

3.7. Lynx clinical health examination protocol

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3.7.1. Introduction

Clinical examination protocol was designed for assessment of the overall health in lynx. By facilitating specific disease detection, valuable data can be provided on the prevalence and distribution of diseases within lynx populations. This might further prevent the introduction or spread of diseases in both *in situ* as *ex situ* lynx populations safeguarding the conservation efforts aimed at preserving these species, as lynx populations can be particularly vulnerable to introduction of genetic or infectious disorders due to their low population density. A checklist as a guide of the medical checks and treatments necessary to prepare a captive bred lynx for release can be found in Appendix XIII.

3.7.2. Signalment and history

A basic signalment, specifically pertaining to the lynx's age and sex, serves as the keystone for directing the subsequent clinical evaluation and determining the focal points for diagnostic interventions. In the wild, the Eurasian lynx typically has a lifespan ranging from 10 to 12 years, occasionally extending to 18 years. Under human care, lynxes can live even longer, up to 24 years. Lynxes can be categorised as juveniles (first year of life), subadults (females in their second and males in their second and third year of life) or adults (≥ 2 years for females, ≥ 3 years for males). Old individuals might be further classified as seniors (14-18 years), spanning the period beyond the usual lifespan in the wild up to the maximal reproductive phase; and geriatric (>18 years), extending beyond the reproductive phase up to the maximum lifespan under human care. The age of free-ranging lynxes can be estimated based on tooth eruption (Table 3.7.1) and tooth wear (Table 3.7.2) (Marti and Ryser-Degiorgis, 2018). The provided estimated age classes serve as a useful framework for clinicians to tailor their diagnostic approach when addressing conditions that tend to be more prevalent within distinct age groups.

Table 3.7.1. Aging scheme for juvenile Eurasian lynx based on tooth eruption, distinguishing eight different age classes.

Age (months)	Deciduous teeth			Permanent teeth			
	Incisors	Canines	Premolars	Incisors	Canines	Premolars	Molars
1	Erupted	Erupted	Erupting (p3 & p4 - P3 & P4)	-	-	-	-
2-3	Erupted	Erupted	Erupted	-	-	-	-
4	Displaced	Erupted	Erupted	Erupting	-	-	-
5	-	Still in place (double dentition)	Erupted	Erupted	Erupting	-	Erupting
6	-	Being displaced	Erupted	Erupted	Erupting	-	Erupting
7-8	-	-	Displaced	Erupted	Erupting	Erupting (P4 - P3 & p4 - p3)	Erupted
9	-	-	-	Erupted	Erupting	p3 still erupting	Erupted

10-11 - - - Erupted Erupted Erupted Erupted

Table 3.7.2. Ageing scheme for Eurasian lynx based on tooth wear, distinguishing six different age classes.

Age (years)	Colour	Calculus	Buccal ridge	Distal ridge	Canine tips	Premolar tips	Molar shape	Incisors	Open pulp cavity	Enamel flaking
< 1	White	None	Present	Intact	Sharp	Sharp	V-shape 89%	11-12	10%	13%
1-2	Beige	None	Present	Wear present	Sharp	Sharp	V-shape 65%	9-12	14%	45%
3-6	Slight brown-yellow	Slight	Present	Wear present	Sharp	Sharp-extended wear	U-shape 60%	3-12	40%	50%
7-9	Slight brown-yellow	Moderate	Absent (+/- traces of grooves)	Worn down	Rounded	Extended wear	U-shape 100%	2-10	70%	75%
10-13	Distinct brown-yellow	Moderate-severe	Absent (+/- traces of grooves)	Worn down	Rounded	Extended wear	U-shape 100%	0-6	100%	100%
≥14	Distinct brown-yellow	Moderate-severe	Absent (+/- traces of grooves)	Worn down	Premolar length	Extended wear	U-shape 100%	0-4	100%	100%

Moreover, it is of great relevance to delve into the comprehensive medical history of the individual animal and, if applicable, the entire lynx group as this information serves as a basis for the further clinical examination, helping to identify any pre-existing conditions or recurring issues. By examining the medical history or evaluating observed symptoms, specific diagnostic procedures can be conducted that are most relevant and necessary for the lynx's current health state. This ensures a more targeted and effective approach to the examination and subsequent care.

3.7.2.1. Vaccination review

In ex-situ situations the animal should be up to date on all recommended vaccinations, as outlined in Table 3.7.3. Free ranging lynxes considered for translocation need to be vaccinated against rabies. In rabies-free countries a single rabies vaccination (at capture) and post-vaccination testing of rabies antibody titer is often accepted by veterinary authorities. This allows for a significantly shorter quarantine period. For animals in human care recommended vaccinations should encompass feline leukaemia virus (FeLV), feline panleukopenia virus (FPV), feline herpesvirus (FHV) and feline calicivirus (FCV) (vaccines containing inactivated virus are preferred). It is useful to conduct a thorough review of all (including other) previously administered vaccinations. Furthermore, a comprehensive risk analysis, considering the facility's and country's specific circumstances, should be undertaken to determine whether additional vaccinations are warranted during the procedure.

