TRAINING MANUAL ON WILDLIFE HEALTH RISK ASSESSMENT IN SUPPORT OF DECISIONS AND POLICIES

Third Cycle

Workshop for OIE National Focal Points for Wildlife

OIE

WORLD ORGANISATION FOR ANIMAL HEALTH
Protecting animals, preserving our future

TRAINING MANUAL ON WILDLIFE HEALTH RISK ASSESSMENT IN SUPPORT OF DECISIONS AND POLICIES

Workshop for OIE National Focal Points for Wildlife

Table of Contents

Introduction

The first OIE Training Workshop for OIE focal points for wildlife, held in all OIE Regions in 2009-10, provided an overview of the importance of pathogens in wild animals to domestic animal health, to trade in animals and animal products, to human health and to wild animal populations themselves, which often have very high economic, social and cultural value.
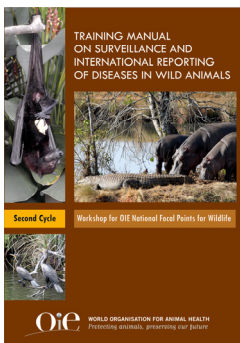
A second OIE Training Workshop was offered in all OIE Regions during 2011-2012. It provided information and exercises concerning the design of surveillance programs for pathogens and diseases in wild animals, including both general and targeted surveillance, diagnostic test performance and evaluation, data interpretation, survey design and sample size calculation for different purposes.

The **Training Manuals** of the first and second Workshop are available on the OIE web site in English, French and Spanish.
http://www.oie.int/en/international-standard-setting/specialists-commissions-groups/working-groups-reports/working-group-on-wildlife-diseases/

Introduction to the World Organisation for Animal Health (OIE)

An **overview of the OIE**, its organisation, mission and history, is available on the OIE website at http://www.oie.int. Click on this box:

The **responsibilities of OIE Focal Points for Wildlife** to their OIE Delegates are outlined in the Terms of Reference for Focal Points for Wildlife, as follow:

1. To establish a network of wildlife experts within his/her country or to communicate with the existing network;

2. To establish and maintain a dialogue with the Competent Authority for wildlife in his/her country, and to facilitate cooperation and communication among several authorities where responsibility is shared;

3. To support the optimal collection and submission of wildlife disease information to the OIE through WAHIS;

4. To act as a contact point with the OIE World Animal Health Information and Analysis Department and the Science and New Technologies Department on matters related to information on wildlife including wildlife diseases;

5. To receive from the OIE Headquarters:

    – copies of the reports of the Working Group on Wildlife Diseases

    – selected reports of the Scientific Commission for Animal Diseases

    – other relevant reports on wildlife or related to the livestock–wildlife interface, and to conduct the in-country consultation process on such draft texts and of drafts of proposed changes to OIE Standards dealing with wildlife diseases;

6. To prepare comments for the Delegate

    • on relevant meeting reports

    • on the proposals for new OIE standards and guidelines related to wildlife reflecting the scientific view and position of the individual OIE Member and/or the Region.

Recommendations from the OIE Global Conference on Wildlife – February 2011

The *OIE Global Conference on Wildlife: Animal Health and Diversity-Preparing the Future* took place in February 2011, in Paris (France). Over 400 people with relevant expertise and experience met there to review and discuss issues in animal health and biodiversity. At the conclusion of this 3-day conference, the participants made the following recommendations to the OIE as an organisation and to each of the Member Countries of the OIE. Several recommendations of particular relevance to the roles of focal points for wildlife are highlighted below in bold type.

CONSIDERING

1. The emergence and re-emergence of diseases that are transmissible among wildlife, domestic animals and humans,

2. The societal, economic and ecological value of diverse and healthy wildlife populations,

3. The key contribution of biodiversity and ecosystems services to health and the need to encourage research and expand knowledge on its interactions,

4. The need to increase the capacity of all countries worldwide to conduct surveillance, early detection, and initiate appropriate response to outbreaks and spread of diseases in wildlife,

5. The fundamental responsibilities of Veterinary Services and their government partners to protect and improve animal health, including aspects related to wildlife and biodiversity,

6. That the OIE is continuously developing and updating standards and trade facilitating mechanisms such as disease free zoning, compartmentalisation and safe trade in animal origin commodities to harmonise national regulation contributing to address the ecosystem interface between wildlife and domestic species,

7. That organisations internationally and nationally responsible for the delivery of public health, veterinary services, wildlife and the environment may be accommodated in different institutional units,

8. The increased need for animal protein for growing populations worldwide,

9. The changes in land use and management that may lead to new or modified interfaces between humans, domestic animals and wildlife that could favour disease transmission and loss of biodiversity,

10. The need for a multidisciplinary commitment and cooperation by stakeholders including public and non-governmental organisations to achieve mutually beneficial outcomes within the wildlife/domestic animal and human ecosystem interface.

