
Keywords: disease/documentation/felids/health risk assessment/pathogen/priorities/protocols/translocation/veterinary

Abstract: Appropriate veterinary measures are required to quantify and minimise the health risks that are inherent in the translocation of animals. Veterinary considerations should be addressed both at the individual level and at the ecosystem level. Disease risks in translocation and reintroduction projects can be basically summarized in two main scenarios, both involving the animals being translocated, other wildlife, domestic livestock, pets, and humans: 1) introduction of a pathogen into the destination environment by the animals being translocated and 2) transmission of a pathogen that is new to the animals being translocated during the translocation process or from the destination environment. Disease or health risk assessment (HRA) is the application of common sense to evaluate whether or not important health-related risks are associated to the translocation of animals, acknowledging that it is impossible to work without any risk. To identify potentially associated health hazards, three points need to be considered: 1) disease susceptibility and potential carrier role of the species to be translocated; 2) presence of pathogens and other potential health problems in the source environment, and 3) presence of pathogens and other potential health problems (including toxic compounds) in the destination environment. Adequate scientific documentation is almost as important as HRA. Every single individual, alive or dead, is a valuable source of information, for the present and for the future. Thus, emphasis should always be placed on extensive sampling and information collection. Decisions on whether or not to proceed with wild animal translocations may be determined by the results of HRA, resources, sociopolitical aspects, logistics and conservation issues. In this regard, and since resources are usually limited, priorities have to be set. Amongst others, it is essential to establish clear criteria to decide what are the minimum standards to render an individual acceptable for translocation -i.e., what are the key agents to be tested for- before deciding whether an animal can be translocated or not. As a next step, suitable protocols can be proposed. A multidisciplinary approach is required both during the planning and the implementation stages. Also, it is essential to consider these projects as adaptive processes, i.e., to learn from results and adjust the methodology accordingly.

Notes: Incl. Spanish abstract
Resumen
Los riesgos de enfermedad en los proyectos de translocación y reintroducción se pueden resumir principalmente en dos tipos de escenarios, que en ambos casos afectan a los animales a translocar, a otros animales silvestres, al ganado doméstico, a mascotas y a seres humanos. Estos dos escenarios son: 1) la introducción por los animales reubicados de un patógeno en el entorno de destino y 2) la transmisión de un patógeno que sea nuevo para los animales a reubicar durante el proceso de translocación o procedente del entorno de destino. Para cuantificar y minimizar los riesgos sanitarios que son inherentes a la translocación de animales se necesitan medidas veterinarias apropiadas. Las evaluaciones veterinarias deben realizarse tanto a nivel individual como a nivel del ecosistema. La evaluación de los riesgos de enfermedad o para la salud consisten en la aplicación del sentido común para valorar si la translocación de los animales pueda implicar riesgos significativos relacionados con la salud, a sabiendas de que es imposible trabajar sin riesgo alguno. Para identificar los posibles riesgos para la salud hay que tener en cuenta tres aspectos: 1) la susceptibilidad a la enfermedad y posible papel portador de la especie a reubicar; 2) la presencia de patógenos y otros problemas potenciales para la salud en el entorno de origen, y 3) la presencia de patógenos (o de compuestos tóxicos) en el entorno receptor. La documentación científica correcta es casi tan importante como la evaluación de riesgos para la salud. Cada uno de los ejemplares, tanto vivos como muertos, es una fuente valiosa de información para el presente y para el futuro. Por consiguiente, se debe poner mucho énfasis en el muestreo amplio y en la recopilación de información. Las decisiones acerca de si hay que proceder o no con las traslocaciones de animales silvestres pueden estar determinadas por los resultados de la evaluación de riesgos para la salud, los recursos, los aspectos logísticos, sociopolíticos y por cuestiones de conservación. Teniendo en cuenta que los
recursos suelen ser limitados, es necesario establecer prioridades. Además, es imprescindible determinar cuáles son los resultados necesarios para decidir si un animal puede ser reubicado o no. Una vez finalizada la evaluación de riesgos para la salud y determinadas las prioridades, se pueden proponer los protocolos correspondientes. Es necesario un enfoque multidisciplinario durante las fases de planificación e implantación. Asimismo, es imprescindible que todo proyecto sea considerado como un proceso flexible: hay que intentar reducir al mínimo las pérdidas y los problemas, pero en caso de que ocurriessen, hay que aprender de ellos y adaptar los procedimientos debidamente.