Table 3.7.3. Vaccination scheme for ex-situ lynxes and animals crossing national borders

Target population	Vaccinations	Timepoint
Kitten in human care	FeLV, FPV, FHV, FCV	8 weeks
Kitten in human care	FeLV, FPV, FHV, FCV	12 weeks
Adult in human care	FHV, FCV	Once a year
	FeLV, FPV	Every 3 years
Breeding pair in human care	FeLV, FPV, FHV, FCV	Once year
Or animals at risk		

3.7.2.2. Feline Immunodeficiency Virus (FIV) and Feline Leukaemia Virus (FeLV)

Lynxes active in the breeding programme and animals in contact with a breeding pair have to be tested for FIV and FeLV. Approved methods are western blot (FIV), Ag-ELISA (FeLV) and provirus PCR (FeLV). Only animals negative for FIV and FeLV are accepted into the breeding programme. The testing is repeated in lynxes after contact with any felid of unknown disease status or upon development of unspecific symptoms. All lynxes are tested before translocations (e.g., transfer of juveniles to coordination enclosures). In inconspicuous cases (absence of clinical signs, confirmed negative status of parents, no positive cases at the institution) this might be done via SNAP FIV/FeLV Combo test.

3.7.2.3. Parasite control

Living in near-natural enclosures and feeding on wildlife carcasses, most lynxes under human care will experience parasitic infections. Numerous endo- and ectoparasites have been documented to affect lynxes (Appendix X). It is essential to conduct routine faecal examinations (see further) and take appropriate actions based on the results, whether they indicate the presence or absence of parasites. Be aware that a negative result does not always guarantee the absence of parasites (as latency periods, low sensitive tests, and intermittent shedding can be underlying factors).

For a breeding pair testing and if necessary, treatment twice a year is advisable. Suitable timepoints are April (before the kittens are born) and autumn. Animals under human care that are translocated (e.g., transfer of juveniles to coordination enclosures) should be tested approximately two weeks before the planned transport. This allows time for adequate treatments and a follow-up examination to ensure treatment success.

In general, treatment should only be administered when a positive result confirms the presence of endo- or ectoparasites, with the aim of preventing the development of resistance. In situations where the enclosure or environment (fleas, nematodes, giardia spp., ...) is heavily contaminated, posing a high risk of reinfection, a strategic approach may involve periodic prophylactic treatment, even in the absence of positive test results.

3.7.3. Clinical Examination**3.7.3.1. Inspection**

Thorough clinical examination starts with inspection of the animal in a stress-free situation. Visual inspection provides a general impression of the animal's overall health and well-being and can also provide insights into any specific symptoms that may be present. Note that lynxes may be capable to hide mild to moderate clinical signs. The animal should show natural behaviour and normal awareness of its surroundings, as any change in behaviour may indicate underlying general illness or pain. Furthermore, the posture and the gait of the animal should be assessed to gather insights into any potential discomfort or specific musculoskeletal pain. Also breathing pattern and frequency can best be evaluated before proceeding to general anaesthesia. The respiratory rate should approximate 10-30 breaths per minute in a stress-free situation.

3.7.3.2. Anaesthesia

Details about anaesthesia (including recommended drugs and doses) are described in *3.6 Anaesthesia*.



Fig. 3.7.1. Lynx under general anaesthesia (In-Situ). Oxygen is supplemented via intranasal tube, while the oxygen saturation is monitored with a portable pulse oximeter clipped to the tongue ©Jonas Steiner, FIWI Bern.

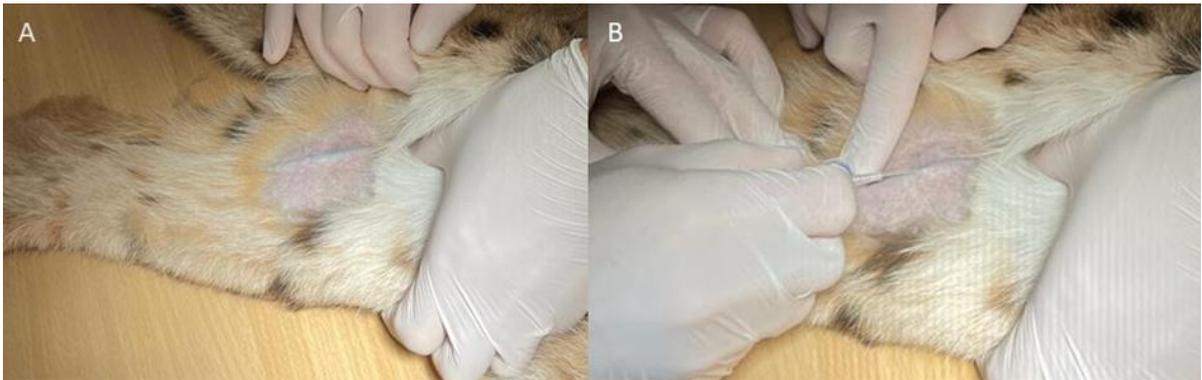


Fig. 3.7.2. A) Visualisation of the medial saphenous vein. B) Intravenous catheter (22-gauge) placement in the medial saphenous vein, ©Laurens Van Mulders.

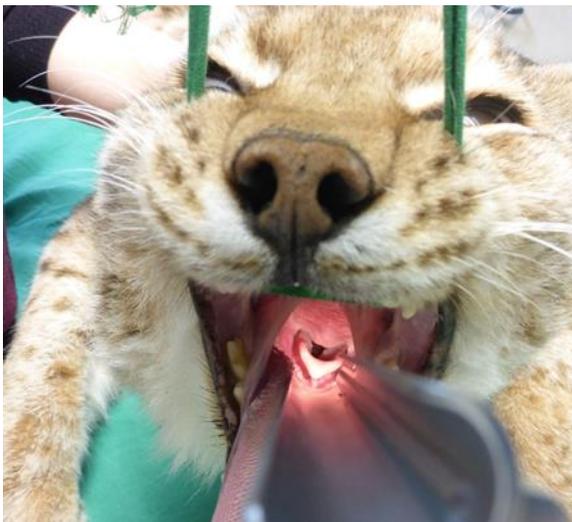


Fig. 3.7.3. Visualisation of the larynx before endotracheal intubation ©Benoit Quintard, @Zoo Mulhouse.



