Appendix X

Lynx pathogens and diseases

All tables taken from Behnke and Walzer (2020)

Viral diseases

Name	Epizootiology	Cases	Signs	Diagnosis	Treatment	Captivity	Wild
Feline panleucopenia or parvovirosis (FPV) also known as **Feline infectious enteritis** (FIE)	Highly contagious virus that is shed in all secretions and excretions. It is shed in faeces for up to six weeks after recovery. Illness last five to seven days; usually fatal. Mortality is highest in felids <five months of age.	In a study of Naidenko et al. (2018) on seprovalence in wild felids, none of the tested wild Eurasian lynx were positive FPV-tested. Ryser-Degiorgis (2009) tested one wild individual positive for FPV antibodies. Wasieri et al. (2009) showed infections in a captive held individual in a wildlife park, potentially caused by contact with feral domestic cats. In 2019, an individual captured in Romania, held in quarantine for reintroduction in the LIFE Lynx project in Slovenia tested positive for FPV, without showing clinical signs (M. Krofel, pers. comm.). FPV can pose a threat to lynx held in captivity, as well as to individuals in the wild exposed to temporarily quarantined individuals reintroduced for population-reinforcement. Vaccination of (temporarily) captive held individuals is therefore recommended.	Can be subclinical; acute cases show fever, depression, anorexia and dehydration, vomiting and diarrhoea may be present; death.	Presumptive diagnosis is based on clinical presentation; confirmation by demonstrating FPV antigen in faeces; Test kits for canine parvovirus antigen may detect FPV antigen during the acute phase.	Virus is resistant to inactivation and can survice >1 year in a suitable environment; Virus is inactivated by 6 % household bleach (sodium hydrochlorite); Prevention relies on vaccination, and use of a product containing an inac- tivated or killed virus is recommended (Miller & Fowler 2015).	X	X

Rabies	Rabies is caused by a lyssavirus that affects the central nervous system. Bites of infect- ed animals (carnivores or bats as vectors), contact of saliva with mucous membranes or open wounds. Aerosol in an enclosed envi- ronment, fatal disease within two to seven days of illness (Miller & Fowler 2015).	Rarely have cases of rabies been reported in Eurasian lynx (Matjuschkin 1978; Stahl & Vandel 1999; Ryser-Degiorgis 2009).	Salivation, abnormal be- haviour (ag- gression), neurologic signs (paresis, seizures).	Recommend eutha- nasia and shipment of head to a qualified laboratory for FA or VI Serology used to monitor response to vaccination (Miller & Fowler 2015).	Immunization with Purevax® Rabies ad us. vet. or Nobivac® Rabies ad us. vet. from the age of 12 weeks to prevent mortality from infec- tion recom- mend- ed;. Lyssaviruses are not stable; inactivated by common disin- fect- ants (www.vetpharm.uzh. ch).	X	X

Name	Epizootiology	Cases	Signs	Diagnosis	Treatment	Captivity	Wild
Orthopoxvirus (OPV)	Orthopoxviruses are a group of large, complex, double- stranded DNA viruses that replicate in the cytoplasm of the host cell. Most orthopoxvirus infections are zoonotic, with humans serving as accidental hosts (Munoz 2014).	In 2011, orthopoxvirus (OPV) DNA was detected in tissues (lung, kidney, spleen) of 24 (9%) of 263 wild Eurasian lynx (Lynx lynx) from Sweden. The prevalence was higher among individuals from regions with dense, rather than rural human population (Tryland et al. 2011). According to Tryland et al. (2011), lynx are probably exposed to OPV through predation on small mammal reservoir species. They concluded that “OPV is widely distributed in Sweden and may pose a threat to humans”, so far no detection of OPV in other lynx populations is known of.	Orthopoxvirus infections may be localized to the skin or disseminated. The initial site of infection may be the skin, a mucosal surface, or the respiratory tract. The virus then spreads through regional lymphatics to cause viraemia and involvement of the reticuloendothelial system with secondary viraemia. The typical pock skin lesions result from direct viral infection of the skin (Munoz 2014).	Diagnostic laboratory testing for orthopoxvirus infections can include polymerase chain reaction, viral culture, and electron microscopy of rash lesion material, as well as serologic testing of serum (Peterson and Damon 2015).	Vaccinia virus continues to be used as a vaccine. Vaccinia Immune Globulin Intravenous (VIGIV) is licensed for the treatment of certain complications of vaccinia vaccine administration (Peterson and Damon 2015). No antiviral drugs are currently licensed for use in the treatment of orthopoxvirus or other poxviral illnesses. Antibodies directed against a member of the orthopoxviruses can provide cross-protection against other poxvirus species. Although no specific antiviral treatment is available, certain compounds, such as cidofovir and		X

					ribavirin, have in vitro activity against all pox viruses. Drugs active against herpes virus, particularly acyclovir, are not active against pox viruses (Munoz 2014).		
Feline leukemia virus (FeLV)	FeLV is a retrovirus of domestic cats; FeLV in nondomestic felids is rare	Individuals infected with FeLV occured in captive *Lynx rufus* (Sleeman 2001) and an outbreak occurred in the wild in *Lynx pardinus* in 2006/7 (Geret et al. 2011)	infection indicated by pale gums, yellow color in mouth and whites of eyes, enlarged lymph nodes, bladder, skin, or upper respiratory infections	Early infections: diagnose by blood testing (ELISA); IFA blood testing detects progressive phase of the in-fection	Presently, there is no cure for FeLV infection	X	X