**PALABRAS CLAVE**
Evaluación de riesgos para la salud, enfermedad, documentación, patógeno, prioridades, protocolos, reubicación

**ABSTRACT**
Appropriate veterinary measures are required to quantify and minimise the health risks that are inherent in the translocation of animals. Veterinary considerations should be addressed both at the individual level and at the ecosystem level. Disease risks in translocation and reintroduction projects can be basically summarized in two main scenarios, both involving the animals being translocated, other wildlife, domestic livestock, pets, and humans: 1) introduction of a pathogen into the destination environment by the animals being translocated and 2) transmission of a pathogen that is new to the animals being translocated during the translocation process or from the destination environment. Disease or health risk assessment (HRA) is the application of common sense to evaluate whether or not important health-related risks are associated to the translocation of animals, acknowledging that it is impossible to work without any risk. To identify potentially associated health hazards, three points need to be considered: 1) disease susceptibility and potential carrier role of the species to be translocated; 2) presence of pathogens and other potential health problems in the source environment, and 3) presence of pathogens and other potential health problems (including toxic compounds) in the destination environment.

Adequate scientific documentation is almost as important as HRA. Every single individual, alive or dead, is a valuable source of information, for the present and for the future. Thus, emphasis should always be placed on extensive sampling and information collection. Decisions on whether or not to proceed with wild animal translocations may be determined by the results of HRA, resources, sociopolitical aspects, logistics and conservation issues. In this regard, and since resources are usually limited, priorities have to be set. Amongst others, it is essential to establish clear criteria to decide what are the minimum standards to render an individual acceptable for translocation –i.e., what are the key agents to be tested for– before deciding whether an animal can be translocated or not. As a next step, suitable protocols can be proposed. A multidisciplinary approach is required both during the planning and the implementation stages. Also, it is essential to consider these projects as adaptive processes, i.e., to learn from results and adjust the methodology accordingly.

**KEYWORDS**
Health risk assessment, disease, documentation, pathogen, priorities, protocols, translocation
Planning of veterinary supervision for translocation programmes of wild felids

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INTRODUCTION

Translocations are defined as the intentional movement of animals and their release into the wild in an attempt to reintroduce a species in an area which was once part of its historical range, to supplement an existing low density native population or to introduce a species outside of its recorded distribution (IUCN, 1998). Translocations are thus an important tool in wildlife conservation and management (Figure 1).

The success of translocation projects depends on several factors. Besides non biological and biological considerations, such as local support together with the choice of a suitable habitat with sufficient and appropriate food resources in the release area, health aspects play a crucial role in wildlife translocation and reintroduction strategies. Indeed, the veterinary implications of projects involving the movement of wild animals, even over relatively short distances, are sometimes unexpected (Woodford and Kock, 1991).

Appropriate veterinary measures are required to quantify and minimise the health risks pertaining to the translocations of animals, and to ensure the health and wellbeing of released stock throughout the length of the Programme (IUCN/SSC, 1998; Woodford and Rossiter, 1993; Kock et al., 2007). Disease risks in a translocation project can be basically summarized in two main scenarios: 1) Introduction of a pathogen into the destination environment by the animals being translocated. Relocation of wild animals never consists of the movement

Figure 1. Release of a translocated Eurasian lynx.

Figura 1. Suelta de un lince eurasiático en un proyecto de translocación.
of a single species, rather, it always entails relocation of a “biological package” consisting of the animal itself and its passenger organisms such as parasites, viruses, bacteria and fungi (Davidson and Nettles, 1992). 2) Transmission of a pathogen new to the animals being translocated during the translocation process or from the destination environment. In both cases, pathogen transmission has to be considered between the animals being translocated and other wildlife, domestic livestock, pets and humans (Figure 2). All of them can be healthy carriers and/or potential victims of pathogens. Thus, for a health risk assessment, it is necessary not only to consider diseases affecting the species of concern, but also the infectious agents that the translocated animals could potentially pass on to other animal populations or even to humans.

