NATIONAL VETERINARY INSTITUTE

WILDLIFE DISEASE MONITORING IN SWEDEN 2014

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Foreword

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

This annual report summarizes the activities and results of the work done within VSÖP, and highlights wildlife diseases of relevance or of particular interest in 2014.

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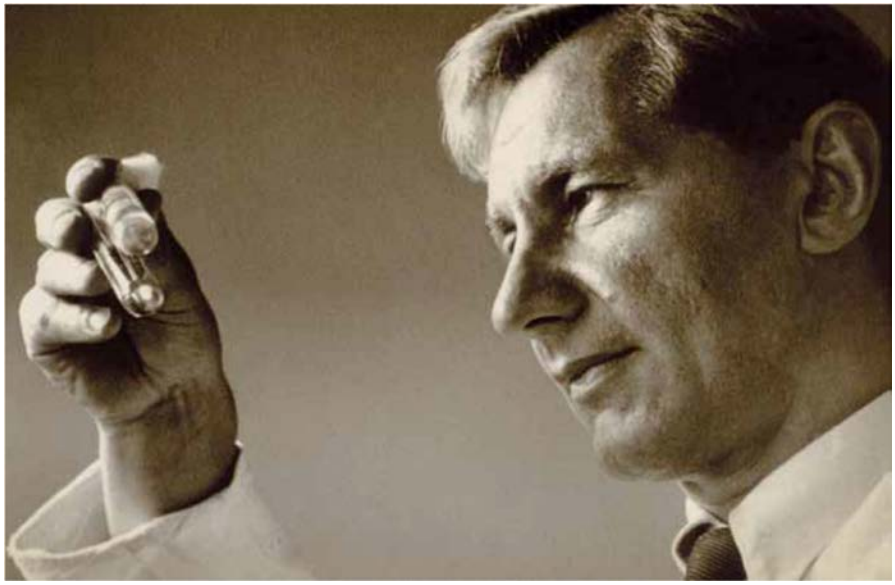

Professor Karl Borg, initiator of wildlife disease surveillance in Sweden. Photo: SVA archive.

Wildlife disease surveillance in Sweden

The Government's regulatory letter specifies that the veterinary expert authority SVA shall do a comprehensive assessment and analysis of the health and disease status of domestic and wild animals in Sweden. This report describes the activities and results of interest concerning wild animals.

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 routine work is carried out through general disease surveillance (fallen game), supplemented with active monitoring and other investigative efforts. The basic wildlife work at SVA is financed by the EPA´s fund for of biodiversity and by funding from the State Wildlife Fund (Viltvårdsfonden).

General disease surveillance involves diagnosing diseases and monitoring the national disease situation through necropsies of fallen wildlife or euthanized sick wild animals, as well as by documenting observations of morbidity and mortality among wild animals received from the public or from involved government agencies.

Targeted disease surveillance involves performing targeted sampling, and examining sick or healthy animals for certain specific diseases or disease agents. These investigations are usually initiated after detection of diseases within the general surveillance programme, or by gathering information about ongoing outbreaks or reported population changes.

Wildlife Disease Council (VSR) is a group of experts and officials from the EPA and SVA who exchange information on wildlife diseases and wildlife management, and discuss appropriate targeted disease surveillance studies on wildlife in Sweden. In 2014, the Council consisted of Klas Allander, Ola Inghe and Tulikki Rooke from the EPA. SVA has been represented by Carl Hård af Segerstad, Torsten Mörner and Erik Ågren, with Henrik Uhlhorn as secretary. VSR held two meetings in 2014.

STAFF WORKING WITH WILDLIFE DISEASE INVESTIGATIONS IN 2014

Wildlife pathologists

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Large predators

Arne Söderberg, research engineer, Jessica Åsbrink, BSc, research engineer

Other staff

Ewa Backman, Secretary, Dolores Gavier-Widén, Head of Department, Associate Professor, Torsten Mörner, State veterinarian in wildlife diseases, Associate Professor, and Carl Hård af Segerstad, Associate Professor.

Wildlife diseases and increased mortality events of interest 2014

BIRD FLU VIRUS IN HARBOUR SEALS

In 2014, bird flu virus was detected in seals for the first time in Europe. The diagnosis was made by SVA during investigations of a mortality event in harbour seals (*Phoca vitulina*) on the west coast of Sweden, in cooperation with the Museum of Natural History. The virus was identified as H10N7, a low pathogenic influenza virus that previously had not been found in seals. The virus is closely related to the bird flu strains circulating among wild waterfowl in Europe and seals likely were infected through contact with birds or their feces. A targeted surveillance study of bird influenza in harbour seals is ongoing.

FOX TAPEWORM – ECHINOCOCCOSIS

In 2014, the fox dwarf tapeworm was discovered in two new areas in the country, in the municipality of Gnesta, in the county of Södermanland and in the municipality of Växjö in the county of Kronoberg. In Gnesta the tapeworm was found in three different samples analyzed in 2014; in an *Arvicola* sp. water vole (intermediate host for the parasite), in a shot fox, and in a sampled fox scat. All the samples came from a very limited area, and this represents the second location in Södermanland where Echinococcus has been found. The other municipality with positive foxes in Södermanland is Katrineholm. In Växjö, the tapeworm was found in fox scats. In an on-going study in 2014-2015, up to 30 foxes hunted within 20 km from the findings in Gnesta and Växjö will be collected to search for the parasite in the fox intestines.

MORTALITY EVENT IN FALLOW DEER

In 2014, free ranging fallow deer (*Dama dama*) populations in the counties of Örebro and Södermanland were for the second consecutive summer affected by a mortality event caused by pasteurellosis, an infection with the bacterium *Pasteurella multocida*. Also, the bacteria *Anaplasma phagocytophilum* was found in four of eight tested carcasses of affected deer which suggests that this bacteria may be one of several co-factors involved in the outbreak. Genetic analyses of the isolated strains of Pasteurella bacteria from different geographic areas showed that there were several local outbreaks that coincided in time, and that the mortality event was not a single widespread continuous outbreak.

*Fallow deer (*Dama dama*). Photo: Torsten Mörner, SVA*

TRICHOMONIASIS IN GREENFINCHES

In April 2014, the first suspected case of the parasitic disease trichomoniasis was reported in a greenfinch (*Carduelis chloris*) in the county of Västernorrland. During the spring and summer, numerous reports of single cases or outbreaks from most of the country followed. In total, 18 greenfinches were submitted to SVA, of which 11 had died due to inflammation of the oral cavity, crop and/or esophagus, and trichomoniasis was identified or suspected. Since the first outbreak of trichomoniasis in Sweden in 2008, the greenfinch population has drastically decreased in size. The number of reports of dead greenfinches decreased after the first few years following parasite introduction, but increased again in 2014. Necropsy results indicate that trichomoniasis continues to be one of the main causes of death among greenfinches. In 2014, a PCR-test was established and validated at SVA to improve the diagnostic capacity for trichomonas parasites, see **targeted surveillance projects**.