Name	Epizootiology	Cases	Signs	Diagnosis	Treatment	Captivity	Wild
Feline immunodeficiency virus (FIV)	FIV is a lentivirus that affects mainly domestic cats	FIV strain was detected in *Lynx rufus* (Lagana et al. 2013)	initial stage (acute phase) is accompanied by mild symptoms such as lethargy, anorexia, fever and lymphadenopathy; followed by the asymptomatic stage with no noticeable symptoms, follwed by final stage, where the individual is extremely susceptible to secondary diseases which induce death	blood testing for FIV antibodies; testing identifies those individuals, that carry the FIV antibody but does not detect the actual virus; individuals tested positive might be tested later negative due to seroreversion	Treatment via Lymphocyte T-Cell Immunomodulator (LTCI); LTCI is a potent regulator of CD-4 lymphocyte production and function (Beardsley et al. 1983. It has been shown to increase lymphocyte numbers and Interleukin 2 production (Beardsley et al. 2007).		X
Feline herpes / rhinotracheitis virus (FHV-1/FVR)	FVR is caused by the feline herpesvirus 1 (FHV-1)	Low prevalences of minimally positive titres were found in *Lynx pardinus* (Roelke et al. 2008)	Upper respiratory infection of the nose and throat; uncontrollable sneezing; watery or pus containing nasal discharge; loss of sense of smell; eyelid spasms resulting in closure of the eye blepharospasm); conjunctivitis; keratitis	Diagnosis of FVR by corneal ulceration; Definitive diagnosis can be done by direct immuno-fluorescence or virus isolation	No specific antiviral famciclovir is effective at treating this infection in cats. Conjunctivitis and corneal ulcers are treated with topical antibiotics for secondary bacterial infection.		X

Feline calicivirus (FCV)	FCV is caused by a virus strain of the family Caliciviridae, causing respiratory infection in cats	In a study by Meli et al. (2009), antibodies to FCV were detected in 29 of 74 (39.2%) tested free ranging *Lynx pardinus*	Acute upper respiratory infection (URI); gingivitis and stomatitis; limping syndrome (in young individuals); rare: Virulent systemic FCV infection (vsFCV)	Presence of typical signs of URI; sample of pus by ocular; virus detection by PCR	FCV infections frequently complicated by secondary bacterial infections; supportive treatment with antibiotics; severe cases need intravenous fluid therapy, nutritional support		X
Feline corona virus (FCoV)	FCoV is a enveloped single-stranded RNA virus	Antibodies to feline coronavirus (FCoV) were detected in 19/74 (25.7%) tested free ranging *Lynx pardinus* (Meli et al. 2009)	Fever, lethargy, in-appetence, vomiting, diarrhea, dehydration, icterus, tachypnea, uveitis, neurologic signs, abdominal distention due to ascites.	Virus detection via electron microscopy or PCR from diarrheic feces aid diagnosis of FCoV enteritis	Treatment largely supportive and includes fluid and nutritional support. Disease is rogressive and ultimately fatal.		X

Name	Epizootiology	Cases	Signs	Diagnosis	Treatment	Captivity	Wild
Bluetongue virus (BTV)	Bluetongue virus; orbivirus (with at least 24 serotypes described)	Recent emergence of BTV8 in northwest Europe with over-wintering and seasonal pattern of disease – in 2007 one case of BTV in Eurasian lynx in a zoo in Belgium (Jauniaux et al. 2008)	Hemorrhage and ulceration, oral cavity and teats, epiphora and periocular inflammation, transient but severe corneal edema, limb edema - in Eurasian lynx anemia, emaciation, en-larged and gelatinous lymph nodes, pneumonia, sub-cutaneous hematomas, pe-techial hemorrhages, lung congestion with endema (Jauniaux et al. 2008)	History & clinical signs,histopathologic examination, PCR test & serologic examination	Vector control, vaccination with BTVPUR AlSap 8, resp. 4 ad us. vet.; The vaccine contains inactivated serotype 8 or 4 bluetongue virus. It gives the animal an active and specifically anti-serotype 8 Bluetongue virus immunity (www.vetpharm.uzh.ch).	X	