Figure 3.7.4. Lynx under general anaesthesia (Ex-Situ). The animal is intubated and maintained with isoflurane anaesthesia. An intravenous catheter is in place providing the necessary fluids. Vital signs (heart rate, respiratory rate, SpO₂, etCO₂, ECG, temperature and blood pressure) are monitored continuously ©Laurens Van Mulders, @Thoiry ZooSafari.

Following anaesthetic induction, it is recommended to insert an intravenous catheter (Figure 3.7.2) and administer approximately 10 ml/kg of Hartmann (Ringer's lactate) solution over a period of 30 to 60 minutes. This is done to mitigate the risk of hypoperfusion in specific organs, such as the kidneys, especially in older individuals with potentially underlying renal disease. Furthermore, oxygen should best be supplemented intranasally (Figure 3.7.1). For longer procedures it is advisable to intubate the animal and maintain the anaesthesia with isoflurane (or sevoflurane) (Figure 3.7.3).

Monitoring of vital signs (heart rate, respiratory rate, SpO₂, end tidal CO₂, ECG, temperature and assessment of the mean arterial blood pressure) may aid in the prevention of peri-aesthetic complications (Figure 3.7.4).

3.7.3.3. Physical Examination

A comprehensive physical examination should consist of:

Evaluation of the coat and skin

The animal's coat should exhibit an appropriate seasonal pattern and be maintained in good grooming condition. A poorly cared for coat, characterized by grease, plucked areas, or matting hair, may signal various underlying issues. These issues can span from physical challenges in grooming of the coat, such as musculoskeletal pain, to discomfort originating from oral problems, obesity, or a general sense of illness, irrespective of the specific underlying cause.

The skin should be evaluated thoroughly for wounds (post-fighting), dermatitis and/or alopecia related to parasitic (*Sarcoptes spp.*, *Notoedres spp.*), fungal (*Trichophyton spp.*, *Microsporum spp.*) and secondary bacterial agents (Figure 3.7.5). Moreover, the clinician must be aware of the potential occurrence of neoplastic lesions such as squamous cell carcinomas or other skin tumours, especially in

senior or geriatric animals. Female lynxes typically have bite wounds on the neck if examined during or shortly after the mating period. In older females the skin in the neck often shows hyperpigmentation and thickening of the epidermis, possibly resulting from recurring bite lesions in this area (Figure 3.7.6).



Figure 3.7.5. Lynx with severe dermatitis associated with *Sarcoptes* spp. infection ©FIWI Bern.



Figure 3.7.6. Female lynx with a subacute bite wound on the neck, ©FIWI Bern.

Palpation for body and muscle condition scoring

Examine the vertebrae, shoulder, ribs, hip and thigh through visual inspection or palpation to assess the body condition based on the provided chart. Typically, a healthy body condition (3/3) should be observed. However, if you observe a combination of underweight and a lower muscle condition score, it could indicate a wide array of underlying issues, spanning from insufficient nutrition to intestinal parasites or various chronic systemic diseases. In contrast, overweight is predominantly associated with an excessive intake of dietary energy coupled with insufficient physical activity. Free-ranging adult males typically lose weight during the mating period (February-March) and females during lactation. Those animals may therefore have a body condition score of 2/3.

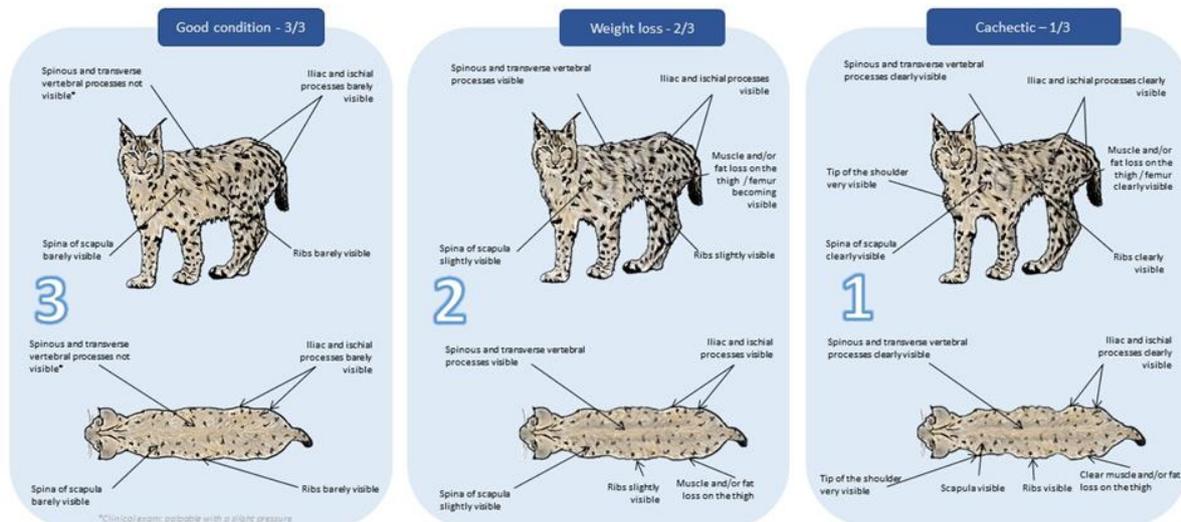


Figure 3.7.7. Body condition scoring chart, ©Julie Merlin, Ghislaine Letourneur.

