout the year and stored in freezers, were necropsied and sampled in a collaborative session at SVA. The research focus of SVA is primarily to determine the cause of death and identify disease conditions. Since 2010, liver flukes, a few millimeter long parasite has been noted with increased frequency in grey seals. In some cases, liver tissue damage due to massive parasite infection has been so extensive that the seal dies. Organ samples are saved in SVA's bio-bank and in NRM's environmental testing bio-bank, for ongoing and future research.

Necropsy of a porpoise at SVA, in collaboration with the Museum of Natural History.

EAGLES

Since 2009, all white-tailed eagles and golden eagles found dead are submitted to SVA for examination and sampling, and then the carcass is sent to the Swedish Museum of Natural History (NRM) for their research and collections. Prior to 2009, only eagles suspected to have died of disease or poaching were submitted to SVA. As all found dead eagles now are examined in a systematic and consistent manner, an improved documentation of the causes of death and diseases affecting these birds can be done. In 2013, SVA received 67 white-tailed eagles and 14 golden eagles. The majority (53) had died from traumatic injuries, primarily caused by traffic, on roads or railroads (40), but also by wind turbines and predators. Seven had died of lead poisoning, which is likely most often caused by scavenging on offals from game animals shot with lead-based ammunition.

X-ray image of a white-tailed eagle

OTTERS

The number of otters (*Lutra lutra*) found dead has increased in recent decades (45 otters submitted to SVA 2013), which is an indirect indication of an increasing otter population throughout Sweden, after a severe population decline in the mid-20th century. Road killed is the absolute dominating cause of death in otters, 39 cases in 2013. Otter carcasses examined at SVA are sent to NRM, for further sampling and analyses of environmental toxins and pollutants. A study of the high prevalence of proposed Müllerian duct remnant cysts on the spermatic duct was published by NRM researcher Anna Roos, in collaboration with SVA staff.

Otter (zoo exhibit animal).

INTERNATIONAL SCOPE, SURVEILLANCE AND COOPERATION

An important part of SVA's task is to monitor what is happening in the wildlife disease field internationally. Discussion lists on the Web, e-mail alert subscriptions, electronic news forums and membership and participation in various international associations and networks forms the basis of this international monitoring in order to evaluate the international wildlife disease situation. This surveillance is part of early warning and preparedness for possible introductions of new or emerging wildlife diseases.

The Wildlife Section hosts students and post graduates who spend a longer or shorter time at the department to experience and follow the routines of wildlife disease surveillance. These visitors can collaborate in ongoing projects involving wildlife disease or large predators, and gain experience in wildlife pathology.

WILDLIFE RESEARCH PROJECTS

Moose

The research project "Reproduction and health of moose" is the main focus of a PhD student at the Swedish University of Agricultural Sciences (SLU), who also is employed at SVA (Jonas Malmsten). The project is funded by the Environmental protection agency's wildlife disease council, SVA (Wildtech- the 7th EU framework programme), and SLU (environmental monitoring and assessment).

Studies are focused on the reproductive physiology of female and male moose, and the possible effect of tick-borne diseases on reproductive success in moose. Together with the SLU in Umeå (Department of Game, Fish and Environmental studies) reproduction in moose is studied in GPS-collared moose in southern Sweden, where newborn calves are ear-tagged and calf survival is monitored. Extensive collection and analysis of organs from hunted moose is done in several study sites. The project is continued in 2014.

Tularemia

Tularemia is a disease caused by the bacterium. A multitude of species are susceptible to the disease, including humans. Gete Hestvik is working on a project aiming to describe and better understand the disease in wild animals, in particular in European brown hares *Francisella tularensis*, and mountain hares. Affected hare tissue is studied with histopathology, immunohistochemistry, and PCR in order to describe the distribution of the disease in the body organs and tissues. This is to learn about how the hare becomes infected and how the disease is spread. Of 59 surveyed hunter shot hares, none were shown to carry *Francisella tularensis* bacteria.

A serological study to detect antibodies against *Francisella tularensis* in blood samples from hunted or euthanized red foxes, wild boar and invasive raccoon dogs has been initiated during the year. These species were chosen because they hunt or eat carrion of hares and small rodents and are tested to see if they could serve as indicators of spread of tularemia to new areas.

Wild boar

Hepatitis E virus in wild boar and moose

In cooperation with the SVA's Department of Virology, Immunobiology, and Parasitology, (PhD student Jay Lin, supervisor Frederik Widén) examines wild boar and moose for the presence of hepatitis E virus, which can infect humans. The project is expected be completed in 2015.

Human pathogens carried by wild boar

PhD student Axel Sannö at SLU is studying wild boar to find out if they are carriers of selected human pathogens that can be transmitted from hunted wild boar if the meat is contaminated, and cause disease in humans. The focus is on the two bacteria; Salmonella and Yersinia, that may be carried in the gut or in lymph nodes without causing apparent disease in the wild boar. The project is funded by the environmental protection agency's Wildlife Research Committee, and the Sandberg's Foundation.

THE BIO-BANK

Frozen tissue samples collected from SVA's biobank freezers are an important and valuable resource that is used for research collaborations internationally. In 2013, another 1066 sets of tissues from various wildlife necropsy cases were added to the bio-bank. Most are saved in minus 20 degree Celsius freezers, with a smaller number of samples from selected cases stored in minus 80 degrees Celsius. From carcasses in fresh enough kondition, up to seven tissues can be stored; samples of brain, lung, spleen, liver, intestine, kidney, and musculature.