Borna disease (BDV)	Order: Mononegavirales Family: Bornaviridae (enveloped single-strand RNA virus) - Multiple genotypes	In Sweden, one individual in the wild showed abnormal behaviour and was shot. PCR analysis showed the presence of Borna disease virus infection in the brain. To our knowledge, this is the first confirmed case of Borna disease in a large felid. Host spectrum of BDV is very broad and includes horses, sheep, cattle, cats, rabbits, and ostriches, rarely wild mammals such as lynx (Degiorgis et al. 2000).	BDV infection causes severe neurologic syndrome called Borna disease (BD), manifested as nonsuppurative encephalmomyelitis with a predilection for the limbic system, the basal ganglia, and the brain stem.Symptoms vary but may include excited or depressed behaviour, ataxia, ocular disorders and abnormal posture and movement (Miller & Fowler 2015).	PCR, VI, IFA of cell culture, IHC; Western blot crop biopsy and histo-pathology. Antibody test not commercially available. When present, gross lesions consist of dilated proventriculus and cardiac enlargement. Histopathology of pro-ventricular dilatation disease is characterised by nonsuppurative in-flammation in the central, peripheral and autonomic nervous systems (Miller & Fowler 2015).	No proven zoonotic potential. Care limited to supportive with easily digestible high calorie food, NSAIDs. Screen for viral infection and shedding via PCR. Maintenance of an ABV free collection preferred but is rarely currently feasible. Testing and separation is difficult based on inter-mittent shedding and latency of virus. No re-commended commercially available vaccine. Appropriate disinfection uninvestigated (Miller &Fowler 2015).		X

Bacterial diseases

Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Salmonellosis	Salmonellosis can be acquired from contaminated raw meat fed to captive held individuals. The symptoms range from mild diarrhoea to severe gastroenteritis with generalised infection, causing dehydration. Some infected animals appear unaffected (Krelekamp 2004).	One case of Salmonella arizonae was reported in a young captive Eurasian lynx (Macri et al. 1997)		The treatment apart of replacing fluids and electrolytes, consists of administering broad-spectrum antibiotics such as Synulox® ad us. vet. (active agent Amoxicillin and Clavulan acid) (Miller & Fowler 2015). To lessen the risk of salmonella infection, it has been suggested that the intestines are removed from the carcasses before offering poultry to captive individuals (Blomqvist et al. 1999). In general, the offering of poultry should be avoided and rabbits or similar naturally accepted prey items should be offered instead to avoid salmonella infection.	X	X
Tuberculosis	Tuberculosis (TBC) is usually transmitted from feeding infected meat with wild birds acting as potential vectors for *Mycobacterium bovis*, the bacteria that causes TBC. The disease can take several months or even years to develop. The bacterium is also transmitted in aerosols and other secretions. Symptoms include localized lymph node swelling, acute respiratory distress, weakness and chronic emaciation/strong weight loss.	So far there have been no known cases in Eurasian Lynx, but TB has been reported in free-living Iberian Lynx (Briones et al. 2000; Pérez et al. 2013).	Antemortem testing: multi-modal approach and cautious interpretation. Clinical and necropsy findings; detection of M. bovis by acid-fast and immune-histochemical stains, PCR, and culture (“gold standard”); tuberculin skin test and antigen-stimulation tests (Miller & Fowler 2015).	TBC is rarely treated (Miller & Fowler 2015). In captivity prevention consists of deep freezing whole or partial prey items prior to feeding them (Mellen 2003). With the general expansion of TB in Europe this could become a major concern in the future.	X	X

Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Pseudo-tuberculosis (*Yersinia pseudo-tuberculosis*)	Occurred in the wild as chronic form with multifocal necrotic foci in inner organs; in a rescue station fascility, an acute form with diarrhoea, anorexia and apathetic behaviour followed by septicaemia was observed (Ryser-Degiorgis and Robert 2006); Outer Symptoms: skin injuries, lymph nodes enlarged, abscesses in lymph nodes open with infectious, yellow-green pus; abscess in internal organs, mostly lungs/liver	Observed in individuals from the alpine population from Switzerland, both in the wild and in rescue station facilities (Ryser- Degiorgis and Robert 2006).	Diagnosis by PCR	Regular blood testing to establish unsuspicious virus free individuals (applies for individuals held in captivity)	X	X
Feline infectious anaemia (FIA)	Feline infectious anaemia (FIA) is a feline retrovirus caused by a variety of infectious agents, most commonly *Mycoplasma haemofelis* (Mhf), which is transmitted by blood sucking insects (cat fleas) (Blomqvist et al. 1999). Signs include lethargy, decreased appetite. Physical examination findings are non- specific and can include anaemia, such as mucous membrane pallor, tachypnea and tachycardia, pyrexia, occasionally splenomegaly and jaundice. The anaemia can be severe and fatal in some cases. Coinfection often occurs with other infectious agents including feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV).	In a study of Willi et al. (2007), prevalence for feline hemoplasma infections in wild Eurasian lynx from Switzerland 44% tested via real-time PCR for *M. haemofelis* positive.	Most commmon findings from complete blood counts from cats showing a Mhf infection are a macrocytic, hypochromic regenerative anaemia. Reticulocytes and Howell-Jolly bodies can be identified on cytologic examination. Mhf infection can be diagnosed by identification of organisms on a blood smear. However, examination of a single blood smear is less than 50% sensitive, as the animal's immune response causes organisms to disappear from the blood stream for several days often to reappear a few days later (Hagiwara 2009). The gold standard for diagnosis of Mhf infection is PCR, which detects the 16S RNA gene.	Treatment consists of blood transfusion (in cases of severe anaemia) and antibiotics for at least two weeks (e.g. Doxycycline) (Miller & Fowler 2015). Only cats who are anaemic and have clinical signs and laboratory results consistent with haemoplasmosis should be treated, as the drug does not reliably eliminate the organism (Sykes 2010). Enrofloxacin is also an effective treatment but should be considered as secondary choice due to the risk of acute retinal damage in cats (Tasker et al. 2004). In view of the known risk factors that exist for FIA infection, it is wise to take measures to prevent flea infestation (flea treatment see p. 61) in captivity. Treatment with antimicrobials may result in false negatives on PCR; so collecting before beginning therapy is preferable (Miller & Fowler 2015).		X

Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Anthrax	Anthrax is caused by a bacterium called Bacillus anthracis that forms spores and may remain dormant in soil for years (Miller and Fowler 2015). The disease is usually associated with feeding of contaminated carcasses (Blomqvist et al. 1999). Animals infected with the bacterium show signs of septicaemia, fever, depression and weakness. Acute death, with blood draining from body cavities is possible (Miller & Fowler 2015).	Grigoryan (2002) described a case, where a silver puma, a serval and a black lynx died of anthrax in an Armenian zoo after being fed contaminated carcasses.	Staining smears of peripheral blood, postmortem lesions.	The disease can be treated with antibiotics (Penicillin: streptomycin). However, a diagnosis is rarely made in time for antibiotics to be effective (Miller and Fowler 2015). Prevention consists of deep-freezing whole or partial prey items prior to feeding them to individuals.	X	
Borreliosis	*Borrelia burgdorferi* is the agent causing borreliosis or Lyme disease. Although domestic cats do produce specific antibodies, it is unclear whether they develop clinical symptoms.	Antibodies *to B. burgdorferi* were demonstrated in one of two investigated free-ranging lynx from France (Ryser- Degiorgis 2009). A recent study on borreliacidal effect of carnivore's serum complement indicated that wolf and lynx probably are competent reservoir for *Borrelia spp.* (Ryser-Degiorgis 2009).	Serology is the main way of confirming a clinical impression of Lyme disease	Standard treatment for disease caused by B. burgdorferi infection in captive held individuals is doxycycline at 10 mg/kg orally every 24 hours for 30 days. Longer courses of treatment may be necessary in some cases, particularly those with nephropathy (capcvet.org).		X

Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Heliobacter sp.	Histological: Macroscopic lesions in the stomach or liver. Helical, coiled, corkscrew-like organisms closely resembling *Helicobacter spp.* in gastric mucosa Gastritis, vomiting, and diarrhea have been associated with Helicobacter infection, although a direct causal relationship has not been identified (Mirzaeian et al. 2013). Mucosal inflammation, glandular degeneration, and lymphoid follicle hyperplasia accompany some infections (Blois, n.d.).	Mörner et al. 2009 detected *Helicobacter spp.* in the stomach by PCR analysis in 17 (68%) of the lynx tested in the study. PCR fragments, amplified from the tested lynx were sequenced and compared with those of known Helicobacter species, which resulted in a closely relatedness to *H. heilmannii.*	Upper GI endoscopy or exploratory laparotomy. Surface mucus from a large area of the stomach can be obtained by taking brush samples via endoscopy. If organisms are present, they are readily identified under 100× oil-immersion magnification. Because brush cytology samples a large area of the stomach, the sensitivity of this test is high. Gastric biopsies should be obtained from multiple areas in the stomach, because organism distribution can be patchy. Routine H&E staining is usually sufficient to identify organisms, although special silver stains may be required if the organisms have a glandular location.	Recommended treatment regimens include amoxicillin or tetracycline, metronidazole, bismuth subsalicylate, and a proton pump inhibitor (eg, omeprazole) or H2-receptor blocker (eg, famotidine) for 2–3 wks. Other treatment combinations of omeprazole and azithromycin or clarithromycin have been described (Blois, n.d.).		X
Conjunctivitis/ Chlamydiosis (*Chlamydia felis*)	Clinical signs typically include a marked hyperemia of the nictitating membrane, prominent chemosis, blepharospasm, and ocular discharge Often start unilaterally but become bilateral after a few days. Chlamydiosis in cats can additionally be associated with fever, infection of the upper respiratory tract, pneumonia, reproductive disorders (Gruffydd-Jones et al. 2009).	A free-ranging adult Eurasian lynx (*Lynx lynx*) captured in Switzerland presented with a severe purulent unilateral conjunctivitis.	Chlamydia felis was detected in conjunctival swabs by real-time quantitative PCR (Marti et al. 2019)	Systemic treatment with oxytetracycline and ketoprofen led to complete recovery.		X

Other common bacterial infections encountered in Eurasian lynx in the wild and in captivity

According to Ryser-Degiorgis (2009), most bacterial induced mortalities are caused, apart from those already mentioned above, by commonly occurring bacteria strains from infected wounds. Pulpitis following canine teeth injuries, associated with alveolar periostitis; osteomyelitis and/or septicaemia in lynx orphans kept in rescue station facilities; as well as dental abscess in carnassial tooth associated with *Arcanobacter pyogenes* infection. Furthermore, purulent bronchopneumonia due to *Streptococcus spp.*, *Pasteurella sp*. and occasionally associated with pyothorax and/or pericarditis; purulent cystitis and pyelonephritis due to an ascending urinary tract infection with hemolytic *Escherischia coli*.

