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# Health risk assessment of the translocation of wild animals

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**Summary**

Potential health risks are always associated with the translocation of wild animals. A formal assessment of these health risks should be conducted in advance of each translocation, and the results of the risk assessment should be incorporated into decisions as to whether or not the translocation should occur or whether changes in the translocation protocol could substantially reduce health risks inherent in the translocation. Credible health risk assessments can be performed by individuals without extensive previous experience, given the necessary background in animal health and wildlife biology and access to sufficient valid information. Assessment of health risks should not be performed or influenced by those who will use the results to make decisions or those with vested interests in a particular outcome. The assessment process itself must be transparent, and the final risk assessment report must clearly present each step taken, all available information and all reasoning. Health risk assessment is a rigorous application of common sense to evaluate whether or not important health-related risks are associated with a proposed activity. The level of health risk inherent in a planned translocation is determined by identifying the full range of possible health hazards that might be associated with that translocation, identifying from among these a subset of potential hazards that require complete assessment, and for each hazard thus selected, evaluating the probability that the hazardous event will occur and the magnitude of negative consequences if it does occur. The combination of probability of occurrence and magnitude of consequences constitutes the risk posed by a potential health hazard, and the combined risk for each assessed health hazard constitutes the overall health risk estimate for the translocation. A valid numerical (quantitative) health risk assessment for wild animals is rarely possible because the available information on which the assessment must be based is too approximate and imprecise. Qualitative health risk assessments for wild animal translocations are usually of equal or greater value than numerical assessments and can be of enormous importance to wildlife conservation, domestic animal health and public health.

**Keywords**

Health risks – Risk assessment – Translocation – Wildlife.

## Introduction

Wildlife translocation, the transportation of wild animals from one geographic location to another, is undertaken for many different reasons, including stocking areas for hunting or fishing, conservation of endangered species, re-population of former ranges, establishment of new populations and commercial exploitation. Wildlife translocations are performed on a massive scale world-wide. For example, between 1973 and 1986, an average of 515 translocations were documented per year in Australia, Canada and New Zealand alone; and the total number of translocations performed annually doubled during this fourteen-year period (5).

Translocation of domestic animals and animal products is widely recognised to pose significant risks in terms of transmission of infectious diseases along with the animals and products; this was the concern that led to the establishment of

the Office International des Epizooties (OIE) and is the basis for many regulations involving international trade. Each translocation of wild animals is also associated with some risk of harmful consequences due to infectious diseases. The animals being translocated may carry new diseases to the destination environment or may acquire diseases new to them during the translocation procedure or from the destination environment. The movement of diseases to new environments in this way may have important effects on wildlife, agriculture or public health, and may affect the success of the translocation effort itself.

Many examples can be found of harmful consequences of diseases translocated with animals. Wild ungulates in Africa were severely affected when rinderpest was imported in domestic cattle; similarly, wild ducks and geese in North America experienced epidemic mortality when duck plague was imported in domestic ornamental waterfowl (17, 22). The giant liver fluke, *Fascioloides magna*, was introduced into Europe in elk (wapiti) from North America, and the massive epidemic of rabies in racoons, which is still expanding in north-eastern North America, was initiated by translocation of rabid racoons from the State of Florida to the State of West Virginia (13, 16, 21). Over half the native birds of the Hawaiian Islands have become extinct because of the introduction of avian malaria (19, 20). Attempts to re-establish caribou populations in parts of their former range in eastern Canada and the United States of America (USA) have failed because the translocated animals died from infection with a parasite, *Parelaphostrongylus tenuis,* that had become endemic in the destination environment (9). Many parasites of freshwater fish have become established in new locations through fish translocations; these include the protozoan, *Myxobolus cerebralis*, which is a benign parasite of the European brown trout, but also the cause of the serious and costly disease known as whirling disease in rainbow trout and several other species of salmonid in North America (6, 23). The potential harm from infectious diseases associated with wildlife translocation has been reviewed in several publications (4, 18).