MYXOMATOSIS

In 2014 a severe outbreak of the viral disease myxomatosis decimated the wild rabbit populations in the county of Skåne, in the southernmost part of Sweden. Several reports and photos of sick and dead rabbits with severe swelling of the eyelids were submitted to SVA. The changes are typical for the disease, and the few submitted carcasses confirmed myxomatosis. The first reports came from Ängelholm, but after SVA asked for further samples, multiple reports of cases came from the entire county, with some cases also in the neighboring counties of Blekinge and Halland. Myxomatos is a notifiable disease and is reported to the Board of Agriculture and to the OIE (the World Organisation for Animal Health).

Wild rabbit with myxomatosis in Torekov, Sweden, 2014. Photo: Ann-Marie Steinmann

MORTALITY EVENT OF WOOD LEMMINGS

During July and August 2014 reports of mass deaths among small rodents were received from the counties of Dalarna, Värmland and Örebro. Twenty-five wood lemmings (*Myopus schisticolor*) and two shrews were submitted for necropsy. The body condition ranged from emaciated to average and in most cases, the cause of death was trauma, typically bite wounds from small predators. No apparent signs of disease were found. The bacterium *Francisella tularensis* causing tularemia was not detected in three tested lemmings.

*Wood lemming (*Myopus schisticolor*) submitted to SVA. Photo: SVA.*

HARES

During 2014 a total of 28 European brown hares (*Lepus europaeus*) and three mountain hares (*Lepus timidus*) were submitted to SVA for necropsy. Fourteen hares had died of generalized bacterial infections. Of these, two died of tularemia. *Staphylococcus* abscesses in the subcutaneous tissue and/or internal organs had affected two hares. Two hares had died from pseudotuberculosis caused by *Yersinia pseudotuberculosis* which also causes abscesses in internal organs. Two hares died of coccidiosis, a single-celled parasite that causes tissue damage in the intestines. *Toxoplasma gondii* is another single-celled parasite that causes severe inflammation of the liver and spleen (toxoplasmosis). Six hares died of trauma (traffic injury or predators).

Kidney from a European brown hare with yersiniosis. Two yellow abscesses can be seen. Photo: SVA

MOOSE

Moose were, as in previous years, frequently investigated within the Swedish wildlife disease surveillance programme at SVA. In total, 113 moose carcasses or parts of moose were submitted in 2014. The most common diagnosis was inflammation/infection (26 moose, 23%), followed by emaciation (21 moose, 19%). Diagnosis categories and case distribution can be seen in the table below.

Cause of death	No. of cases
Infection/Inflammation	26
Emaciation	21
Parasitic infection	16
Lesions not detected	15
Trauma	14
Cause of death undetermined	6
Neoplasia/tumor	5
Organ disease	5
Malformation	2
Decomposed material	2
Other lesions	1

Table 1. Diagnosis distribution for 113 moose or samples from moose necropsied at SVA in 2014.

ROE DEER

In 2014, parts or whole carcasses from 64 roe deer (*Capreolus capreolus*) were examined, which is twice the number examined in 2013. No specific increased mortality events were reported during the year, but roe deer with diarrhea, a condition noted since the 1990s, are still reported occasionally. Extensive studies have been performed in both Sweden and Denmark in order to investigate the underlying cause of roe deer diarrhea, but the etiology of the syndrome has not been determined. SVA is still interested in receiving reports diarrhea in roe deer. Of the submitted roe deer in 2014, infection or inflammation (18 cases, 28%) dominated among the causes of death.

Cause of death	No. of cases
Infection/Inflammation	18
Parasitic infection	9
Emaciation	9
Trauma, predation	8
Organ disease	4
Trauma	4
Neoplasia/tumor	3
Inappropriate material	3
Malformation	2
Lesions not detected	2
Cause of death undetermined	1
Other lesions	1

Table 2. Diagnosis distribution for 64 cases of roe deer necropsied at SVA in 2014.

BROWN BEAR

In 2014, whole carcasses or parts 338 bears were submitted to SVA. Seventy cases were bears found dead or euthanized as nuisance animals. The majority of the cases were the selected sets of tissue samples from bears shot during the licensed hunt in 2014. Excluding hunting and euthanasia, the most common causes of death were train or car accidents.

Examination of gunshot trajectories in a submitted brown bear before necropsy, with the body placed in a natural position on a "bear mannequin", which has been constructed at SVA. Photo: SVA

WOLVERINE

In 2014 a total of 31 wolverines (*Gulo gulo*) were examined at SVA. Of these, 27 had been euthanized with a permit from the County Board to prevent predation of reindeer herds. Two wolverines died in traffic accidents and one died from intraspecific predation (infanticide, i.e. a youngster killed by an adult wolverine).

LYNX

In 2014, 77 lynx (*Lynx lynx*) were submitted to SVA, where 57 were fallen wildlife and 20 were shot during the licensed hunt. The most common causes of death in fallen lynx were traffic accidents (33 lynx, 58%), and emaciation (12 lynx, 21%). Ten of the emaciated lynx were affected by sarcoptic mange. The hunting bag for lynx allowed in the licensed hunt has decreased in recent years because of a declining population.

WOLF

In 2014, a total of 33 wolves (*Canis lupus*) were submitted to SVA. Most wolves (21 wolves, 64%) were euthanized as problem animals, shot according to regulations for protection of domestic livestock. Traffic accidents (9 wolves, 27%) were the second most common cause of death.

Road-killed wolf, 2014. Photo: SVA.

WILD BOAR

The wild boar (*Sus scrofa scrofa*) population has increased dramatically in Sweden over the past few decades, but high hunting pressure in 2013 may have contributed to a slower rate of population growth. With a denser population, there is also an increased risk for spread of diseases. There were 16 cases from wild boar in 2014. The most common diagnosis was infection or inflammation (five cases), trauma and parasitic infection (three cases each), and emaciation (one case). Only one case of sarcoptic mange was diagnosed in 2014, but demodicosis, infection with *Demodex* sp. hair follicle mites, was noted, possibly for the first time in Sweden. Demodicosis is uncommon in wild animals but has been found in rare cases in Sweden, including in roe deer.

Wild boar. Photo: SVA.

General wildlife disease surveillance 2014

FALLEN WILDLIFE

Fallen wildlife are the base of SVA's general disease surveillance in wild mammals and birds. Typically, surveillance is achieved through necropsies and examinations of carcasses or parts of wildlife submitted to SVA. In some cases, submitted material is sent directly for microscopic, bacteriological, virological, parasitological or mycological analysis.