Parasitic diseases

Phylum	Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
	Gastro-intestinal parasites						
Nematodes	***Toxocaridae (Toxascaris, Toxocara spp.)***	The most common nematodes (roundworms) found in lynx faeces are ascarids such as Toxascaris and Toxocara cati., both of which have an indirect life cycle, most Euasian lynx carry them. Ova of *Toxascaris* and *Toxocara cati* are very resistant and difficult to eliminate from the environment. Re-infection readily occurs by contaminated food, by ingestion of secondary hosts (rodents) and can also be passed to cubs in mother´s milk. Heavy infestation can cause diarrhoea, vomiting, weight loss, poor hair coat (Miller and Fowler 2015) and in severe cases, death due to intestinal obstruction (Krelekamp 2004).	In Sweden, according to Ryser-Degiorgis (2009), 71% of more than 200 individuals were infested most commonly with ascarids such as *Toxocara cati*. Investigations from Switzerland and other northeastern European countries reveal similar results with infestation rates reaching from 63% and 93%, respectively (RySource?). The prevalence of *T. cati* is with 26% of tested lynx indivi- duals reported as rather low in Bialowieza, Poland (Szczęsna et al. 2008).	Scat contains ova of *Toxascaris* and *Toxocara cati*	Captive held animals particularly should have regular parasitic egg counts carried out on faeces (Mellen and Wildt 2003). Because elimination is essentially impossible once infection has occurred, periodic treatment with anthelminthics (e.g. Zantel® ad us. vet.) is necessary. A variety of effective compounds is available and can be ad- ministered in food (Miller & Fowler 2015). It is good practice to vary the type of anthelmintic (e.g. Fenbendazol®, Praziquantel®) employed (Blomqvist et al. 1999).	X	X

Phylum	Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Nematodes	***Trichinella spp.***	Trichinella spp. are small parasitic nematode worms that infest the intestines of various mammals and whose larvae move through the bloodstream, becoming encysted in muscles. In Europe, Trichinella is common in foxes that are considered as an important infection source for other wildlife. Lynx harbour Trichinella without developing a disease condition.	Prevalence in Eurasian lynx is usually high, reaching from 30-50% (Ryser-Degiorgis 2009). In Finland, prevalence varies from 5-70%, depending on the geographical region (Oksanen et al. 1998; Oivanen et al. 2002), and in Sweden, it is generally very low with 5% prevalence (Pozio et al. 2004). Trichinella species identified in Eurasian lynx are T. pseudospiralis in Sweden (Pozio et al. 2004), T. nativa in Finland (Oivanen et al. 2002) and Estonia (Järvis et al., 2001), and T. britovi in Switzerland (Frey et al. 2008).	Blood tests. An increase in the number of eosinophils or existing antibodies (several weeks after infection) Muscle biopsy to look for trichinella larvae.	Anti-parasitic medication with anthelminthics such as albendazole (Albenza) or mebendazole can be effective in eliminating the intestinal worms and larvae of captive held individuals		X
	Capillaria sp., Uncinaria sp.,	Capillaria sp. are extremely thin, filamentous worms measuring 15-25mm long (males) and 35-80mm long (females). Uncinaria sp. hookworms range in size from 10 to 20 mm by 0.4 to 0.5 mm. Clinical signs of infection include: weight loss, diarrhoea, regurgitation, anaemia and oral necrotic plaques (wikivet.net).	In a study on endoparasite infestation of Eurasian lynx in Finland, only eggs were detected for Capillaria sp. and Uncinaria sp. nematodes, and only adults were detected for Mesocestoides sp. cestodes (Deksne et al. 2012). *Capillaria sp.* was found in the bronchi and trachea of 33% lynx from Latvia and in less than 2% of lynx from Sweden (Bagrade et al., 2003; Ryser-Degiorgis and Robert 2006)	Faecal flotation, to identify the typical barrel-shaped eggs. Eggs laid within the gastrointestinal epithelium are only released into the lumen of the digestive tract when the epithelium sloughs. Severe clinical signs may be associated with negative or low faecal egg counts.	For captive individuals Fenbendazole, Mebendazole, Pyrantel Pamoate and Ivermectin have been used and efficacy of therapy should be checked through repeat faecal flotation tests (wikivet.net).	X	