# Health risk assessment

In the past, wildlife translocations were commonly undertaken without much thought to disease issues (5). Prior to the 1990s, such reckless behaviour could be attributed to a lack of awareness of potential health risks (4). However, translocation of wild animals without due consideration of the potential health risks is no longer acceptable. Fortunately, much work and thought has been devoted to the analysis of health risks associated with animal movements, and guidelines for undertaking such assessments have been developed (1, 14, 15). These tools make assessment of health risks of wild animal translocations both feasible and achievable by those responsible for such animal movements.

The formal assessment of risk as an aid to decision making is an ancient practice, dating back at least to 3200 BC (3). The approach to risk assessment now widely applied to human and animal health evolved, in large measure, within the United States Environmental Protection Agency (established in 1970) in tackling issues of environmental contamination and human health. The basic steps and essential procedures of risk assessment were established in a joint publication of the United States National Academy of Sciences and the National Research Council in 1983 (11), and this approach, with refinements and modifications, has remained the basis for risk assessment in a wide range of fields (7).

Health risk assessment is no more and no less than a rigorous application of common sense to evaluate whether or not important health-related risks are associated with a proposed activity, such as a translocation of wild animals. Health risk assessment can be qualitative, in which risk is estimated as being negligible, low, medium or high, or can be quantitative, in which mathematical models are used to give numerical estimates of the probability of a negative outcome and the extent of economic, ecological and social harm that would occur as a result.

# Who should perform risk assessments?

Risk assessment is not the exclusive domain of specialists. While expertise and experience in risk assessment can contribute significantly to the precision and rapidity of an assessment process, those without specific experience of risk assessment who are knowledgeable in the appropriate areas of wildlife biology and animal health and have access to the required information can perform a credible assessment of health risks. Small teams which bring together individuals with a variety of backgrounds to match the issues encompassed by the particular risk assessment being undertaken may maximise efficiency and rigour.

# Who should not perform risk assessments?

An essential requirement of risk assessment is a clear separation between the assessment of risk, an essentially scientific process, and the use of the results of that risk assessment to make decisions, such as, for example, whether or not a wild animal translocation should be permitted. The National Research Council in the USA emphasised the importance of this separation of the assessment process from subsequent use of the results in an evaluation of risk assessment in 1994 (10, 12). This separation is required in order to free the assessment process from the bias and influence of personal or public pressures and expectations that the results should support a

particular decision. Thus, those who assess risk should neither make decisions based on the results of the risk assessment nor be influenced by those who make these decisions.

## Information requirements

Many different kinds of information are required for assessment of health risks of wild animal translocations. These include species and populations of animals and disease-causing agents in both source and destination environments, mechanisms of transmission and spread of the pathogens of concern, transportation and quarantine facilities and procedures to be used, and general information about the source and destination ecosystems, including the local economy and culture. If sufficient information is not available, an assessment of health risks is not possible. The availability of sufficient information to perform a valid health risk assessment should be determined early in the risk assessment process. If sufficient information does not exist, this should be acknowledged and the process halted.

## Objectivity, subjectivity and transparency

Health risk assessment must be as objective as possible. Any assessment should be based firmly on science and on all of the relevant information available. Although a health risk assessment will never be entirely free of subjective judgement, it is possible, and essential, to clearly identify when a subjective judgement is used within a risk assessment. The basis for such judgements should be clearly stated to prevent any confusion by the reader of the risk assessment report regarding which elements of the assessment are based on science and which are based on subjective judgement. Thus, health risk assessment must be transparent. The reader of a health risk assessment report must be informed of all of the information that was available to the assessor, must be shown how the information was evaluated and how risk assessments were derived, must be advised of information that was not used or ignored, and must be informed of the uncertainties associated with the risk assessment. The OIE *International Animal Health Code* urges that transparency is 'essential because data are often uncertain or incomplete and, without full documentation, the distinction between facts and the analyst's value judgements may blur' (14).