Up to seven different tissues are saved in biobank freezers at SVA from all necropsied wildlife, providing that the material is not too decomposed. The biobank currently contains samples from over 10 000 animals.

Geographical distribution of submitted material

Material from a total of 960 wild animals was submitted to SVA within the fallen wildlife disease surveillance in 2014 and originated from all 21 counties of Sweden. As in previous years, the highest number of animals or animal parts were submitted from counties that are geographically closest to SVA in Uppsala, but a large portion was also submitted from counties with large populations of large carnivores (see Figure 1 below).

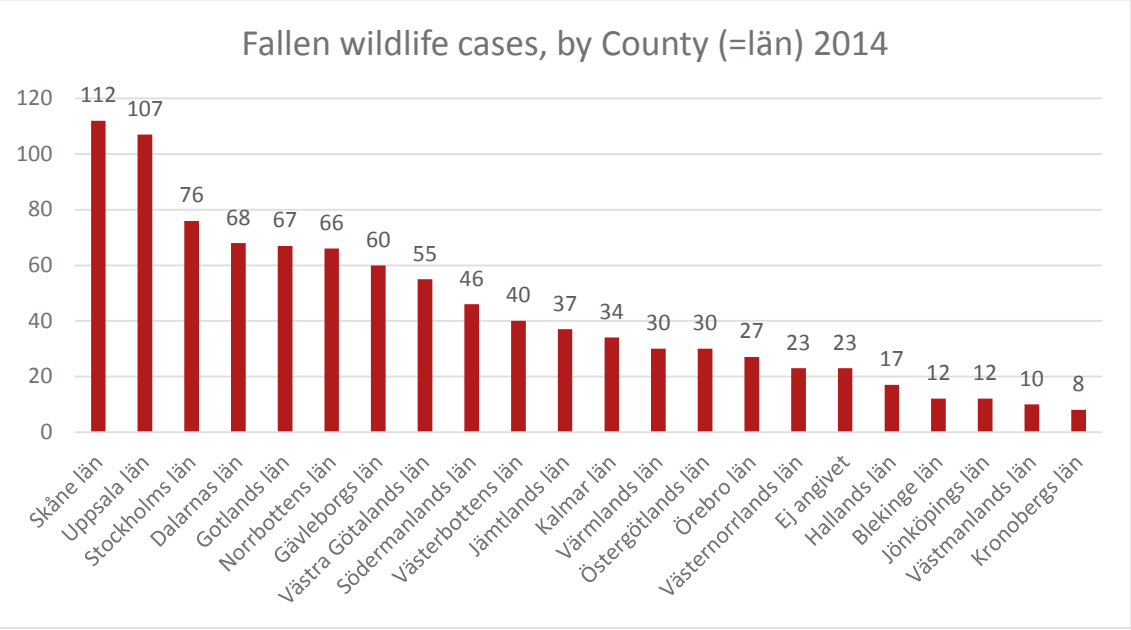


Figure 1. Submissions of animals or parts of animals in 2014 by county.

Animal species distribution, general disease surveillance cases

Of the 960 submitted wildlife cases, most were mammals (606), followed by birds (342), and frogs and reptiles (12). An overview can be seen in Figures 10 and 11 below. The cases were either whole carcasses (829) or parts of animals (131).

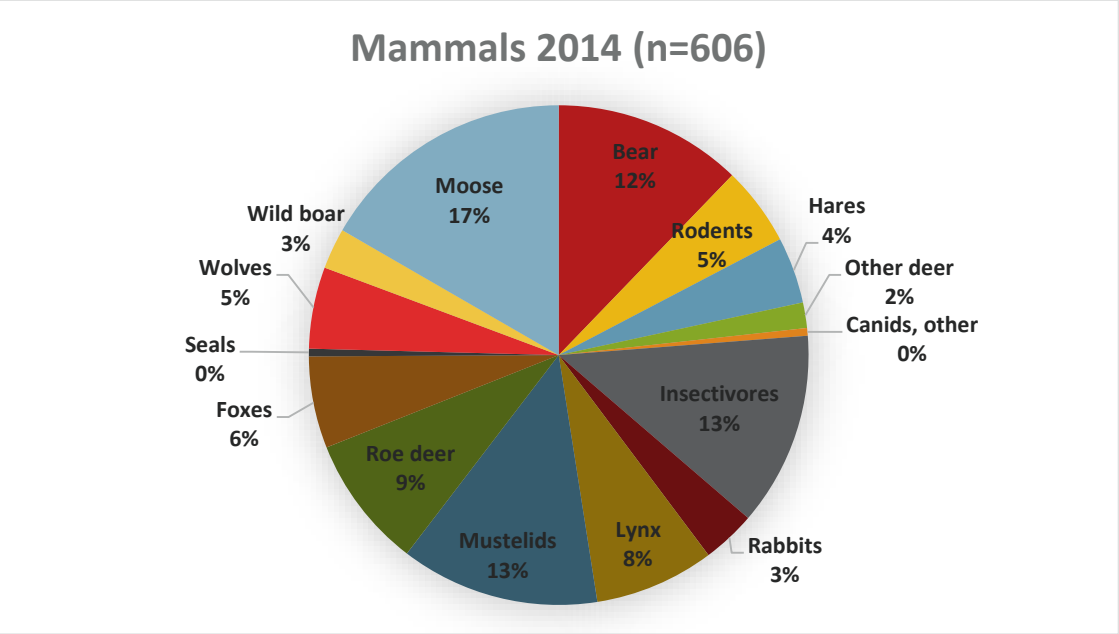


Figure 2. Species composition of mammals submitted to SVA as fallen wildlife 2014.