THE PARTICIPANTS OF THE OIE GLOBAL CONFERENCE ON WILDLIFE **RECOMMEND TO THE OIE**:

1. To continue developing science-based standards on disease detection, prevention, and control as well as safe trade measures to harmonise the policies related to disease risks at the interfaces between wildlife, domestic animals, and humans.

2. To continue supporting and updating the notification mechanisms of wildlife diseases through the global information systems OIE WAHIS and *WAHIS-Wild*, while carefully considering possible impact of such notification by Members on the trade in domestic animals and their products, and to further promote data sharing at the international level on the GLEWS platform.

3. To assist Members to strengthen their Veterinary Services to protect animal health including aspects related to wildlife and biodiversity using, if needed, the OIE PVS Pathway.

4. **To encourage OIE Delegates to utilise their OIE focal points for wildlife to identify needs for national capacity building.**

5. To support Members' ability to access and utilise appropriate sampling and diagnostic expertise, as well as validated tools for disease surveillance and management in domestic and wild animals.

6. To encourage research to expand the scientific basis for the protection of biodiversity and environment to promote animal health and public health.

7. To encourage systematic inclusion, in the curriculum for veterinary education, of the promotion, the protection and the improvement of animal health and animal welfare including aspects related to wildlife and biodiversity.

8. To explore opportunities for communication and establishing strong collaboration with relevant global public and private organisations working on wildlife and biodiversity such as FAO, WHO, UNEP, IUCN, CIC, CITES[1] and other relevant Multilateral Environmental Agreements and international organisations to strengthen support to existing regulations on trade in wildlife and wildlife products and advocate for the need for mobilisation of resources in this area.

9. To continue to develop and update OIE strategies and policies on wildlife and biodiversity through the work of the Scientific Commission and its Working Group on Wildlife Diseases as well as the network of OIE Reference Laboratories and Collaborating Centres.

THE PARTICIPANTS OF THE OIE GLOBAL CONFERENCE ON WILDLIFE **RECOMMEND TO OIE MEMBERS**:

10. To continue to implement international standards and guidelines on prevention and control of diseases including those transmissible among wildlife, domestic animals and humans.

11. To continue to implement international standards and guidelines to facilitate the acceptable, legal trade of wildlife animals and wildlife products and to help reducing the illegal trade in wildlife.

12. **To notify diseases in wildlife through WAHIS and *WAHIS-Wild*, including in quarantine facilities, while carefully acknowledging when the notifications should not impact on trade of domestic animals and their products with commercial partners according to the OIE standards on relevant diseases.**

13. To ensure that the national Veterinary Services and their partners fulfil their responsibilities on aspects of biodiversity conservation, animal health and animal welfare as they relate to wildlife and the environment, including appropriate legislation and regulation, and, where needed, seek assistance through the OIE PVS Pathway to improve their services.

14. **To nominate and support national OIE Focal Points for Wildlife in their tasks and encourage their collaboration with partner agencies and organizations.**

15. To seek and apply appropriate sampling and diagnostic expertise and validated disease management tools for wildlife diseases, including with the participation of private veterinarians, medical doctors, community workers, fishermen, hunters, rangers, and other stakeholders.

16. To support relevant research to expand the scientific basis for the protection of biodiversity and environment to promote animal health as well as public health.

17. To support systematic inclusion, in the curriculum for veterinary education, of the promotion, the protection and the improvement of animal health and animal welfare including aspects related to wildlife and biodiversity.

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[1] Food and Agriculture Organization of the United Nations, World Health Organization, United Nations Environment Program, International Union for Conservation of Nature, International Council for Game and Wildlife Conservation and Convention on International Trade in Endangered Species of Wild Fauna and Flora

18. To encourage public and private components of Veterinary Services to play an active role in promoting biodiversity and protecting wildlife.