## The process of health risk assessment of wild animal translocations

The level of health risk inherent in a planned translocation is determined by identifying the full range of possible health hazards that might be associated with that translocation, identifying from among these a subset of potential hazards that require complete assessment, and for each hazard thus selected, evaluating the *probability that the hazardous event will occur* and *the magnitude of negative consequences* if it does occur. It is the combination of probability of occurrence and magnitude of consequences that constitutes the risk posed by a potential health hazard, and it is the combined risk for each assessed health hazard that constitutes the overall estimate of health risk for the translocation. The basic steps in health risk assessment of animal translocations are outlined in Figure 1, and each is considered in some detail below. More details are provided in a report by the Canadian Cooperative Wildlife Health Centre (CCWHC) and the OIE (1).

| | |
|---|---|
| 1. Translocation plan | A complete, detailed description of the translocation is produced. This clearly defines the activity for which health risks are to be assessed |
| 2. Identification of health hazards | All potential health hazards are listed and a subset is selected for full assessment |
| 3. Assessment of risks | Risk is assessed for each health hazard selected:<br>– the probability that the health hazard will occur in the translocation programme<br>– the magnitude of the negative consequences if the hazard occurs |
| 4. Overall risk assessment and statement of uncertainty | An overall assessment is produced by combining the results of the assessments of each of the health hazards assessed individually |
| 5. Assessment of associated hazards and risks | Hazards that may not be directly related to health issues often become apparent during health risk assessement. A statement identifying these hazards is included in the risk assessment |
| 6. Risk reduction | During a risk assessment, it may become evident that some of the risks identified could be reduced by changing procedures to be used in the translocation programme. A statement regarding methods of reducing risks is included in the risk assessment |

**Fig. 1**
**Basic steps in the health risk assessment of wild animal translocations**

## Step 1: the translocation plan

The translocation event for which health risks are to be assessed must be defined precisely, in detail, and in advance. Details of the translocation procedures can have enormous impact on the level of risk inherent in the translocation. Thus, an assessment of risk cannot be made unless all details of the proposed translocation are known.

The translocation plan should include a general description of the proposed translocation, stating the objectives of the translocation, the species, numbers, ages, and sexes of the animals to be moved, and the dates of the translocation, and describing the source and destination ecosystems, the methods of capture and veterinary protocols to be followed, and the methods to be used to release the animals. The general description should also state clearly which people, societies or enterprises will benefit from the translocation and which will suffer any potential negative consequences. The range and kinds of potential health risks inherent in the translocation should be outlined and the presence of additional ecological or economic risks associated with the proposed translocation should be stated.

The translocation plan must also include a detailed description of the various procedures and methods to be used in the proposed translocation. The methods and procedures that actually will be used must be described, not the methods that would be desirable but, in the end, will not be used for various reasons. A detailed explanation must be provided of methods of capture of animals, transportation of animals, management of the animals in captivity, nutrition while in captivity, all veterinary procedures and quarantine protocols to be used, and release of animals in the destination environment.

## Step 2: identification of health hazards

The next step is to make a complete, inclusive list of all possible health hazards that might be associated with the translocation described in the translocation plan. This is followed by a preliminary assessment of the list of hazards, and selection of a small number of potentially important hazards for detailed risk assessment. At this stage, the assessor must identify sources of information about health hazards and related matters, and determine whether or not sufficient valid information is available to make health risk assessment possible. As part of this review of information sources, an evaluation of the Veterinary Services, animal disease surveillance and control programmes, wildlife services, and wildlife population surveillance and census information for both source and destination environments and jurisdictions must be performed to determine whether or not these are capable of furnishing valid information required in the risk assessment. Guidelines for evaluation of Veterinary Services are given in the OIE *International Animal Health Code* (14). A similar approach can be used to evaluate the capacity of other institutions and agencies, as required.

The comprehensive list of potential health hazards should provide an inclusive list of all infectious agents and diseases potentially carried by the animals to be translocated (infectious agents and diseases present in the source ecosystem) and an inclusive list of all infectious agents and diseases which are present in the destination ecosystem and to which the animals to be translocated may be susceptible. Potential pathogens of concern include all live biological medical preparations, such as live vaccine viruses, to which the translocated animals will be exposed and which may be carried into the destination environment. Consideration must be given to those animal species in the destination ecosystem that may share infectious agents or diseases with the species to be translocated, and to agricultural, forestry or environmental practices in the destination ecosystem, such as use of toxic pesticides on crops or for control of the vectors of human and animal diseases, that may affect the health of the animals after release into the destination ecosystem. The basic nutritional and related habitat requirements of the animals to be translocated must be evaluated to determine whether or not the destination ecosystem will support the animals after release.