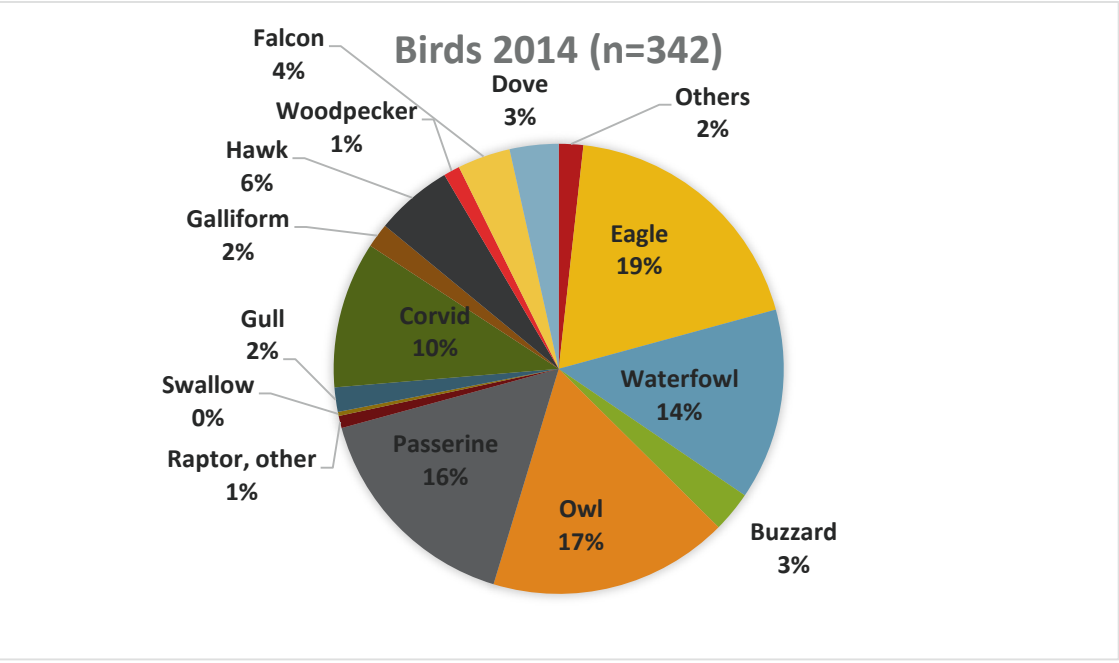


Figure 3. Species composition of birds submitted to SVA as fallen wildlife 2014.

Distribution of diagnoses, fallen wildlife cases

The most common diagnosis in the general disease surveillance programme is trauma, representing approximately 31% of all cases. Causes of trauma included traffic accidents, other collisions, predation and firearms. About 14% of submitted cases showed no pathologic lesions. This can be explained to some extent by the fact that in many of these cases, only selected tissues from dead animals were submitted for examination and those tissues did not show lesions.

Inflammation and infection were determined to be the cause of death in about 17% of the submitted cases. This category includes diseases caused by bacteria, viruses, parasites and fungi. Emaciation was also a very common diagnosis (11%). Emaciation often resulted from starvation, but in other cases it represented the end-stage of underlying problems such as worn teeth, degenerative changes or infections that had affected the animals over a longer period of time. An overview of diagnoses recorded in 2014 can be seen in the figure below.

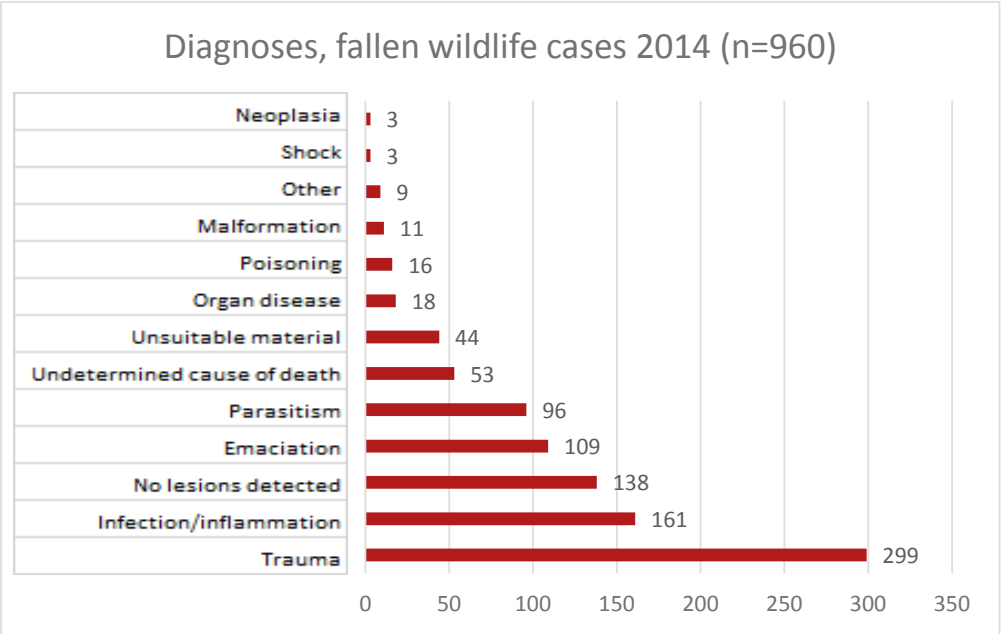


Figure 4. Distribution of diagnoses of submitted wildlife in 2014.

TARGETED SURVEILLANCE CONDUCTED WITHIN THE GENERAL SURVEILLANCE PROGRAMME

Salmonella monitoring

Intestinal samples from 709 fallen wildlife cases (417 mammals and 291 birds) were analyzed for the presence of salmonella bacteria in 2014.

Salmonella bacteria were demonstrated in 50 cases, with the most findings (17 cases) in European hedgehogs (*Erinaceus europaeus*). The high number of findings in hedgehogs can be explained by a focused collection and testing of hedgehogs on the island of Gotland this year (see targeted projects section below). A graph of Salmonella types and in which species these were found in is shown below.