Veterinary considerations should be addressed both at the individual and at the ecosystem level. In the first case, the aim is to maximize the survival of each single individual to be translocated, which is essential for the success of the project. Safe and effective anaesthesia, stress management, wound treatment, and individual health screening are crucial at this level. Clinically healthy animals are not necessarily pathogen-free (Cunningham, 1996) and thus, capture, transport and change of environment—which are always a source of enormous stress—may affect animals in various ways; e.g., in predisposing them for the development of a disease (Woodford, 2001; Teixeira et al., 2007). Furthermore, animals can get wounded during capture or transport and may require medical treatment. And last but not least, animal welfare considerations have to be taken into account (IUCN, 1998; Woodford, 2001). At the ecosystem level, the aim is the prevention of the movement of pathogens through the movement of animals, since the movement of pathogens to new environments may have important effects on wildlife, agriculture or public health, and may affect the translocation effort itself (Leighton, 2002). This implies detailed disease risk assessment in both the source and destination environments, as well as individual health screening procedures.

A thorough planning of the veterinary supervision is a necessity. However, not only health concerns, but also further factors such as biological, political and scientific considerations will influence the veterinary protocols (Figure 3; Jiménez, this book). A multidisciplinary approach is therefore required both during the planning and the implementation stages (Woodford & Kock, 1991). All involved staff must be consulted for decision making, and potentially critical situations that may occur during the project have to be discussed prior to taking action.

**HEALTH RISK ASSESSMENT**

Disease or health risk assessment is the rigorous application of common sense to evaluate whether or not important health-related risks are associated with a proposed activity, such as the translocation of animals (Leighton, 2002). Health risk assessment requires a detailed translocation plan, and the subsequent identification of associated health hazards, both in the source and destination ecosystems. For this purpose, a comprehensive list of potential health hazards has to be provided. This includes three important steps (Figure 3).

**Disease susceptibility and eventual carrier role of the species to be translocated**

All existing information on the species needs to be gathered, including published and unpublished reports or personal observations. Known causes of morbidity and mortality, potential sources of infection, performed
serological surveys, epidemiological relationships with other species, persistence of relevant infectious agents in the environment, their pathogenicity and routes of transmission are all important information to be considered. The compiled data must be organized in a database and presented in a detailed written review. In this way, the knowledge on the species at the time of project planning is well documented and available for all concerned participants, facilitating discussions regarding veterinary procedures. In this context, it should be noted that if no diseases are recorded for the species in question, it does not mean that this species is not susceptible to diseases (Cunningham, 1996).

**Presence of pathogens and other potential health problems in the source environment.**
Knowledge regarding the health status of the source population(s) (captive or free-living) is essential to evaluate the risk of “pathogen translocation” and of “translocation” of non infectious health problems such as genetic defects. Therefore, data need to be collected on the infectious agents and diseases present in the source ecosystem, i.e., all available information concerning causes of death, infectious and non-infectious diseases, and carrier status of the concerned population(s)—post-mortem investigations, epidemiological surveys, etc.—must be compiled and taken into account during the planning process.

**Presence of pathogens in the destination environment**
The presence of pathogens that could entail a risk for animals being translocated (according to the abovementioned review) has to be assessed in the release area. Such pathogens might be present in other wildlife species, or in domestic stock and pets that live within the surrounding area. Furthermore, the presence of infectious agents that may be introduced by translocated animals has to be investigated, both in the species of concern (in case of re-stocking) and in the associated fauna. In this second scenario, pathogens that are already present in the area do not necessarily need to be considered, while those that are absent would require more attention. In addition, it is important to assess the presence of toxic substances in the environment (e.g. pollutants, poison distributed for control of pest species, etc.) that could affect the animals targeted for translocation.
The pathogenic potential of infectious organisms can basically be classified into three categories: 1) pathogenic, for those known to produce disease; 2) non-pathogenic, for those studied well enough to determine that they never produce illness, and 3) unknown, for those where there is insufficient information to evaluate their pathogenicity. However, risk assessments are not absolutely predictable, especially since biological factors in the release areas might favour “exotic” pathogens normally considered harmless, thereby producing unpredictable disease syndromes (Davidson and Nettles, 1992).

Since an assessment of the health risk of each identified hazard is almost never feasible, it is necessary to select a small number of hazards that appear to have the greatest potential to pose important health risks. Risk must be then completely and rigorously estimated for each selected health hazard, i.e., the probability that the hazardous event will occur and the magnitude of the consequences that may result if such event does occur (Leighton, 2002). It is important to note that it is impossible to work without taking any risks. The aim is to minimize them as far as possible, but one has to keep in mind that a certain risk will always remain.

**Scientific documentation and sample archives**

Disease risk assessment is of central importance in the veterinary supervision of translocation projects. Yet, especially when dealing with an endangered species, adequate scientific documentation of the project implementation – including individual veterinary records – is crucial. Conservation projects imply a significant amount of manpower and financial investment. Every single individual, alive or dead, is a truly valuable source of information, for the present and for the future. Thus, even if disease risk assessment reveals that there are no diseases of concern in the frame of the translocation project, emphasis should still be placed on extensive sampling and information collection.