Utilize palpation to assess the muscles thickness around the temporal region, scapula, thoracic vertebrae, and hind leg and assign a muscle condition score (Figure 3.7.8 and 3.7.9). In (sub)adult animals, good (3/3) muscle condition score is expected. However, for senior and geriatric animals, mild muscle loss alongside a normal body condition may be attributed to the natural aging process. Conversely, the loss of muscle condition combined with a reduced body condition could signal a range of issues as discussed earlier. Furthermore, a decline in muscle condition while maintaining a normal body condition may indicate reduced muscle use due to orthopaedic or other conditions or muscle breakdown resulting from specific systemic diseases, such as chronic kidney disease or neoplasia.

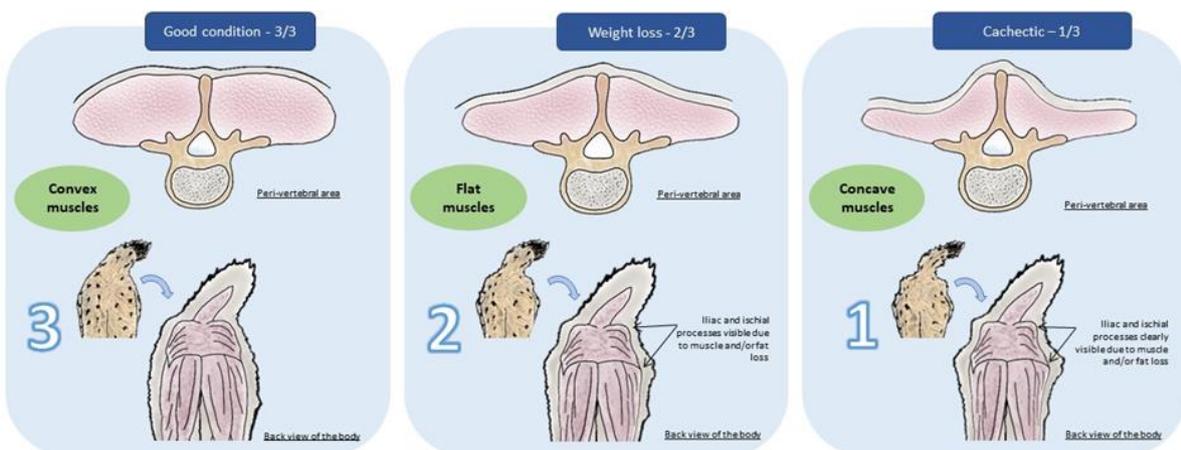


Figure 3.7.8. Muscle condition scoring chart, ©Julie Merlin, Ghislaine Letourneur.



Figure 3.7.9. Palpation of the muscles around the thoracic vertebrae at several locations provides a valuable means to assess the lynx's general muscle condition score, ©Laurens Van Mulders.

Palpation of the lymph nodes

Peripheral lymph nodes can be assessed by palpating for their size, shape, and texture. Any abnormality in lymph nodes could be indicative of various underlying issues, including inflammation (reactive), infections (lymphadenitis), or even neoplastic processes in the corresponding draining area of the lymph node. For instance, swollen mandibular lymph nodes might accompany severe gingivitis, periodontitis, or stomatitis. Axillary and popliteal lymph nodes can also become reactive as a secondary response to inflammation or infection in the front and back paws, respectively. (A general increase in lymph node size may raise concerns about systemic conditions like chronic infections, autoimmune disorders, or multicentric neoplastic processes, although such cases are rare.)

- Mandibular lymph nodes
- Retropharyngeal lymph nodes
- Prescapular lymph nodes
- Axillary lymph nodes
- Inguinal lymph nodes
- Popliteal lymph nodes

Inspection of the nails and foot pads

The length and shape of the nails should be assessed and trimmed if necessary (Figure 3.7.10). The nails and footpads should be examined for any signs of wounds, swelling, or warmth.

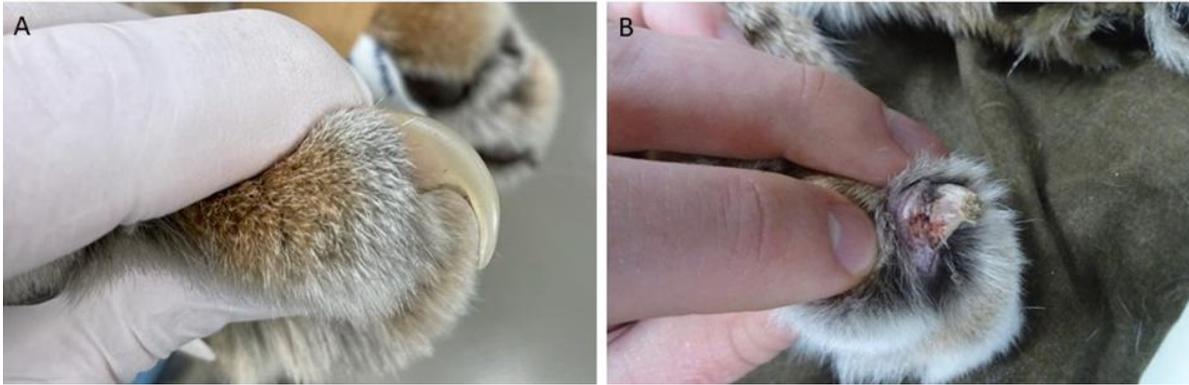


Figure 3.7.10. A) Normal aspect and length of claws in lynxes. B) Splintered claw in a free-ranging lynx after housing in a quarantine enclosure, ©Laurens Van Mulders, FIWI Bern.