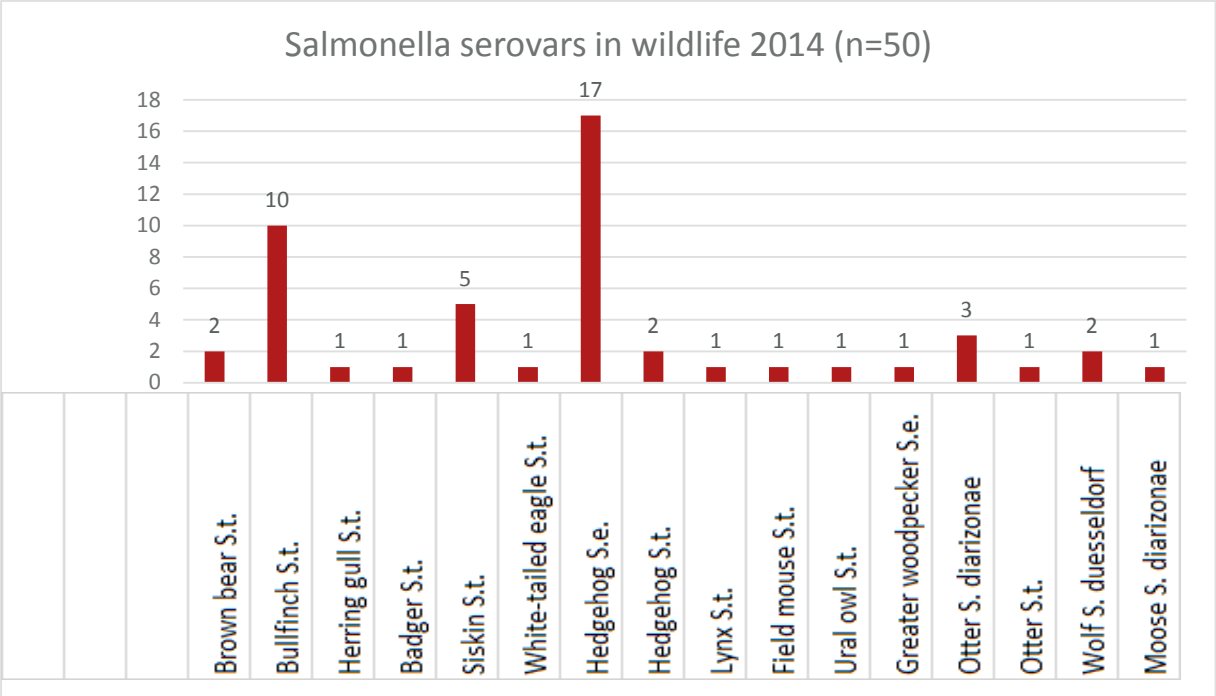


Figure 5. Salmonella detected in various wildlife species at SVA in 2014. S.t.= Salmonella Typhimurium, *S.e.=S* Enteritidis

Tularemia surveillance

Tularemia is a bacterial disease that can affect many species. Hares and small rodents most frequently succumb to the disease and continuous monitoring of wildlife submitted for necropsy is done. Tularemia was found only in two of 31 tested hares in 2014, and not in any other species, which represents fewer findings than most years.

Trichinella

The large predators (brown bear, wolf, lynx and wolverine) necropsied at SVA routinely are examined for the muscle parasite *Trichinella*. Additionally, a subsample of red foxes, badgers, otters and birds of prey from the general surveillance programme are also analysed for this parasite. Trichinella screening is funded in part by the Board of Agriculture within their surveillance programme for disease-causing agents that may affect public health. Excluding wild boar, 473 wild animals were examined for Trichinella in 2014, with the majority from brown bears (241 samples, Table 3). Findings in wolverine have not been very common, but in 2014, three out of 25 (12%) were found to be infected. Muscle samples from hunted wild boar are submitted by hunters directly to the parasitology lab at SVA or to other parasitology labs. In 2014, about 67 100 samples from Swedish wild boar were analyzed for Trichinella, of which about half were examined at SVA. Six wild boar (less than 0.01% of analyzed samples) were infected with Trichinella. Twenty-three wild birds of prey were investigated, but no Trichinella parasites were detected. Trichinella appears to be a rare occurrence in birds, with only two cases previously documented in Swedish wild birds (two tawny owls, *Strix aluco*). An overview of wild animals tested for Trichinella in 2014 can be seen in the table below.

Animal species	Number of samples	Number of positive (per cent)
Brown bear	241	1 (0.04)
Lynx	70	4 (5,7)
Red Fox	53	0 (0)
Wolf	32	2 (6.3)
Wolverine	25	3 (12.0)
Birds of prey	23	0 (0)
Raccoon dog	16	1 (6,3)
Badger	7	0 (0)
Otter	3	0 (0)
Seal	1	0 (0)
Marten	1	0 (0)
Arctic fox	1	0 (0)
TOTAL	**473**	**11 (2.3)**

Table 3. Number of Trichinella analyses and findings in wild animals (except wild boar) at SVA in 2014

Targeted wildlife disease surveillance projects in 2014

The targeted disease surveillance projects at SVA focus on selected diseases or animal species to provide information on the current status of diseases that can affect wildlife, domesticated animals or people. These projects usually involve participation of hunters and the general public to help collect desired samples from a particular species of animal. The targeted surveillance project usually is preceded by findings within the general surveillance programme or by detection of the disease in neighbouring countries or other parts of the world where there is deemed to be an increased risk for disease emergence in Sweden.

MONITORING OF ECHINOCOCCUS TAPEWORM 2014

The fox tapeworm *Echinococcus multilocularis* is an approximately 3 mm long intestinal parasite that is harmless for foxes. However, the parasite's larval stage can cause severe disease in intermediate hosts (small rodents), and in rare occasions, also in humans. All Canidae, including wolf and raccoon dog, can carry the parasite. Monitoring of hunter-shot foxes for the fox tapeworm was done at SVA between 2000 and 2010 through a surveillance programme funded by the Board of Agriculture. Approximately 300 red foxes were submitted annually by fox hunters in different parts of Sweden. The first finding of the fox tapeworm was from the intestine of a fox shot in the municipality of Uddevalla in late 2010. An intensified collection of hunted foxes was done in 2011, and the parasite was also found in the municipalities of Katrineholm and Borlänge.

Between 2012 and 2014, nationwide surveillance of tapeworm was conducted, primarily through the analysis of collected fox scat, a project commissioned by the Board of Agriculture. The Swedish Association of Hunting and Wildlife Management organized a network of contact people in all counties to coordinate the collection of fox scats from all municipalities in the country.

Some samples also came from a research project at the University of Agricultural Sciences (SLU), investigating the presence of parasites among small rodents in southern Sweden. Within this project, an infected water vole (*Arvicola* sp.) in Gnesta, and positive fox scats in the municipality of Växjö were found. During the three year fox scat study, 2,779 samples were analyzed. Three positive samples found in the municipalities of Uddevalla, Katrineholm, and Gnesta. The conclusion of the monitoring programme is that parasite prevalence in the country is very low, but in focal areas, it may be present at a higher rate. In addition to analysis of fox scats, collection of hunter-shot foxes is still ongoing. These foxes have been collected within 20 km from each of the five locations where the tapeworm has been found in Sweden. The collection of up to 30 foxes from both Gnesta and Växjö municipalities is being conducted during the hunting season of 2014-2015. Additionally, 29 wolves and 17 raccoon dogs were also analyzed for Echinococcus in 2014, but no positive cases were found.

Red fox. Photo: SVA.