Phylum	Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Nematodes	***C. feliscati***	Adult female worms are ~ 5 cm long; males are half that size. In cats with a heavy infection, symptoms can include frequent urination, painful urination, bloody urine, straining to urinate. Infected cats are usually over 8 months of age.	C. felis cati were a.o. observed in the urinary bladder of lynx from Estonia (Bagrade et al. 2003) and captive held lynx in Poland (Filip and Demiaszkiewicz 2017).	Feacal flotation - finding eggs in the urine. Adult worms can be seen and removed if the bladder is surgically opened.	No approved treatment is available, an oral dose of 0.1 mg/lb. of Ivermectin has been suggested.	X	X
Flatworms	***Mesocestoides sp.***	Causing mild gastrointestinal symptoms: nausea, diarrhea, abdominal discomfort, vomiting.	Mesocestoides sp. was a.o. observed in free-ranging Eurasian lynx in a study in Finland (Deksne et al. 2013)	Adult mesocestoides intermittently shed proglottids, not eggs. ; M. adult tapeworm infections will not be detected during routine ova and parasite screening procedures such as faecal flotation.	Therapy with mebendazole, after recurrence of the initial episodic clinical signs postoperatively. Daily use of mebendazole for intermittent periods of up to 3 months to reduce gastrointestinal signs in captive held individuals (Barsanti et al. 1979)		X
	Spirometra janickii	Tapeworms in the genus *Spirometra* (*Cestoda: Diphyllobothriidae*) are mainly reside in the small intestines of cats and dogs. Clinical signs vary from unthriftiness, malaise, irritability, capricious appetite, and shaggy coat to colic and mild diarrhea; rarely, intussusception or blockage of the intestine, emaciation, and seizures are seen	Spirometra janickii was identified as the most common parasite in Eurasian lynx in Poland (Szczęsna et al. 2008).	Faecal flotation and identifying proglottid segments in faeces	Can be treated with praziquantel at 7.5 mg/kg, PO, for 2 consecutive days.[10] Spirometra species infections in cats can also be treated with a single dose of praziquantel at 30 mg/kg, SC, IM, or PO. Mebendazole at 11 mg/kg (Peregrine, n.d. Veterinary Manual)		X

Phylum	Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Lungworms	***Lungworms***						
	Aelurostrongylus sp.	A moderately common lungworm in felids. Felids may be subclinically infected and display no clinical signs, but heavy infections cause coughing or increased respiratory rate.	In Bialowieza Forest, Poland *A. abstrusus* was first recorded and subsequently identified in 17% of the investigated samples (Szczęsna et al. 2006). The species was also found in Eurasian lynx in Switzerland and in Iberian Lynx (Schmidt- Posthaus et al. 2002, Rodriguez and Carbonell 1998)	Faecal flotation – to count and see helminthic eggs	1–5 day: Fenbendazole 4.8g (Panacure®PetPaste 187.5mg in 1g) –at a dose of 20mg/kg, p.o. once every 24 hours. On 6th and 20th day: Ivermectin (Kepromec®10mg/ml) at a dose of 0.4mg/kg s.c On the 30th day: Advocate cat spot on, and it is recommended this treatment to be monthly.		X
Tapeworms	***Taenia spp.***	Cestodes are transmitted by inter-mediary or paratenic hosts, are less commonly found in lynx (Ryser-Degiorgis 2009).	Mostly found in Estonia Latvia, where all investigated lynx harboured *T. psifomes* (Bagrade et al. 2003; Valdmann et al. 2004). Found in Poland as well (Kolodziej-Sobocinska et al. 2018).	Faecal flotation – to count and see helminthic eggs	Anthelmintic Therapy: Albendazole or Praziquantel.		X
	Diphyllobothrium sp.	D. species are large (~2m) and can have a mechanical effect on the host, many infections are asymptomatic. Diarrhea, discomfort, fatigue, constipation, pernicious anemia	Found in free-ranging lynx from Estonia and Poland (Valdmann et al 2004; Szczesna et al. 2008; Kołodziej-Sobocińska et al. 2018)	Faecal flotation – to count and see helminthic eggs, respectively identifying proglottid segments in faeces	Anthelmintic Therapy: Albendazole or Praziquantel.		X
Protozoans	***Isospora sp., Cystoisospora sp.***	Protozoans (*Isospora sp., Cystoisospora sp.*), transmitted by intermediary or paratenic hosts are less commonly found in lynx (Ryser-Degiorgis 2009).	Isospora sp. was found in free-ranging Eurasian lynx from Finland (Deksne et al. 2013) and *Cystoisospora sp. in captive individuals in Poland (Filip and* Demiaszkiewicz 2017)	Isosporosis is more often diagnosed by histology than by feacal floatation only.	Sulfadimethoxine given at 50 mg/kg orally once a day for 10to14dayswilleliminateoocyst excretioninmostdogsandcats(104, 191). The combination of ormetoprim (11 mg/kg) andsulfadimethoxine (55 mg/kg) given orally for up to 23 days hasbeen used effectivel		X