On the one hand, all procedures, results from physical exams, complementary diagnostic tests and laboratory analysis need to be recorded in detail. Data on pathogens that are apparently not influencing the health status of the animals should, as far as possible, also be collected in order to learn about the species and about the pathogens.

On the other hand, biological samples should be stored for eventual retrospective studies. For example, an apparently emerging pathogen that was not considered at the time of translocation might be detected in the release area several years after translocation. If appropriate samples of the translocated animals have been stored, it will be possible to use them for a retrospective analysis in order to determine whether the translocated animals were already infected with this apparently new pathogen at the time of translocation.

**Priority setting: decision-making vs. documentation**

Within the frame of any project, priority-setting is key, since human and financial resources are often limited. This has to be done for every single aspect of the project, including the health criteria for the selection of animals for the translocation programme, the length of the quarantine period, and the individual health screening protocols (Figure 3). Decisions whether or not to proceed with wild animal translocations may be determined by the results of health risk analysis, but they also may be influenced by a variety of other factors such as political and/or conservation issues. Health risk analysis informs decision makers regarding potential health risks and provides them with options to reduce risk if it is decided to proceed with the translocation (Leighton, 2002). For example, in case of a highly endangered species, it might be very difficult to capture animals for translocation that are free of any pathogen that could represent a risk for another, widely distributed species in the destination environment. If this risk appears to be rather low, the conservation goals of animal translocation might be of higher priority than the avoidance of introducing pathogens into the destination environment.

Furthermore, it is fundamental to differentiate between optimal and minimal – or essential – requirements. It is always interesting to perform testing for numerous infectious agents in all animals. However, it is necessary to establish clear criteria to decide which are the minimum standards to render an individual acceptable for translocation. The selected key agents should have first priority, and the tests should be done as soon as possible. All other infectious agents will have second priority, i.e., the needed samples will be taken, but only analyzed according to the laboratory capacity and the financial resources. No simple guidelines can cover all situations. Each species, each geographical area, each project is a case in itself and must be evaluated separately, taking into account all biological, ecological, geographical and epidemiological circumstances (Woodford and Rossiter, 1993).
- Disease risk assessment
- Health criteria for inclusion into the translocation programme
- Options if the health criteria are not fulfilled*
- Considerations of the legal and veterinary restrictions on translocation of wildlife
- List of duties of the field veterinarian(s)
- List of material:
  - Immobilization
  - Physical exam
  - Pharmacy
  - Record sheets (physical exams, anaesthesia, quarantine, transport, post-mortem)
  - Individual record sheets and boxes for sample shipment
- Telephone list:
  - Project veterinarians
  - Laboratories
  - Animal hospital
  - Quarantine station
  - Field biologists
  - Project leader
  - Responsible authorities
- Sampling:
  - Required samples (e.g. blood, faeces, swabs)
  - Sampling methods
  - Collaboration with laboratories
  - Priority list for analysis
  - Preservation
  - Shipment
- Capture (in the wild or in captivity):
  - Anaesthesia protocol
  - Health screening (physical exam, sampling)
  - Complementary diagnostic tests (radiography, ultrasound, etc.)
  - Treatment (e.g. against parasites), vaccination
  - Identification
- Transport (from capture site to quarantine station, and from quarantine station to release site):
  - Design of transport boxes
  - Vehicles
  - Heating/cooling of vehicle according to the temperature:
    - Anaesthesia / tranquillization
    - Animal monitoring
    - Paperwork (e.g. official health certificates, transport documentation)
- Quarantine:
  - Duration**
  - Location
  - Isolation of animals (other species, humans)
  - Design of facilities (size of enclosures, structure)
  - Diet (type of food, sources, frequency)
  - Hygiene (incl. disinfection after release)
  - Observation (e.g. camera surveillance)
  - Use of tranquillizers
  - Medical records
- Release:
  - Procedure for re-captures in the enclosure
  - Pre-release physical exam
  - Sampling
  - Treatments, re-vaccination
- Post-release monitoring:
  - Health screening and sampling protocol for captures
  - post-mortem protocol

* Release in the source area, treatment, euthanasia, collaboration with a veterinary clinic or a rehabilitation center.
** Minimal requirements, considering both the goals of the quarantine and the fact that it is a stressful situation for animals coming from the wild.