WILD BOAR AS CARRIERS OF PATHOGENIC AGENTS

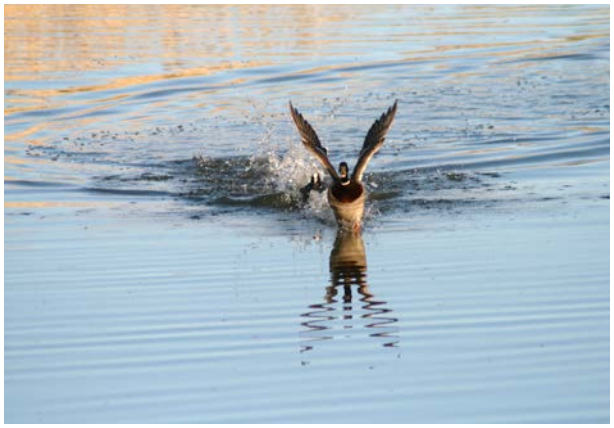
Blood samples from wild boar shot during hunting are submitted to SVA for serological tests to screen for a number of important infectious agents affecting wild boars, domestic swine and/or humans. Following wider spread of African Swine Fever (ASF) in Russia in 2013, a small investigation into this virus was initiated in 2013 and continued in 2014. In 2014, five necropsied wild boar within the general surveillance programme were tested for ASF, and all were negative. Of 403 blood samples screened for various viral diseases, including classical swine fever and pseudorabies, only one sample showed a positive reaction. This was a reaction against PRRS (porcine reproductive and respiratory syndrome), but further investigation revealed that this sample was a "false positive" and the animal was determined not to have been infected by PRRS virus.

BIRD FLU MONITORING

Wild birds necropsied at SVA are examined for bird flu virus, which is funded by the Board of Agriculture, which then reports the results to the EU. In 2014, 263 wild birds of 54 different species were tested. Virus was detected in one mallard (*Anas platyrhyncos*), but further typing of the virus showed it was a low pathogenic (less infectious) variant of the influenza virus. The table below shows the 10 most commonly tested species in the bird flu surveillance.

Species of bird	Number of sampled
White-tailed eagle	43
Jackdaw	22
Greenfinch	18
Bullfinch	11
Golden Eagle	11
Pigeon	10
Great grey owl	9
Ural owl	9
Mallard	7
Siskin	7

Table 4. Distribution over the 10 most common bird species tested for bird flu at SVA in 2014.



Coot and Mallard. Photo: Roland Mattsson, SVA.

INVESTIGATION OF MOOSE CALF MORTALITY ON ÖLAND

Investigation of an abnormally high moose calf mortality continued in 2014 on the island of Öland. Twenty-six moose (20 females, six males) were provided with GPS/GSM-collars in 2012, and calving and summer mortality rates were followed in 2013 and 2014. The results for 2014 showed that calf mortality rate remained high, as 11 of 13 moose calves (delivered by eight moose females) were dead by the end of the summer. Three calves found dead during the first week of life died of starvation, which is similar to results from 2012 and 2013. Another calf was found dead in the month of July (at approximately 6 weeks of age), and was emaciated. However, unlike the younger calves, the underlying cause was bacterial infection with both anaplasmosis and clostridiosis. Field observations of female moose that calved suggested that they were in poor, or deteriorating, body condition at the time of birth and in the weeks following birth. The study of female moose will continue in 2015.

Female moose. Photo: SVA.

PASTEURELLOSIS IN FALLOW DEER

Increased mortality of wild fallow deer (*Dama dama*) in parts of Södermanland and Örebro counties occurred in the summer of 2013 and was again observed in the summer of 2014. Two deer were necropsied in 2014 and a large number of carcasses were reported from one of the previously affected areas. Severe pneumonia caused by the toxin-producing bacteria *Pasteurella multocida* was found. Healthy deer can carry *Pasteurella* bacteria in the nasal cavity or pharynx, but if the immune system is compromised by stress or disease, these bacteria start multiplying and form toxins, which often results in death of the animal. A high population density of fallow deer, coupled with limited feed and water access (due to drought in the area during the hot summer), are believed to be underlying factors in the outbreak. In one of the necropsied deer, the tick-borne bacterium *Anaplasma phagocytophilum* was also found. Anaplasmosis is a newly discovered disease in wild deer in Sweden and it is unclear how long it has been present in the population and what significance it has for infected animals. In the fall, SVA initiated a targeted survey of hunted, apparently healthy, deer in the area where the outbreak occurred. *Pasteurella* bacteria were not found in the pharynx of the hunted deer.

Further genetic studies were performed on the isolated *Pasteurella* bacteria from the affected fallow deer in 2013 and 2014. Whole-genome sequencing of these strains was done along with samples from cases in farmed fallow deer from the county of Västra Götaland. The bacterial strains isolated from deer from all three counties (Södermanland, Örebro and farmed deer from Västra Götaland) had exactly the same set of genes within each geographical area, but 65 genes differed between Södermanland and Örebro and 174 genes differed between Södermanland and Västra Götaland. Strains were considered to be closely related but they differed sufficiently to conclude that it was not the same strain that infected all the deer. This suggests that there were multiple and simultaneous outbreaks, independent of each other.

PCR DIAGNOSIS OF TRICHOMONAS INFECTION IN WILD BIRDS

Trichomonas gallinae is a single-celled parasite which causes significant mortality in passerines, primarily in greenfinches (*Carduelis chloris*). This parasite was first seen in greenfinches in the United Kingdom in 2005 and it has been documented in songbirds in Sweden and the Nordic countries since 2008. Trichomoniasis is estimated to have reduced the greenfinch population by as much as 40% from

2008–2012 (Swedish Bird Counting data). The diagnosis previously required direct observation or culture of live parasites from very fresh necropsy samples. In bird carcasses that have been frozen or dead for more than two days, the parasites are dead and can no longer be visualized under a microscope or cultivated. A PCR method for diagnosis of *Trichomonas gallinae* was developed at SVA in 2014 and validated in 2015 by analysis of archived samples from surveyed birds. The analysis has been very successful and with PCR technology, almost four times as many positive cases from necropsy material could be confirmed compared to previous methods relying on microscopy of live parasites. Trichomoniasis has also been confirmed in other passerine species such as chaffinch, yellow bunting, house sparrow, great tit, grosbeak, bullfinch, siskin, magpie, rock pigeon, wood pigeon, and birds of prey such as goshawk, tawny owl and great horned owl.

SALMONELLA IN HEDGEHOGS

Salmonella bacteria have been reported in hedgehogs (*Erinaceus europaeus*) from Europe, and SVA has confirmed occasional cases in Sweden. In the fall of 2013, an unusually high number of deaths occurred in hedgehogs admitted to wildlife rehabilitation centers. The cause of death in many cases was salmonellosis, a generalized infection caused by salmonella bacteria (*Salmonella* Enteritidis). The source of the salmonella infections is unknown and hedgehogs on Gotland could be a reservoir for *S.* Enteritidis. The goals of the study in 2014 were to gather more knowledge about salmonella in hedgehogs on Gotland and set up a new subtyping method for S. Enteritidis to compare differences between strains.