Palpation of the thyroid glands

Although hyperthyroidism seem rare in lynxes in comparison to other Felid species, thyroid palpation can be executed by gently stroking both fingers along the trachea, starting from the larynx and moving towards the thoracic inlet. Normally, the thyroid glands should not be palpable. However, if you detect any symmetrical or asymmetrical enlargement or nodule, it should raise concerns about potential underlying thyroid disease.

Inspection of the ears

The ears should be inspected externally for signs of scratching (redness, crusts) or extensive amounts of cerumen. Otosopic examination can be of additional value to assess the external ear canal for signs of inflammation as this may indicate external otitis, which may have different causes including parasitic (*Otodectes spp.*), bacterial and yeast infections.

Inspection of the eyes and conjunctiva

In healthy lynxes, the conjunctiva of the eyelids is not readily visible and has a pale pink colour. The conjunctival membranes become red and swollen in cases of conjunctivitis potentially in combination with ocular discharge and may warrant further testing (FHV, FCV, Chlamydia, mycoplasma, see below) (Figure 3.7.11).



Figure 3.7.11. Lynx with severe conjunctivitis and mucopurulent ocular discharge associated with a Chlamydia Felis infection ©Journal of Wildlife Diseases.

Inspection of the nose

The nasal plane should have a slightly moist texture. There should be no nasal discharge present, and there should be no signs of chronic nasal discharge, such as reddening and hair loss under the nostrils. When nasal discharge is observed, the type (serous, mucous, blood, ...) must be described, as this may warn for additional sampling (FHV, FCV, Chlamydia, mycoplasma, ... see below).

Examination of the oral cavity, teeth, and gums

Dental issues are commonly observed in the Felidae family. Therefore, it is essential to conduct a comprehensive examination of the teeth, gingiva, and oral cavity to identify any abnormalities. Lynxes under human care often exhibit dental plaque and tartar, making it useful to include routine tooth cleaning as part of their regular health assessments (Figure 3.7.12). Additionally, special attention should be given to the identification and management of canine fractures or dental wear. In instances where the dental pulp is exposed, prompt and appropriate treatment measures should be implemented, given that this is a painful condition and to prevent the development of dental root abscesses (consult protocol for dental fracture repair). In cases of severe dental tartar and gingivitis, a thorough review of the diet may be necessary to address the underlying causes. Furthermore, in instances of significant gingivostomatitis, additional screening for Feline Immunodeficiency Virus (FIV) may be warranted.



Figure 3.7.12. Aspect of the teeth in different lynxes. A) Mild gingivitis around the region of the upper canine B) Normal dental wear of the lower canine without exposure of the dental pulp C) Severe dental tartar around the upper premolars in combination with periodontitis, dental wear of both canines without exposure of the dental pulp, ©Benoit Quintard and Laurens Van Mulders.

Cardiac auscultation

During cardiac auscultation, it is relevant to evaluate both the heart rate and rhythm. Any irregularities in the heart rhythm should be carefully noted and documented. Additionally, any abnormal heart sounds (murmurs), should be described in terms of their intensity on a scale ranging from 1 to 6 (as described further), the timing of occurrence (systolic, diastolic, or continuous), and their location (left or right side, heart apex, or base). Any abnormal rhythm (including brady/tachycardia) or auscultated murmur (> 2/6) may indicate the use of further electrocardiographic and/ or echocardiographic examination. For further details see the protocol on cardiac screening. It's important to keep in mind that certain irregular rhythms (such as 2nd degree AV-blocks), bradycardia, and minor valvular murmurs might be induced or exacerbated by the use of anaesthetics, particularly alpha-2-agonists.



Figure 3.7.13. Heart auscultation with an electronic stethoscope, ©Jonas Steiner, FIWI Bern.

<u>Grade 1</u>	Low-intensity murmur that can only be heard after a few seconds of attentive auscultation, in a quiet environment
<u>Grade 2</u>	Soft murmur, which is heard immediately at the beginning of auscultation of a specific area
<u>Grade 3</u>	Moderately loud murmur, also heard further away from the punctum maximum
<u>Grade 4</u>	Loud murmur without fremitus, heard over several to all areas
<u>Grade 5</u>	Loud murmur with fremitus, no longer audible when stethoscope comes off thorax
<u>Grade 6</u>	Very loud murmur with fremitus, which can even be heard as stethoscope is held loose from thorax

Temperature

Reference values for temperature in lynxes are not well-established. Therefore, it may be appropriate to adapt normal rectal temperature ranges from those observed in domestic cats, typically ranging from 37.5-39°C. However, note that the upper limit for lynxes may not be as high. It is important to consider factors such as pre-anaesthetic excitement and stress, as they can potentially induce hyperthermia. Additionally, in healthy animals, it's common for body temperatures to slightly decrease during the course of anaesthesia.