19. **To foster effective communication and collaboration at the national and regional level between different governmental agencies that share responsibilities for the environment and the health of wildlife, livestock and the public.**

20. **To explore and promote opportunities for communication, collaboration and partnerships with relevant public and private organisations having an interest in wildlife management and biodiversity including the tourism industry, private veterinarians and medical doctors, natural park and zoo managers, rangers, hunters, fishermen, conservation associations and local indigenous communities and stakeholders.**

21. To promote the adoption of legislation to clarify or define ownership of wildlife by people and organisations.

Wildlife health risk assessment

Introduction to the Workshop

This one-day Workshop has two main themes:

1. Wildlife Health Risk Assessment: what it is, how to do it and consideration of its strengths and limitations

2. Wildlife health risk as one component of complex issues and a systematic approach for evaluating decision options regarding issues for which there are multiple stakeholders with differing views and values.

This Training Manual contains all of the information that will be presented during the workshop. In addition, it contains instructions for exercises and activities that will take place during the workshop.

Health risk assessment – What is it?

Health risk assessment is the process of evaluating the health risks associated with some activity or event. For animal health issues, a somewhat standardized method for evaluating health risks has evolved over the past 2-3 decades. The OIE presents this basic approach for terrestrial animals in Section 2 of the *Terrestrial Animal Health Code* and for aquatic animals in Section 2 of the *Aquatic Animal Health Code.*

Health risk assessment is, to a large degree, a rigorous application of common sense. Most often, health risk assessments are carried out to identify and evaluate potential health risks so that these can be taken into account in deciding whether or not to carry out the activity for which the risks have been evaluated, or to identify ways in which such health risks might be reduced.

Wild animals frequently are captured in one location, transported a long distance and released in a new location[2]. Such wild animal translocations are carried out internationally or within countries for conservation purposes and for commercial reasons, such as for game farming, the pet trade and zoos. Hides, meat, trophies and other products derived from wild animals are transported internationally in substantial quantities[3]. Wild animal species also sometimes are raised in captivity and then released into the wild, often for hunting and fishing purposes. Wild animals also are captured in the wild and brought into captivity, and often are placed in close proximity to other wild and domestic animal species.

Potential health risks are associated with all such activities and prudent wildlife, veterinary and public health authorities will want to ensure that some assessment of these health risks is made or kept up to date for all such activities.

There are many examples of wild animal translocations that have resulted in unfortunate and costly negative consequences because of associated pathogens and diseases. The current epidemic of rabies in raccoons in eastern North America is one example, as are the massive extinctions of tropical and temperate amphibian species due to chytrid fungus and the precipitous

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[2] Griffith et al. 1993. Animal translocations and potential disease transmission. *Journal of Zoo and Wildlife Medicine*, **24**(3): 231-236, 1993

[3] Chaber *et al.* 2010. The scale of illegal meat importation from Africa to Europe via Paris. Conservation Letters doi: 10.1111/j.1755-263X.2010.00121.x

decline of the European crayfish after introduction of a fungal pathogen on introduced American crayfish[4].

Wildlife health risk assessment is a practical, feasible way to evaluate health risks associated with activities involving wild animals. Nearly all such risk assessments are qualitative; they can categorize risks from high to low to negligible. They do not provide precise numerical estimates of probabilities or employ advanced statistics or modelling. The data available for wildlife health risk assessments almost never permit fully quantitative risk assessment, and such quantitative methods should never be employed unless the data are sufficient to support their application. For wild animals, population size, age and sex ratios, geographic distribution, reproductive rate, infection prevalence and other such data seldom are precisely known, but some data on these parameters usually do exist and it is possible to make a rational qualitative evaluation of health risks in such settings that clarifies uncertainties and provides important and useful risk estimates.

> "Risk assessment may be qualitative, in which case the likelihood of the outcome, or the magnitude of the consequences, is expressed in terms such as 'high', 'medium' or 'low', or it may be quantitative. In quantitative risk assessments the likelihood is expressed in terms such as 'one disease introduction in 100 years of trade' or 'failure to correctly identify one diseased herd out of 100'.
>
> Both qualitative and quantitative approaches to risk assessment are valid and, in fact, every risk assessment must first be conducted qualitatively. Only if further insight is required is it necessary to attempt to quantify the risk. Indeed, as North suggests, quantitative '…risk assessment is best used to develop insights, and not to develop numerical results which might mistakenly be considered to be highly precise."[5]

Qualitative health risk assessment is enormously valuable; its value should not be underestimated. Lives will be saved, biodiversity maintained, costs reduced and economies improved if qualitative wildlife health risk assessment is made a routine practice for animal translocations and other activities involving wildlife.