The study showed that infection with *S.* Enteritidis is common in sick or dead hedgehogs on Gotland (13.5% of samples examined from these animals were positive for *S.* Enteritidis). In samples from apparently healthy animals, salmonella was not detected. However, further studies are needed to ascertain if and to what extent the hedgehog population carries or disseminates salmonella bacteria. The high prevalence of salmonella in diseased hedgehogs stresses the importance of maintaining strict hygiene procedures to prevent the spread of the infection among hedgehogs in rehabilitation facilities, and to avoid the spread to other animals and humans.

Hedgehog. Good hygiene practices include always washing your hands after handling hedgehogs. Photo: Erik Ågren, SVA.

CALICIVIRUS INFECTIONS OF LAGOMORPHS

A new lagovirus (Caliciviridae) called Rabbit Hemorrhagic Disease Virus-2 (RVHD2) was discovered in France in 2010 and spread quickly among wild and domestic rabbits throughout several European countries. There is concern that RVHD2 has also spread to Sweden and may cause mortality among both wild and domestic rabbits and possibly hares. A study of RVHD2 in wild rabbits and hares that have died of suspected RVHD has been initiated. If RVHD2 is detected, the disease will be characterized by pathological and molecular studies at SVA, in cooperation with other European countries.

The four large predators, 2014

Brown bear, wolf, lynx and wolverine are Sweden's four large predators and they are classified as Wildlife of the State. According to regulations of the Environmental Protection Agency, all dead large predators or parts of these species that are found in nature are to be submitted for examination at SVA. In the licensed hunt for bears, a field inspector collects tissue samples and a tooth from shot animals to be sent to SVA. In total, 479 whole carcasses or parts from the four large predators were submitted to SVA in 2014. An important part of the work at SVA includes forensic investigations when there is suspicion of wildlife crimes. In 2014, 42 forensic cases were examined at SVA and included 13 cases concerning brown bear, 8 cases of lynx, 10 wolf cases and 10 golden eagle cases.

In addition to necropises of large predators, work also includes compilation and communication of information to public authorities, scientists, the general public and special interest groups, as well as providing expert opinions in different contexts. Additionally, collaboration with national and international research groups and distribution of data and tissues and from the biobank for use in various scientific studies are a regular part of the work with large predators at SVA.

A necropsy of a lynx. Photo: Erik Ågren, SVA

Collaboration with the Museum of Natural History

SVA collaborates with the Museum of Natural History (NRM) in Stockholm regarding large carnivores, investigation of the health status of marine mammals as well as necropsies and pathological studies of other wildlife species, particularly otters and eagles.

MARINE MAMMALS

In 2014 a wildlife pathologist from SVA worked part time at NRM to perform necropsies of seals submitted through NRM's environmental contaminant monitoring program. SVA's work is primarily focused on determining the cause of death and disease conditions in these species while NRM studies environmental contaminants, food habits, health status, and genetics. A large part of the joint work in 2014 was to investigate increased mortality of harbour seals on the west coast of Sweden. In total, at least 444 dead harbour seals were reported from March to December, which is about ten times more than expected during a normal year. Bird flu virus was detected in some seals and was determined to be associated with the mortality event. An in-depth investigation of the outbreak is still ongoing.

SVA performs necropsies on all species belonging to the Wildlife of the State, and the skin and skeleton are then sent to the NRM for further studies and are added to NRM collections.

Emaciated harbour seal pup in the necropsy room. Photo: SVA

EAGLES

In 2014, 82 eagles (66 white-tailed eagles, 15 golden eagles, and the skeletal remains of an eagle of unknown species) were submitted to SVA for necropsy. The tables below show the causes of death that could be established, where some birds may have more than one diagnosis. As in previous years, traffic accidents were the most common cause of death, along with other causes of trauma. Five white-tailed eagles were killed by wind turbines in 2014. Five eagles had fresh or old gunshot wounds, and these cases have been reported to the police because hunting eagles is prohibited. Six eagles died of lead poisoning, which in most cases likely is caused by feeding from gut piles of hunted game.

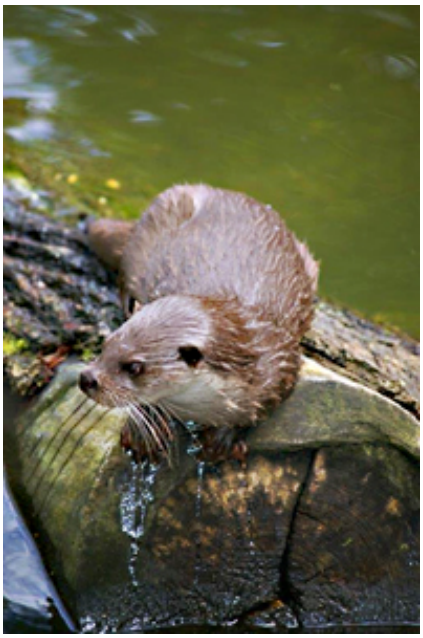
White-tailed eagles, 2014	Number of cases
Traffic killed	22
Other trauma	11
Not determined	10
Lead poisoning	6
Infection	6
Wind turbines	5
Gunshot wound	4
Emaciation	2
Heart malformation	1
Intraspecific trauma	1
Total	**66**

Golden eagles, 2014	Number of cases
Traffic killed	5
Trauma	5
Not determined	2
Infection	2
Gunshot wound	1
Emaciation	1
Total	**15**

Table 5 & 6. Overview of causes of death of eagles necropsied at SVA in 2014.

OTTERS

The otter population and submissions of dead otters have increased in recent decades. In 2014, 37 dead otters were submitted to SVA. Otter carcasses are also sent directly to NRM, and necropsies and sampling are performed at both institutions. Any pathologic findings are examined by pathologists at SVA, and all carcasses are sampled for environmental pollutants at NRM. The most common cause of death is traffic trauma and this was found in 23 otters (62%) in 2014. Six otters (16%) had died of emaciation.



Otter (zoo animal). Photo: Caroline Bröjer, SVA

International wildlife disease 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 internet and via e-mail, electronic news forums and membership and participation in various international associations and networks form the basis of this monitoring. The Wildlife section at SVA also admits students and other scholars to spend time at SVA to experience, receive training in, and learn about the wildlife disease work at the institute.

Visiting student receiving training on necropsies. Photo: SVA

Wildlife research

MOOSE

The project "Reproduction and health of moose" is funded by the Wildlife research fund at the Environmental Protection Agency, SVA (Wildtech-the 7th EU framework program), and the Swedish University of Agricultural Sciences (SLU). Jonas Malmsten, a veterinary wildlife pathologist at SVA, defended his thesis based on this project in April 2014. Moose in southern Sweden were further studied in 2014 in collaboration with SLU in Umeå (Department of wildlife, fish and environmental studies), by placing GPS-collars on adult animals, labelling (ears) of newborn calves, as well as collecting and analyzing organs from shot moose in Södermanland, Kronoberg and Öland. The project is expected to continue throughout 2015.