Phylum	Name	Characteristics/Signs	Cases	Diagnosis	Treatment	Captivity	Wild
Blood parasites	***Aconoidasida (Cytauxzoon felis)***	Cytauxzoon felis is an apicomplexan protozoal parasite that causes severe, and often fatal disease, in cats. Organisms parasitize erythrocytes and schizonts are found in macrophages in blood and tissue.	Cytauxzoon felis infection has been demonstrated in various non-domestic felids including the Eurasian lynx, with a prevalence of 26% in Switzerland (Meli et al. 2006)	In wild felids, C. felis infection is usually subclinical with a fatal progression of the disease been reported in bobcats (L. rufus) under experimental and natural conditions only (Ryser-Degiorgis 2009).	The organism can be recognized in blood smears as 1-2 um small, ring or safety pin-shaped bodies in red blood cells, but can be readily missed with low levels of parasitemia		X
	Alphaproteobacteria (Anaplasma phagocytophila)	The presence of Anaplasma phagocytophila, which causes tickborne fever in domestic ruminants has been reported in a number of domestic and wildlife species.	Seroprevalences lower than 10% have been demonstrated in Eurasian lynx in absence of clinical signs (Ryser-Degiorgis et al. 2009).	Anaplasmosis is diagnosed by culture, histopathology, PCR, or serology.	An effective treatment for feline anaplasmosis is doxycycline administered orally at a dosage of 5 mg/kg once a day for 14-28 days.		X

<u>Other nematodes and trematodes found in lynx</u>

Other nematodes found in Eurasian lynx include *Diphyllobothrium latum*, *Ancryolstoma tubaeforme*, *Eucoleus aerophilus*, *Metastrongylus sp.*, *Nematodirus sp.* and *Alaria alata* not been reported previously in Eurasian lynx (Szczesna et al. 2008).

Ectoparsites

Name	Characteristics	Cases	Diagnosis / Signs	Treatment	Captivity	Wild
Ear mites (*Otodectes cynotis*)	Otodectes cynotis is a non-burrowing mite commonly causing otitis externa in domestic cats.	Otodectic or ear mange has been reported in free-ranging Eurasian lynx from Sweden (Degiorgis et al., 2001) and Switzerland (Schmidt-Posthaus et al., 2002; Ryser-Degiorgis et al., 2005c). It seems to be very common in lynx from Switzerland (Ryser-Degiorgis 2009).	Ear mites can be seen macroscopically in the external ear (Krelekamp 2004). According to a report on occurring otacariasis in free ranging lynx presented by Degiorgis et al. (2000), histologically, hyperkeratosis and acanthosis was present and the epithelial surface was overlained by hyperkeratotic and parakeratotic crusts of mites, mite detritus and cerumen. In the subcutis was a slight to moderate infiltration of lymphocytes and macrophages found. The ceruminous glands were bypertrophic and hyperplastic and an hyperplasia of the sebaceous glands was visible. The found lesions seemed to correlate with the degree of infestation (Degiorgis et al. 2001).	Affected animals and those in contact with them should be treated regularly with an ear preparation (commonly used is ivermectin and selamectin as drop preparations) to kill the mites (Mellen and Wildt 2003). Furthermore, the ears of a captive held individual can be regularly checked and cleaned, if necessary, but this requires anaesthesia.	X	X
Fleas and Louse Flies	Fleas are wingless insects, 1.5 to 3.3 mm) long, that are agile, with a proboscis, or stylet, adapted to feeding by piercing the skin and sucking their host's blood through their epipharynx; winged louse flies, dark brown in colour, flat shaped, leathery in appearance.	Louse flies and fleas occasionnally found on free-ranging Eurasian lynx (Ryser-Degiorgis 2009).	Fleas can be found in the hair coat over the entire body (Miller and Fowler 2015). Infestation is difficult to detect unless there are obvious clinical signs such as excessive scratching, loss of hair or poor coat condition. Heavy flea infestations may cause anaemia in young lynx (Blomqvist et al. 1999).	Flea shampoos (e.g. pyrethrins) can be used as treatment for captive individiduals but must not be employed on individuals about to be reintroduced in the wild (Miller & Fowler 2015). Flea control is a matter of prevention, with a wide array of products existing - commonly used are products that contain Etofenprox or Pyriproxyfen (Rust 2011).	X	X
Ticks	-	-	Ixodid ticks are regularly found on free-ranging Eurasian lynx (Ryser-Degiorgis 2009).	Removal of tick, eventually application of antibiotic cream		X