Table 1. Check list for veterinary procedures in the frame of translocations projects.

Tabla 1. Lista de comprobación de los procedimientos veterinarios en el marco de los proyectos de translocación.
**PROTOCOL PROPOSALS**

Once a health risk assessment has been performed and priorities have been set, suitable protocols can be proposed. Reduction of health risks identified in the risk assessment may be achieved by changing some of the translocation procedures, such as choice of source and destination environments, methods of capture, transportation, quarantine and release of animals, and veterinary procedures such as immobilization protocol, disease testing, therapeutic treatments and vaccinations (Leighton, 2002).

Clear procedures are essential to avoid confusion, destructive emotions and stress situations in case of problems. Procedures should therefore be proposed in advance for each potential worst-case scenario. Furthermore, the project has to be considered as an adaptive process: protocols should be regularly re-evaluated in order to improve them if necessary (see Shenk, 2001). Overall, veterinary planning must take into account a number of points, which are summarized in Table 1. A comprehensive checklist for health risk analysis and protocol development is provided by the Office International des Epizooties and the Canadian Cooperative Wildlife Health Centre (Anonymous).

The following aspects are of particular concern in wild cats. At physical examinations (Figure 4), particular attention should be given to claws, footpads, teeth, and gums. Split claws and abraded pads are hard to observe in conscious animals. Dental problems, such as fractured teeth with pulp exposure, are common problems in captive non-domestic cats and severe cases could be life-threatening due to a potentially secondary systemic disease (Roelke et al., 1991; Blomqvist et al., 1999; Ryser-Degiorgis et al., 2002; Ryser-Degiorgis, this book). Once in quarantine, newly arrived individuals might refuse to eat as a result of the stress caused by the changes in their environment (Roelke et al., 1991; Blomqvist et al., 1999; Ryser-Degiorgis et al., 2002). Freshly killed, whole animals with the abdominal cavity opened can provide an effective feeding stimulus to some cats (Blomqvist et al., 1999). Although a minimal duration of 30 days is generally recommended for the quarantine of non domestic cats (Blomqvist et al., 1999, Woodford, 2001), animal husbandry issues (e.g., stress in captivity) may require that the quarantine period be shortened (Woodford, 2001; Ryser-Degiorgis, unpubl. obs.). There are thorough overviews of common pathogens to be included in the health screening protocols of non domestic cats, and recommended vaccinations and anti-parasitic treatments (Blomqvist et al., 1999; Woodford 2001). Further general information on diseases of non-domestic felids is reported by Terio et al. (this book) and Munson et al. (in press). For transport, animal welfare is a prime consideration. It is not necessary to provide food and water on short journeys (Blomqvist et al., 1999). Crates and boxes must be large enough to meet the relevant regulations and strong enough to contain the species concerned. Recommendations for the design of transport boxes for wild cats are presented in Blomqvist et al. (1999). A crated feline should be left in quiet, dimly lit surroundings and the attention of curious bystanders kept to a minimum (Blomqvist et al., 1999; Ryser-Degiorgis, 2002). Excited cats overheat very easily in confined spaces.

**POST-RELEASE VETERINARY MONITORING**

For a complete, long-term evaluation of the health situation in particular and of the success of the translocation project in general, veterinary data must also be recorded after release (health screening at captures, reproductive success, causes of mortality, archiving of samples; e.g., Wild et al., 1999; Shenk, 2001; Wild et al., 2006). Losses of single individuals in small populations can have a significant impact on future population characteristics. Furthermore, even if epidemics are considered improbable, they still can play an important role in the long-term viability of a population (Ballou, 1993). Valuable information can be gained from blood samples, faecal samples, and post-mortem material (Blomqvist et al., 1999).
LEARNING FROM EXPERIENCES

Many reintroduction projects have been poorly documented (von Arx et al., this book). In order to learn from experiences and to allow for a long-term approach to conservation, documentation is essential (Breitenmoser et al., 2001). Hence, all recorded data should be maintained in a database and presented in written reports, ideally in form of internationally available publications. Information such as anaesthesia protocols that are considered safe and efficient, reference data for the species (e.g. haematology, biochemistry), evaluation of capture methods (stress, injuries; Figure 5), observed infectious agents (serology, PCR, parasitology), diseases, behavior in quarantine (including problems in the enclosures), and encountered difficulties throughout the process, represent important information to be recorded and shared.

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