HEPATITIS-E VIRUS

Hepatitis-E virus in wildlife has been studied through collaboration between hunters, SVA's Department of Pathology and wildlife diseases, Swedish University of agricultural sciences SLU (Department of clinical sciences), Sahlgrenska Academy, University of Gothenburg and SVA Department of Virology, and Parasitology immunobiology (PhD student Jay Lin, supervisor Frederik Widén and Assistant Supervisor Heléne Norder). Wild boar, roe deer, red deer and moose tissue samples have been analyzed for the presence of hepatitis-E virus, which can infect humans under certain conditions. The project was funded largely by FORMAS but also by the EU projects Predemics and Wildtech, and a final report is planned for 2015.

HUMAN PATHOGENS CARRIED BY WILD BOAR

Veterinarian and PhD student Axel Sannö is working on a project called "Human pathogens in wild boar". Various infectious agents can be transmitted from wild boar and cause disease in humans. The projects focuses on two bacteria; *Salmonella* and *Yersinia*, that may be present in the gut or lymph nodes, and can then contaminate meat during evisceration and butchering of hunted wild boar. The project is done in cooperation with the SLU and is funded by the EPA, Environmental Protection Agency wildlife research fund, and Sandberg's Foundation.

TULAREMIA

Tularemia is a disease caused by the bacterium *Francisella tularensis*. A variety of species may be susceptible to the disease, including humans. During 2014, two projects have been running, and both will be completed in 2015. In one project, blood samples for serological testing have been collected during necropises of red foxes, wild boar, lynx, wolf, wolverine and raccoon dogs for the detection of antibodies against the bacterium. Tissue samples also have been collected from lymph nodes (tonsils, maxillary lymph nodes). In those animals with antibodies, the lymph nodes will be studied microscopically to see if they contain bacteria. These species were selected because they hunt and eat carrion of hares and small rodents and can serve as indicators of the spread of tularemia to new areas. In the second project, muscle tissue of hunter harvested hares is tested for presence of tularemia bacteria to investigate potential hazards with human consumption of this meat.

Meat samples from a hunter harvested hare. The hunter was infected with tularemia, and F. tularensis was detected in the submitted meat.

The biobank

Frozen tissue samples in SVA's biobank freezers are an important and valuable resource used in international research collaborations. In 2014, samples from 1,024 different autopsy cases were added to the biobank. Pieces of the brain, lung, spleen, liver, intestine, kidney, and musculature from all suitable wildlife cases were sampled for the biobank.

Communicating knowledge

Dissemination of knowledge is an important part of SVA's work regarding animal diseases. Researchers, governmental agencies, educational institutions, non-profit organizations and the public are informed through reports, articles (scientific and popular science), press releases, newspaper notices, as well as through lectures and seminars, and visits to SVA.

Lecture by member of the wildlife section at SVA.

VISITORS AND LECTURES

Each year, the wildlife section receives visitors, such as students, scholars, officials, or study groups. In 2014, there was on average one visit or external lecture per month. In total, approximately 300 people were informed of the work at the Department, as well as were updated on current projects, disease surveillance and wildlife diseases through these presentations.

Visitor group in the necropsy room, SVA.

TELEPHONE AND EMAIL SERVICES

Every working day, a wildlife veterinarian at SVA is available for answering questions by telephone or via the wildlife section's e-mail (vilt@sva.se). In 2014, approximately 250 questions regarding wildlife were received and answered by email. The questions concerned various animal species, but the most common questions involved birds, hoofed wildlife and predators. A total of 464 telephone calls regarding reports of disease or mortality in wildlife were registered. Moose was the species most frequently reported in calls of findings of dead or diseased wildlife (121 calls).

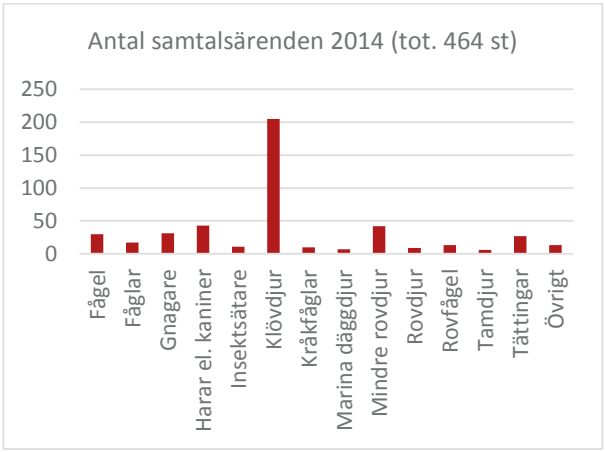


Chart 7. Number of registered phone call reports to the Wildlife section at SVA in 2014, by animal group

Reporting dead wildlife

When dead wildlife is found, people can report this to SVA through a form on SVA's website. This information is monitored to get an early warning of any increased mortality or disease within a wildlife population. Reporting of dead wildlife can be done at: www.sva.se/rapportera-in

PUBLICATIONS 2014

In 2014 the wildlife section staff at SVA participated in the writing of a number of scientific and popular scientific publications, written reports and replies to referrals from various authorities. To disseminate our findings and gather new knowledge and information on wildlife diseases, the staff has participated in various international and national congresses, meetings and seminars where scientific research results have been presented. Listed below is a selection of publications in 2014 concerning wildlife, where at least one of the authors is part of or affiliated with wildlife section at SVA (names in bold).

Scientific publications

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Malmsten J., **Gavier Widen D**., Rydevik,G. Yon L., Hutchings MR., Thulin C-G., Söderquist L., Aspan A., Stuen S., Dalin A-M. (2014). Temporal and spatial variation in Anaplasma phagocytophilum infection in Swedish moose (Alces alces). Epidemiology and Infection 142:1205-1213.

Malmsten J., Söderquist L., Thulin C-G., **Gavier Widén D**., Yon L., Hutchings MR., Dalin A-M. (2014). Reproductive characteristics in female Swedish moose (Alces alces), with emphasis on puberty, timing of oestrus, and mating. Acta Veterinaria Scandinavica 56:23.

Margalida A., Bogliani G., Bowden CGR., Donázar JA., Genero F., Gilbert M., Karesh WB., Kock R., Lubroth J., Manteca X., Naidoo V., **Neimanis A**., Sánchez-Zapata JA., Taggart MA., Vaarten J, Yon L., Kuiken T., Green RE. (2014). One Health approach to use of veterinary pharmaceuticals. Science. 136: 1296-1298.

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