Name	Characteristics	Cases	Diagnosis / Signs	Treatment	Captivity	Wild
Mange	Mange is a skin disease caused by mites that are highly contagious (Muller et al. 1989).	Sarcoptic and Notoedric mange mites occasionally affect Eurasian lynx (Mellen & Wildt 2003; Ryser- Degiorgis et al. 2002).	Infestation is difficult to detect unless there are obvious clinical signs such as excessive scratching, loss of hair or poor coat condition (Blomqvist et al. 1999). Diagnosis is attempted with skin scrapings from multiple areas, which are then examined for mites and mite eggs microscopically. Additionally, if available, a serologic test may be useful in diagnosis. Lesions consist of an extensive encrusting dermatitis that cover the entire body, but usually more prominent on the head, ears, feet and tail. Typical macroscopical changes are thick crusts with deep fissures. Lymph nodes are generally enlarged. Towards the end stage of the disease, individuals are cachectic and often harbour a large amount of Ascarids in the intestine (Ryser-Degiorgis 2009).	With Simparica® 5 mg ad us. vet. tabs containing the active agent Sarolaner. Sarolaner is an acaricide and insecticide from the isoxazoline family. Sarolaner blocks GABA- and glutamate- controlled chloride channels in the central nervous system of insects and mites and kills them. Fleas, mites and ticks must attach to the host and start feeding to be exposed to the drug (www.vetpharm.uzh.ch).		X
Sarcoptic Mange	Sarcoptic Mange is caused by *Sarcoptes scabiei.* Sarcoptic mange is the most frequent infectious disease in Eurasian lynx, reaching up to 22% of non-hunted dead lynx in Sweden (Ryser- Degiorgis et al. 2005).	In Eurasian lynx, sarcoptic mange has been reported in captivity in China (Jeu and Xiang 1982), as well as in the wild in Norway and Sweden associated with an outbreak of sarcoptic mange in red fox (Holt and Berg 1990; Mörner 1992).	See Diagnosis/Signs – Mange (above)	Simparica® can also be used for treating Sarcoptic mange (see above – treatment mange)	X	X

Name	Characteristics	Cases	Diagnosis / Signs	Treatment	Captivity	Wild
Notoedric Mange	Notoedric Mange is caused by *Notoedres cati*. Known to be a sporadic disease in domestic cats and presumed to reflect contact of Eurasian lynx with domestic cats; also a mixed infection with *N. cati* and *S. scabiei* has been documented.	Very occasionally observed among captive lynx in zoos, but has been rarely reported in free-ranging lynx (Dobias 1981). In 1999, in Switzerland, there were two lynx found dead infested with N. cati. Other cases to be known of occurred in Norway, Sweden and Germany, in association with outbreaks of sarcoptic mange in red foxes, which are considered as the main source of infection for lynx (Ryser-Degiorgis et al. 2002).	See Diagnosis/Signs – Mange (above)	Treatments with Avermectins (Ivermectin, Selamectin (e.g. Revolution®) or Moxidectin (Advantage Multi®) and/or acaricidial shampoos for local treatment (e.g. Amitraz®) and lime-sulphur baths for captive held individuals are usually effective, and in- contact animals should also be treated to prevent further spread. This treatment is not allowed for individuals about to be reintroduced in the wild (Mellen & Wildt 2003).	X	X

Protozoal diseases

Name	Epizootiology	Cases	Signs	Diagnosis	Treatment	Captivity	Wild
Toxoplasmosis (*Toxoplasma gondii*)	Toxoplasma gondii is a coccidian parasite primarily affecting felids, in which infection usually does not lead to disease symptoms. The causative agent is the protozoan parasite *Toxoplasma gondii*, for which cats are the main host.	In Fennoscandia, seroprevalence in lynx reaches 70-75% and is significantly higher in subadult and adult lynx than in juveniles. Prevalence of infection appears to be highest in southern regions of Sweden, which are more densely populated by humans, possibly due to the presence of domestic cats shedding oocysts to the environment, to climatic differences (i.e. to survival of oocysts) and/or to variations in prey availability, since prevalence of infection greatly vary between different prey species. Information on toxomplasmosis in Eurasian lynx is still being collected, and so far only the Karelian lynx population in Finland has been confirmed to host T. gondii commonly. There has been no evidence of contribution to an environmental oocyst burden or any of the investigated individuals dying from the infection (Jokelainen et al. 2013. Seropositivity has also been reported in captive lynx (Sedlák and Bártová 2006).	Rarely the disease does cause clinical signs of diarrhoea in cats. Only during the initial infection do cats excrete large numbers of eggs (oocysts) of the pathogen. Most cats then develop a lifelong immunity. No clinical disease has been reported in Eurasian lynx so far, but sporadic cases have been reported in young bobcats (*Lynx rufus*).	Serum samples have to be tested for T. gondii–specific antibodies by direct agglutination test.	Clindamycin or Tetraseptin (Active antiobiotic agent: tetracylin) <u>Clindamycin:</u> Dosage: 10 - 12 mg / kg depending on the clinic p.o. or parenterally twice a day - duration of treatment: 4 weeks <u>Tetraseptin:</u> Dosage: 4 drops of forte (20 mg) / kg body weight, mixed directly with the feed 3 times a day or with liquid (tea, water). The best absorption of Tetraseptin is achieved when administered 1 hour before feeding. The usual duration of use is about 3-10 days. It should be continued for 1-3 days after the symptoms have resolved. Tetraseptin acts against both extracellular and intracellular bacteria by inhibiting the protein synthesis of the bacteria on the ribosomes (www.vetpharm.uzh.ch).	X	X

Non-infectious diseases

Other non-infectious diseases include the development of congenital heart diseases and pelvic malfunctions as well as changes in variation in teeth number, teeth and skull disorders, this anomalies and malformations are believed to be caused by genetic bottlenecks and inbreeding scenarios prevalent in the Swiss-Alpine population as well as the Dinaric population with other populations showing similar cases possible with low prevalent heterozygosity (Morend et al. 2019, Mihaylov et al. 2018, Gomercic et al. 2008).