A comprehensive, inclusive list of potential health hazards in any wild animal translocation will be very long. An assessment of the health risk of each hazard on the list is almost never feasible. Thus, it is necessary to select a small number of health hazards that appear to have the greatest potential to pose important health risks, and then to assess the risks of each selected health hazard completely and rigorously. In selecting a small subset of health hazards for in-depth assessment, emphasis should be placed on diseases or infectious agents that fulfil all of the following three criteria:

*a*) may be carried by the animals to be translocated from the source ecosystem to the destination ecosystem

*b*) may infect or cause disease in one or more wild or domestic animal species or in humans in the destination ecosystem

*c*) may have significant ecological or economic consequences if introduced into the destination ecosystem.

These selection criteria place particular emphasis on diseases or infectious agents that are present in the source ecosystem and absent from the destination ecosystem. Emphasis should also be placed on diseases or infectious agents that are present in the destination ecosystem and that may cause significant harm to the animals that are to be translocated. Corn and Nettles provide a helpful example of health hazard identification and selection of a subset of hazards for detailed assessment (2).

## Step 3: assessment of health risks

For each health hazard selected for detailed assessment in Step 2, risk must be estimated (i.e. the probability that the hazardous event will occur and the magnitude of the consequences or harm that may result if the hazardous event does occur). In wild animal translocations, risk must be

considered with respect to two different kinds of health concerns, as follows:

*a*) the probability that diseases or infectious agents will be carried by the translocated animals to the destination ecosystem and the magnitude of ecological and/or economic harm that will result if this occurs

*b*) the probability that the translocated animals will be exposed to health hazards in the destination ecosystem and the magnitude of ecological and/or economic harm that will result if this occurs.

Risk assessment for each of these two kinds of health concerns is a multi-step process. For example, for each disease that the animals may carry from the source to the destination environment, five separate estimates must be made, as follows:

*a*) the probability that the disease or infectious agent of concern will be transferred to the destination environment

*b*) the probability that susceptible species in the destination environment will be exposed to the disease or infectious agent of concern

*c*) the magnitude of negative consequences to the full range of susceptible host species in the destination environment in the event that the disease or infectious agent of concern infects these host species

*d*) the magnitude of negative consequences to the destination ecosystem as a whole in the event that the disease or infectious agent of concern infects the susceptible host species

*e*) the magnitude of negative consequences to the economy of the destination environment in the event that the disease or infectious agent of concern infects the susceptible host species.

For each health hazard that is present in the destination environment and may cause harm to the translocated animals after release, the following two estimates must be made:

*a*) the probability that the translocated animals will be exposed to the health hazard of concern after release into the destination environment

*b*) the magnitude of ecological or economic harm which may result if the translocated animals are exposed to the health hazard of concern, including the likely impact of this event on the objectives of the translocation programme.

Step 3 is completed when each health hazard selected for in-depth risk assessment in Step 2 has been considered separately. Guidelines for making each of the necessary estimates of probability of occurrence and magnitude of effect are provided in a report by the CCWHC and the OIE (1).

### Step 4: assessment of overall health risk

The results of Step 3 must be synthesised into a statement and explanation of the overall or total health risk by combining the results of the risk assessments of each health hazard assessed. No mathematical formula or standard method exists for creating such a synthesis. Each must be a judgement by the assessor based on the objective information and risk assessments assembled in Step 3. In some cases, the assessment of one particular health hazard will dominate concern and determine the overall assessment. In others, the results of the individual risk assessments of the selected health hazards will have to be considered and combined in a more complicated fashion. The result of Step 4 is a written explanation of overall health risk that includes a clear description of how the various factors were weighted and provides an overall rating of health risk for the proposed translocation. This written explanation must also include a statement that identifies the principal sources of uncertainty in the risk assessment; for example, whether any information used in the assessment was imprecise or of doubtful quality, and how this uncertainty was accounted for in the overall risk assessment.

### Step 5: additional hazards and risks

In some cases, potential risks that are unrelated to health may nonetheless be identified during the health risk assessment. For example, it may become evident that the translocated animals themselves pose some risk to the destination environment because they have the potential to alter the gene pool, compete with other species, or alter the vegetation. The removal of the animals from the source environment may similarly alter gene pools, predation rates or vegetation. When such additional hazards and risks become evident, they should be identified in the risk assessment report. Managers of the translocation then may choose to assess the probability of occurrence and magnitude of the consequences of these additional hazards.