Blood pressure

Indirect systolic blood pressure in lynxes can be assessed using Doppler or oscillometric techniques, which can be applied to the front limb, back limb, or tail. The selection of cuff size should align with the circumference of the chosen limb for accurate measurements (usually size 8/9). An upper reference limit of 160 mmHg can prudently be adapted from the domestic cat.



Figure 3.7.14. Blood pressure measurement in lynxes. A) Oscillometric blood pressure measurement on the hind limb. B) Oscillometric readings provide systolic/diastolic and mean arterial pressure C) Doppler blood pressure measurement, in this case on the front limb, only provides the systolic blood pressure, ©Laurens Van Mulders.

It's important to recognize that anaesthetic drugs can significantly affect blood pressure, making it almost impossible to definitively classify an animal as hypertensive based solely on blood pressure measurements. Particularly, under alpha-2-agonist and ketamine anaesthesia, blood pressure levels can often surpass 160 mmHg, occasionally even reaching values as high as 200 mmHg. As a result, indirect indications of chronic systemic hypertension, such as echocardiographic assessments for hypertensive cardiomyopathy or fundoscopic evaluation for hypertensive retinopathy, form alternatives for diagnosing this condition in animals under anaesthesia.

3.7.3.4. Diagnostic Testing

Blood collection and examination

Blood samples in lynxes can be collected from several veins, including the jugular, cephalic, medial saphenous, or femoral veins as shown in the Figure 3.7.15. The choice of location for blood draw and intravenous catheter placement can vary depending on the situation and the preferences of the clinician. In the authors' case, the preferred location for catheter placement is the medial saphenous vein and the jugular vein for blood draw.

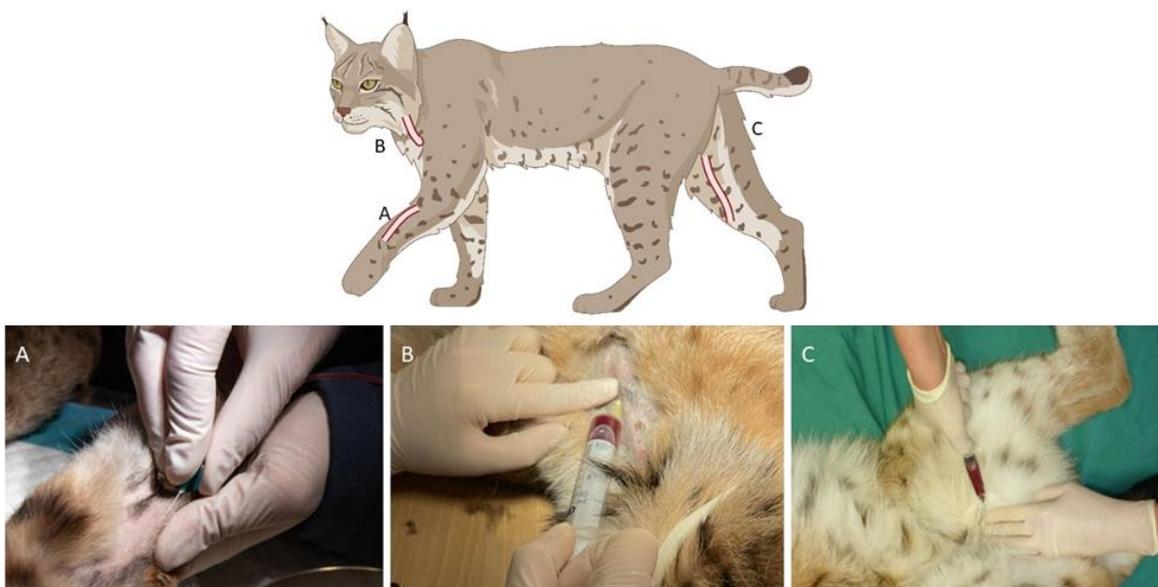


Figure 3.7.15. Locations for blood collection in lynxes. A) The cephalic vein, is often utilized for venipuncture.

In such cases, a butterfly catheter is considered the optimal choice. B) The jugular vein facilitates the collection of larger quantities of blood. C) The femoral vein forms an alternative blood collection site, note that the saphenous veins are best withheld for intravenous catheter placement, ©FIWI Bern, Benoit Quintard, Laurens Van Mulders.

A standard blood profile for routine screening should include the following parameters:

1. Complete Blood Count (CBC):
 - Hemoglobin (Hb)
 - Hematocrit (Hct)
 - Red Blood Cell Count (RBC)
 - White Blood Cell Count (WBC)
 - Platelet Count
 - Mean Corpuscular Volume (MCV)
 - Mean Corpuscular Hemoglobin (MCH)
 - Mean Corpuscular Hemoglobin Concentration (MCHC)
 - Differential White Blood Cell Count (Neutrophils, Lymphocytes, Monocytes, Eosinophils, Basophils)
2. Blood Chemistry Panel:
 - Blood Glucose
 - Blood Urea Nitrogen (BUN)
 - Creatinine
 - Total Protein
 - Albumin
 - Globulin
 - Alanine Aminotransferase (ALT)
 - Aspartate Aminotransferase (AST)
 - Alkaline Phosphatase (ALP)
 - Creatine Kinase (CK)
 - Total Bilirubin
 - Thyroid Function Test (tT4) in senior and geriatric animals
3. Elektrolytes and others:
 - Calcium (total)
 - Phosphorus
 - Sodium
 - Potassium
 - Chloride

Specific or additional selection of parameters in the blood profile should be tailored to the animal's medical history, clinical symptoms, and the intended purpose of the assessment. In some cases, it may be necessary to seek guidance from a specialist to ensure the selection of the appropriate panel and to accurately interpret the results. Note that clearly established species-specific reference values may be missing for some parameters.