Who can do a wildlife health risk assessment?

A wildlife health risk assessment can be done by anyone who comes to fully understand the health hazards and their consequences in any particular situation. A veterinary education provides very useful background knowledge for wildlife health risk assessment but so also does a background in wildlife biology. The selection of the consequences that will be considered in a particular risk assessment also will establish the range and kinds of information and understanding that must be included in the evaluation, for example economics, agriculture, social work, food safety, anthropology. This, in turn, helps identify the backgrounds of education and experience that will be needed. Most often, a wildlife health risk assessment must be done by a small team or by an individual who is able to consult with other people who have different backgrounds.

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[4]   Nettles *et al.* 1979. Rabies in translocated raccoons. *American Journal of Public Health*, **69**(6): 601-602; Cheng *et al.* 2011 Coincident mass extirpation of neotropical amphibians with the emergence of the infectious fungal pathogen *Batrachochytrium dendrobatidis*. *PNAS*, **108**(23): 9502–9507; Alderman. 1996. Geographical spread of bacterial and fungal diseases of crustaceans. *Rev. sci. tech. Off. int. Epiz,*, **15**(2): 603-632.

[5]   S.C. MacDiarmid & H.J. Pharo. 2003 Risk analysis: assessment, management and communication. *Rev. sci. tech. Off. int. Epiz.,* 2003, **22** (2), 397-408.

Who should not do a wildlife health risk assessment?

All risk assessments must be done with as much objectivity as possible. However, fully-objective risk assessments seldom are possible. There are subjective elements in every risk assessment: judgements, assumptions, attribution of greater or lesser importance to various elements.

Two important steps should be taken to minimize any bias that might enter a risk assessment through subjective processes:

1. *Independent assessment*: The risk assessor or risk assessment team must do its work independently and beyond the direct influence of the main stakeholders in the issue for which the health risks are being assessed. In particular, they should be independent of the organisation(s) for which the risk assessment is being undertaken, which most often is a management branch of government responsible for making decisions about the proposed wildlife translocation or other activity. Once the details of the activity or issue have been clarified and agreed to with the stakeholders, including the government decision-makers and managers, the risk assessment team should do its work in isolation. The risk assessor or risk assessment team should not have a stake in the outcome of the assessment other than to be as complete and as objective as possible, and to be completely transparent in their evaluation.

   It follows that the main stakeholders in the issue for which the risk assessment is being done should not participate in the risk assessment itself. Government management personnel, animal owners, businesses, conservation groups and others who have a particular interest in the outcome of the risk assessment should not participate in the risk assessment. These stakeholders should participate in defining exactly what activity is being proposed, clarifying all details of the activity and agreeing on what kinds of consequences will be considered and not considered in the risk assessment, so that the risk assessment addresses the real issues and does not miss important points.

2. *Transparency*: Transparency means that nothing in the final risk assessment is hidden from stakeholders. All the information used, the consequences considered and not considered, the way in which the available information was evaluated and used to draw conclusions and the uncertainty associated with all aspects of the assessment must be written into a readable and understandable report that is available to everyone concerned. A risk assessment must be open to review, to challenge, to cross-examination by any and all stakeholders. Although a decision may be made on the basis of a risk assessment as soon as it is completed, each risk assessment should also be viewed as the most recent draft of a document that may change over time if new and different information becomes available or if different approaches to evaluating the available information are brought forward for consideration.

What to do and how to do it – The process of wildlife health risk assessment

The following is a set of guidelines on how to conduct a health risk assessment for a typical translocation of a group of wild animals, captured at one location, and transported and released at a new, distant location. Although these guidelines are for a translocation event, they can be adapted for use in assessing the wildlife health risks in a wide range of different activities or scenarios.

The guidelines presented here are based on the on-line OIE-CW<HC guidelines[6] which, in turn, follow the basic process outlined in the OIE Animal Health *Codes*. They also are informed by insights from the 2011 report of the Council of Canadian Academies' Expert Panel on Approaches to Animal Health Risk Assessment.[7] Guidelines recently published jointly by the OIE and the International Union for the Conservation of Nature (IUCN) provide similar procedural information with an expanded discussion of context and a catalogue of quantitative tools.[8]

Health risk assessment in wild animal translocations

What is "risk"?