### Step 6: reduction of risk

Reduction of the health risks identified in the risk assessment may be possible by alteration of some of the methods and procedures of the translocation as defined in the translocation plan (Step 1). For example, choice of source and destination environments, methods of capture, transportation, quarantine and release of the animals, and veterinary procedures such as disease testing, therapeutic treatments and vaccinations can have significant effects on the level of health risk inherent in an animal translocation. The health risk assessment may reveal changes in procedures which could lower health risks. A statement about the potential for such risk reduction should be included in the health risk assessment report, and should include an estimate of the degree of risk reduction that the changes in procedures might achieve.

## Qualitative versus quantitative health risk assessment

It is widely assumed that the outcome of a properly-conducted risk assessment should be a quantitative, numerical estimate of

the probability of occurrence and the magnitude of possible consequences, e.g. 'the probability of occurrence is 39% and the consequences of occurrence will include a 13% reduction in reproduction of species *X* and loss of export sales of U$5.6 million per year in the foreseeable future'. In reality, accurate quantitative risk assessment is seldom possible, especially where wild animals are concerned. This is because the accurate numerical information required to make quantitative risk assessments is rarely available. Accurate estimates of parameters as fundamental as prevalence of infection, incubation period, duration of infection, and size and range of animal populations seldom exist for wild animals and diseases of these animals. In fact, adequate information upon which to make an accurate quantitative risk assessment is rare in most fields in which risk assessment is routinely applied. Kolluru warns that 'risk estimates usually exhibit two to three orders of magnitude (of) uncertainty' (8). Not only are the confidence intervals around parameter estimates usually very wide, but calculations of probabilities are based on multiplication and division, calculations across which numerical error is greatly magnified. Thus, attempts to express risk in quantitative, numerical terms are often no more than dangerous fiction (dangerous because they will often be assumed to be accurate by those who use the outcomes of risk assessments to make decisions). Such assessments are likely to do more harm than good.

Mathematical models of risk have immense value in identifying factors that may have high or low impact on health risks. These models can be used to estimate the degree of change in various parameters required to achieve significant risk reduction, and thus can guide revisions of translocation plans that are determined to present too great a risk in their original form. If applied with full knowledge of their limitations, mathematical models can be useful tools in risk assessment itself. However, these models cannot overcome the inaccuracies and wide confidence intervals of the actual biological data available for use in calculations. Thus, the results of a quantitative health risk assessment for a wild animal translocation usually will have confidence intervals so wide that, at best, the assessment will be vaguely equivalent to a qualitative risk assessment framed in terms of 'negligible', 'low', 'medium' and 'high' risk. The qualitative assessment will have the further advantage of being presented in plain language and logic familiar to a wide range of stakeholders in the translocation event and to decision-makers. Health risk assessments of immense potential value to wildlife conservation, domestic animal health and human health can be performed without complex mathematical estimates of probabilities and magnitudes of consequences. Attempting quantitative estimates can be very useful where sufficient data exist or in order to gain insights into the relative importance of different parameters that might be manipulated to reduce risk, but extensive and detailed quantification is not essential for effective health risk assessment. A useful discussion and examples of quantification in health risk assessment are provided in the literature (1, 8).

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# Évaluation des risques sanitaires liés au déplacement d'animaux sauvages

F.A. Leighton

**Résumé**

Le déplacement d'animaux sauvages constitue une source de risques sanitaires potentiels. Une évaluation en bonne et due forme de ces risques sanitaires doit être réalisée avant chaque transfert. Les résultats de cette évaluation seront pris en compte au moment de décider si le déplacement doit ou non avoir lieu et s'il convient de modifier le protocole de transfert pour réduire sensiblement les risques sanitaires inhérents à l'opération. Une évaluation fiable du risque sanitaire peut être effectuée par des personnes sans grande expérience préalable, si elles ont les connaissances générales nécessaires en matière de santé animale et de biologie de la faune sauvage et si elles disposent