Urine collection and examination

Various methods are available for collecting lynx urine samples, such as manual bladder expression, catheterization, blind cystocentesis, and ultrasound-guided cystocentesis. The author recommends

the use of ultrasound-guided cystocentesis (e.g., 40 mm, 22-gauge needle) as it is the safest and typically the most effective approach for urine collection (Figure 3.7.16). Importantly, it is the only method that effectively prevents contamination of the urine and facilitates reliable urinary bacterial culture.



Figure 3.7.16. Ultrasound guided cystocentesis, ©Laurens Van Mulders.

A standard urinalysis for routine screening may include the following parameters:

- Urinary specific gravity (refractometry)
- Urinary-protein-creatinine ratio (UPC) (especially in senior and geriatric animals)
- Dipstick assessment of urinary glucose, protein, RBC's, pH, ketones and bilirubin*
- Sediment examination*
(Always when UPC is assessed to differentiate from post-renal proteinuria)
- Bacterial culture*

*If indicated

Specific or additional selection of parameters for urinalysis should be tailored to the animal's medical history, clinical symptoms, and the intended purpose of the assessment.

Faecal examination

A standard faecal examination for routine screening should include the following tests:

A. Parasitology:

- Sedimentation/floatation for *Toxocara spp.*, *Toxascaris spp.*, cestodes, *Cystoisospora spp.*, *Eucoleus spp.*, ...
- Specific Ag testing for *Giardia spp.*
- Baermann's funnel technique for *Aelurostrongylus spp.* and other lungworms in endemic areas.

B. Bacteriology:

Note that felids in human care frequently shed *Salmonella spp.*, seldom linked to the development of diarrhoea.

3.7.3.5. Specific pathogen screening

Eurasian lynx can potentially carry various feline pathogens (see Appendix X – lynx pathogens and diseases). Overall, the pathogenicity of these infectious agents remains a subject of uncertainty within the scientific community. In the context of free-roaming lynx populations, the impact of these infections may in most occasions be limited due to the typically low level of social interaction among individuals. Consequently, disease prevalence is anticipated to be low, exerting minimal influence on population dynamics. However, challenges can arise when:

- 1) Infections occur in small and fragmented wild lynx populations, where disease transmission can have a more significant impact, for instance, due to a limited gene pool.
- 2) Lynxes are housed close together in zoological settings as this can enhance the transmission of pathogens. Additionally, the simultaneous presence of multiple infections may lead to synergistic interactions, further compounded by stress factors that can promote the manifestation of clinical symptoms.

Considering these factors, it is of great importance to engage in systematic surveillance of vulnerable wild lynx populations to detect and manage various infectious agents. Such measures are critical for mitigating the spread of potentially detrimental pathogens and, consequently, safeguarding the conservation efforts aimed at preserving these species.

Moreover, in zoological institutions, preventative measures, such as minimizing contact between lynxes and domestic cats, import requirements, quarantine and vaccination strategies, etc., should be contemplated to mitigate the potential risks associated with these pathogens.

3.7.3.6. Pathogens requiring surveillance

High priority:

Feline Immunodeficiency virus (FIV) and Feline Leukaemia virus (FeLV) testing is mandatory in free-ranging and ex-situ lynxes. Positive animals are excluded from any translocations/the breeding program. Euthanasia followed by post-mortem examinations is recommended.

Feline Immunodeficiency virus (FIV) test: blood; Ab presence or Provirus PCR

Feline Leukaemia virus (FeLV) test: blood; Ag or Provirus PCR

FIV and FeLV snap test can be done in field conditions.

FeLV is a retrovirus that primarily affects domestic cats, but its impact on wild felids, such as lynxes, can be significant, especially in scattered populations. Animals get primarily infected through direct contact with FeLV-positive animals. FeLV infection in lynxes can lead to a range of health issues, similar to those seen in domestic cats, including secondary infections, anaemia, (may lead to other diseases such as lymphoma) and death, as shown by outbreaks in lynxes in the past. Prevention exists of import testing and separation of infected animals; vaccination regimes are currently not performed.

Intermediate priority:

Testing of pathogens classified as “intermediate priority” is mandatory in ex-situ and free-ranging lynxes before translocations. Positive animals are not automatically excluded from translocations/the breeding program. Their test result needs to be evaluated together with the clinical status and the

epidemiological situation. Depending on the detected pathogen, adequate measures might include treatment, vaccination, further laboratory analyses and a temporary or partial stop in lynx transports (e.g., no exchange with negative institutions).

Feline calicivirus (FCV) test: combined conjunctival, nasal and oropharyngeal swab; PCR

Feline Herpes virus (FHV) test: combined conjunctival, nasal and oropharyngeal swab; PCR

FHV infections exhibit a wide range of outcomes, from asymptomatic carriers to severe upper respiratory tract disease. The interpretation of diagnostic tests, especially PCR assays, is complex, as carriers will not always test positive. FHV prevalence in lynxes is uncertain but clinical disease is considered relatively uncommon. Predicting the risk of clinical FHV in lynx populations involves considering factors like shedding probability (number of carriers, contacts, stress, ...) and susceptibility of individuals. Vaccine use in lynxes under human care can be assumed as effective to reduce clinical disease and limit the spread in a population.