COMMUNICATING KNOWLEDGE

Disseminating acquired knowledge is an important part of the work of SVA. Reports, articles (scientific and popular science), web-based information, press releases, newspaper notices, as well as lectures and seminars, and receiving visitor groups to inform about the routine work and research done on wildlife, are parts of the communication efforts. In 2013, the Wildlife Division had, on average, one group visit a month, with group size varying from 2-3 people, up to around 20.

SVA lecture on wildlife diseases.

Visitor group in the necropsy room, SVA.

Wildlife disease helpdesk

Every office day, a wildlife veterinarian at SVA is on roster to answer questions on the phone or e-mail (vilt@sva.se), as far as the work load permits. In 2013, about logged 250 questions were sent to the Wildlife section, and answered by email. The questions can concern any and all wildlife species, but the bulk of questions are regarding birds, cervids and predators.

Reporting dead or diseased wildlife

When dead wildlife is found, you can report it to us by filling out a form in SVA's web page www.sva.se/rapportera-in. Reports can also always be made by email vilt@sva.se, or by phone. Multiple reports of sick or dead wildlife from an area, is information that can indicate an increased mortality or disease outbreak. Of special concern are reports of large numbers of dead wildlife found in an area, within a short period of time. The wildlife section does not have any field staff, but we can send approved cardboard shipping boxes and plastic bags to those who volunteer, after contacting the wildlife section at SVA, to send in dead wildlife for necropsy and sampling within the general wildlife disease surveillance. There is a possibility that the local municipality game wardens can assist and take care of dead wildlife, so contact with your local municipality is also a possibility. Up to 20 kg animals can be shipped in packages, but larger animals need to be transported by other means. A report of the necropsy results is sent to the submitter of fallen wildlife. Animals listed as Wildlife of the State http://www.nrm.se/forskningochsamlingar/zoologi/statensvilt/arter.1533.html , and are found dead, can be reported directly to the local police, that handle and organize transport of those species.

PUBLICATIONS 2013

Listed below is a selection of publications and reports from 2013 related to wildlife and wildlife diseases, where members of the SVA wildlife section are authors or co-authors. In order to disseminate and gather knowledge and information on wildlife diseases staff members have participated in various international and national meetings and conferences, where selected interesting research results from SVA have been presented.

Scientific publications

Axnér E, Payana-Carreira R, Setterlind P, **Åsbrink J**, **Söderberg A** (2013). Collection of field reproductive data from carcasses of the female Eurasian lynx (*Lynx lynx*). Theriogenology, 80(8), 839-849.

Bröjer C, Järhult JD, Muradrasoli S, Söderstrom H, Olsen B, **Gavier-Widén D** (2013). Pathobiology and virus shedding of low-pathogenic avian influenza virus (A/H1N1) infection in mallards exposed to oseltamivir. Journal of Wildlife Diseases, 49(1), 103-113.

Gillman A, Muradrasoli S, Söderström H, Nordh J, **Bröjer C**, Lindberg RH, Latorre-Margalet N, Waldenström J, Olsen B, Järhult JD (2013). Resistance mutation R292K is induced in influenza A (H6N2) virus by exposure of infected mallards to low levels of oseltamivir. PloS one, DOI: 10.1371/journal.pone.0071230.

Johansson Ö, **Malmsten J**, Mishra C, Lkhagvajav, McCarthy T (2013). Reversible immobilization of free-ranging snow leopards (*Panthera uncia*) with a combination of medetomidine and tiletamine-zolazepam. Journal of Wildlife Diseases, 49(2), 338-346.

Lopes AM, **Gavier-Widén D**, Le Gall-Reculé G, Esteves PJ, Abrantes J (2013). Complete coding sequences of European brown hare syndrome (EBHSV) strains isolated in 1982 in Sweden. Archives in Virology, 158, 2193-2196.

Mörner T, **Malmsten J**, Bernodt K, Lunneryd SG (2013). A study on the effect of different rifle calibers in euthanization of grey seals (*Halichoerus grypus*) in the Baltic Sea. Acta Veterinaria Scandinavia, 55(1), 79.

Monecke S, **Gavier-Widén D**, **Mattsson R**, **Rangstrup-Christensen L**, Lazaris A, Coleman DC, Shore AC, Ehricht R (2013). Detection of *mec*C-positive *Staphylococcus aureus* (CC130-MRSA-XI) in diseased European hedgehogs (*Erinaceus europaeus*) in Sweden. PLoS one, DOI: 10.1371/journal.pone.0066166.

Roos AM, **Ågren EO** (2013). High prevalence of proposed Müllerian duct remnant cysts on the spermatic duct in wild Eurasian otters (*Lutra lutra*) from Sweden. PLoS one, DOI: 10.1371/journal.pone.0084660.

Official requests for consideration and comments

SVA 2013/0691 Remiss om Åtgärder för samexistens mellan människa och varg – betänkande av kommittén för en hållbar rovdjurspolitik för varg SOU 2013:60
SVA 2013/1016 Remiss om Viltmyndighet – jakt och viltförvaltning i en ny tid. SOU 2013:71
SVA 2013/1021 Remiss om Förslag till åtgärdsprogram för äldre lövskogar med vitryggig hackspett som paraplyart, 2014-2018

Hedgehog (Erinaceus europaeus).

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