d'informations valables et suffisantes. Les personnes appelées à décider du transfert des animaux ou celles dont les intérêts dépendent des conclusions de l'évaluation ne doivent pas participer à celle-ci ou influencer ceux qui en sont chargés. Le processus d'évaluation en soi doit être transparent, avec une présentation claire de chaque étape de l'analyse, de toutes les données disponibles et du raisonnement qui a guidé l'auteur du rapport final. L'évaluation des risques sanitaires est un processus rigoureux faisant appel au bon sens pour déterminer si une opération envisagée peut ou non entraîner des risques d'ordre sanitaire. Pour établir le niveau de risque sanitaire inhérent à un projet de transfert, il faut définir tous les risques sanitaires pouvant y être associés, identifier ceux qui nécessitent une évaluation complète, et pour chacun de ces derniers, évaluer la probabilité qu'il se concrétise, ainsi que l'ampleur des dommages qui en résulteraient. La combinaison de ces deux probabilités détermine le risque découlant d'un danger sanitaire potentiel, et la combinaison des risques découlant de chacun des dangers sanitaires détermine le risque sanitaire global estimé du déplacement d'animaux. S'agissant de la faune sauvage, une bonne évaluation numérique (quantitative) du risque sanitaire est rarement possible, car les informations disponibles sur lesquelles l'évaluation doit se fonder sont trop approximatives et imprécises. Les évaluations qualitatives du risque sanitaire lié aux déplacements d'animaux sauvages sont généralement tout aussi valables, voire meilleures, que les évaluations quantitatives, et elles peuvent être d'une importance capitale pour la préservation de la faune sauvage, la santé des animaux domestiques et la santé publique.

**Mots-clés**
Déplacements – Évaluation du risque – Faune sauvage – Risques sanitaires.

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# Evaluación de los riesgos sanitarios asociados al traslado de animales salvajes

F.A. Leighton

**Resumen**
El traslado de animales salvajes trae consigo invariablemente la posibilidad de riesgos sanitarios. Antes de cada traslado es preciso efectuar una evaluación en toda regla de esos riesgos, y tener en cuenta los resultados obtenidos para decidir si se lleva a cabo la operación y si conviene modificar el protocolo para reducir sustancialmente los riesgos sanitarios inherentes al traslado. Aunque carezca de gran experiencia previa, una persona puede realizar una evaluación fiable de los riesgos sanitarios si cuenta con los conocimientos necesarios en materia de sanidad animal y biología de la fauna salvaje y con información válida suficiente. Las personas que vayan a tomar decisiones en función del resultado o cuyos intereses dependen de conclusiones particulares deben abstenerse de intervenir o influir en el proceso de evaluación de riesgos. Este debe ser transparente, y en el informe final han de constar con claridad todas las etapas y datos del proceso, así como el razonamiento completo en el que reposa. La evaluación de riesgos sanitarios no es más que una aplicación rigurosa del sentido común para determinar si la actividad en cuestión trae aparejados

riesgos sanitarios de importancia. El nivel de riesgo sanitario ligado a una propuesta de traslado se establece determinando en primer lugar todos los posibles problemas sanitarios que podría suscitar la operación, desgajando después, de entre todos ellos, un subconjunto de posibles peligros que requieran un análisis detenido y valorando por último, para cada uno de ellos, la probabilidad de que efectivamente la amenaza se concrete y la magnitud de las consecuencias negativas que ello entrañaría. El riesgo que plantea un potencial peligro sanitario viene dado por la suma de estos dos elementos: la probabilidad de que realmente se produzca y la magnitud de sus consecuencias. A su vez, combinando el riesgo inherente a cada uno de esos peligros se obtiene la estimación del riesgo sanitario global asociado al traslado. Tratándose de animales salvajes, resulta poco útil emprender una evaluación numérica (cuantitativa) válida del riesgo sanitario, por cuanto la información disponible en la que ha de basarse el cálculo es demasiado aproximativa e inexacta. En general, para el traslado de animales salvajes resultan de igual o mayor interés las evaluaciones cualitativas, que pueden ser muy importantes para la conservación de la fauna salvaje, la sanidad de los animales domésticos y la salud pública.

**Palabras clave**
Evaluación de riesgos – Fauna salvaje – Riesgos sanitarios – Traslado.

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