Chlamydia Felis test: combined conjunctival, nasal and oropharyngeal swab; PCR

Ocular *Chlamydia felis* infections can cause severe conjunctivitis, chemosis and ocular discharge in lynxes. Symptomatic animals should be treated and retested before release. The prevalence of asymptomatic carriers is unknown at present.

Feline Panleukopenia virus (FPV) test: faeces; Ag or PCR

Canine Distemper virus (CDV): test: blood; Ab presence, if not vaccinated (cross-reaction)

CDV seroprevalence monitoring in wild lynx populations showed that positive titres can occur in absence of clinical signs. Certain populations exhibited significantly higher exposure levels, with seroprevalence rates reaching up to 25%, in stark contrast to other populations that had minimal contact with the pathogen. CDV infection has the potential to induce severe symptoms, encompassing respiratory, gastrointestinal, and neurological disorders. Although current reports of diseased lynxes mentioned only central nervous symptoms linked to chronic meningoencephalitis. The development of such diseases is typically influenced by the virulence of the circulating virus strains, the level of immunity in the population and the immune competence of the individual. General impact of CDV on wild lynx populations remains unexplained but given the high seroprevalence in some areas the overall impact might be limited in genetically healthy populations.

Low priority:

Testing for pathogens classified as “low priority” is not mandatory. To improve our knowledge on their significance and prevalence it is however recommended to include them in the general health screening of lynxes.

Leptospira interrogans spp. test: (blood)/urine; PCR

Toxoplasma gondii test: blood; IgG and/or IgM Ab titre

Cytauxzoon felis test: blood, PCR

C. felis is a type of piroplasm belonging to the Theileridae family. It infects the red blood cells and macrophages of both domestic cats and various wild felids. The transmission of this parasite occurs through ticks of the Dermacentor genus. In domestic cats, infection with *C. felis* typically leads to symptoms like lethargy, jaundice, fever, and often results in death due to haemolytic anaemia. How-

ever, when it comes to infected Eurasian lynxes, there haven't been any discernible signs of illness. In fact, in some populations about 25 % of the animals tested positive, yet they displayed no clinical indications. This suggests that they might possess a natural resistance to the disease, potentially serving as the primary reservoir.

Haemotropic mycoplasmas test: blood, spleen; PCR

Mycoplasma species are typically transmitted through various vectors such as lice, and potentially ticks, flies, and mosquitoes. In domestic cats, three different Mycoplasma species have been identified, each varying in their level of pathogenicity. In infected domestic cats, these bacteria often lead to conditions like haemolytic anaemia, loss of appetite, depression, and fever. The severity of the disease can escalate when co-infections occur with pathogens that weaken the immune system. When tested, approximately 11-39% of Eurasian lynxes were found to be positive for distinct subtypes of Mycoplasma. Remarkably, none of these lynxes displayed any clinical signs of the disease. Nevertheless, the extent of pathogenicity in wild lynx populations remains uncertain and requires further investigation.

Feline Corona virus (FCoV) test: faeces; PCR on 3-day pooled sample or blood; Ab presence/titre

PCR has been used to detect FCoV in faecal sample of domestic cats, and it is sensitive and useful to document that a cat is shedding FCoV in faeces. The strength of the PCR signal in faeces correlates with the amount of virus present in the intestines. These results can be useful to detect cats that chronically shed high virus loads and that pose a high risk in populations. Alternatively, PCR testing of (several) faecal samples can be performed to detect chronic FCoV carriers; these cats should be removed. In cat populations, 40%–60% of cats shed virus in their faeces at any given time. Approximately 20% will shed virus persistently. If a cat remains persistently PCR-positive for >6 wk, it should be placed in a single-cat environment or with other chronic shedders.

Approximately $\frac{1}{3}$ of antibody-positive cats excrete virus; thus, every antibody-positive cat should be considered infectious. Cats with high antibody titres are more likely to shed FCoV and to shed more consistently higher amounts of the virus. Thus, the titre is directly correlated with virus replication rate and the amount of virus in the intestines. Screening a population for the presence of FCoV or screening a cat before introduction into an FCoV-free population are additional indications. After 3–6 months, antibody titres can be retested.

Dirofilaria immitis test: Blood; PCR or Ag snap-test (if animal comes from an endemic region)

Sars-Cov2 test: blood/nasal-oropharyngeal and rectal swabs, Ab titre, PCR

Avian influenza test: oropharyngeal and rectal swabs, PCR

Echinococcus spp. test: feces, PCR

Recommendations for pathogen testing apply to both live and dead animals.

Additional examinations:

Ultrasonography

Point-of-care ultrasound (POCUS) can provide valuable additional insights in assessment of the vital organs. This may involve a focused examination of abdominal organs such as the liver, biliary system, kidneys, spleen, urinary bladder, intestines, and the reproductive system. The POCUS approach allows

for a rapid assessment of these abdominal structures, especially in cases where a specific underlying condition is suspected.



Figure 3.7.17. Point-of-care ultrasound (POCUS) approach, visualisation of the right kidney ©Laurens Van Mulders.

In cases where abnormalities are detected during auscultation, cardiac and/or lung ultrasound examinations may also be warranted. For a comprehensive understanding of cardiac ultrasound examinations, it is advisable to refer to the dedicated chapter that provides more detailed guidance on this specific technique.



Figure 3.7.18. Cardiac ultrasound A) under field conditions B) in an ex-situ setting, ©FIWI Bern, Laurent Locquet.