In common speech, the word "risk" is often used to mean the same thing as "probability" or "chance". However, when used in the context of "risk assessment" or "risk analysis", the word "risk" has a very specific meaning:

In the context of health risk assessment, the "events" of concern are health hazards of various kinds. Potential health hazards are associated with all wildlife translocations and many other activities involving wild animals or their parts and products.

> Risk: The *probability* of an event occurring <u>and</u> *the magnitude of the consequences* if it does occur.

The <u>two main categories of health hazards in wildlife translocations</u> are:

- That the animals will carry new pathogens into the destination ecosystem that will cause harm to the destination ecosystem.

- That the animals being moved will encounter new pathogens in the destination ecosystem and will be harmed by these new pathogens.

Health risk assessments usually are carried out prior to a proposed translocation of wild animals in order to determine:

a) Whether or not such health risks exist and the probability that each might occur, and

b) The magnitude of the potential consequences if they do occur.

The results of the health risk assessment can then be incorporated into the final decision whether or not to proceed with the translocation. If the decision is made to proceed, but significant health risks have been identified, the risk assessment can guide efforts to reduce those health risks.

The risk assessment report

The product of a risk assessment is a comprehensive written report that documents all steps followed, all of the information considered, the way that information was evaluated to reach conclusions about health risks, and the level of uncertainty in the assessment.

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[6]   available at < http://www.cwhc-rcsf.ca/wildlife_health_topics/risk_analysis/>
[7]   Council of Canadian Academies. 2011. Health Animals, Healthy Canada: The Expert Panel on Approaches to Animal Health Risk Assessment. Ottawa. 253 pp. Available at http://www.scienceadvice.ca/en/assessments/completed/animal-health.aspx
[8]   Jacob-Hoff *et al*. (eds). 2013. Manual of Procedures for Wildlife Disease Risk Analysis. IUCN & OIE, Paris and Gland. 240 pp.

Basic steps in health risk assessment in wild animal translocations

1. *Translocation plan:*
   A complete, detailed description of the wild animal translocation is made. This clearly defines the activity for which health risks are to be determined. It requires full consultation with the proponents and others.

2. *Identification of the consequences to be assessed*
   There are many potential consequences that may arise from health hazards associated with wildlife translocations. Most health risk assessments address only a small number of these. It is important to establish at the beginning of a health risk assessment process which potential consequences will be included in the assessment and which will not be included, and to state this explicitly.

3. *Health hazard identification and selection for full assessment:*
   a. A complete, inclusive list of all potential health hazards is made. Most health hazards on the list will be pathogens and diseases of potential concern, but the list also may include capture and handling methods and other potential health concerns. This step requires much gathering of information. If sufficient information is not available, the risk assessment can be halted or can continue with a high degree of uncertainty. (See "Information Requirements" below).
   b. From the complete list of potential health hazards, the hazards that appear most important are selected for detailed consideration. Often, only a small number of hazards can be fully assessed because of time and cost considerations. The few that will be fully assessed must be chosen with care to represent the greatest potential for a harmful outcome.

4. *Health risk assessment for selected health hazards:*
   a. Risk is assessed for each of the major health hazards selected.
      i. The probability that the health hazard will occur in the translocation program.
      ii. The magnitude of the selected consequences if it does occur.

5. *Overall health risk assessment and statement of uncertainty:*
   a. An overall assessment is made by combining the results of the assessments of each of the major health hazards assessed individually.
   b. Uncertainty: In every risk assessment, absence of certain information limits the precision of the assessment. A statement outlining important areas of uncertainty that have affected the risk assessment is written to give a complete picture of the strengths and limitations of the risk assessment.

6. *Additional hazards and risks*
   a. There may be hazards and risks associated with the proposed animal translocation that are not related to health but that are important to consider in the overall decision. A statement about these hazards should be included in the final risk assessment if any have come to light during the health risk assessment process.

7. *Reduction of risk*
   a. It may be possible to reduce the health risks identified by altering parts of the translocation plan. Where possible, recommendations to reduce risk should be included in the final health risk assessment.

Each of these steps in the risk assessment process is described in more detail below.

Step 1. The translocation plan

Prepare a detailed description of the wild animal translocation to be assessed

The purpose of this step is to clearly define the subject of the health risk assessment. Many aspects of health risk assessment depend on the details of the translocation procedures and, thus, an assessment of risk cannot be done unless all details of the proposed translocation are known. This step also results in a preliminary profile of the kinds of risks that may be associated with the proposed wild animal translocation, which is required in subsequent steps in the risk assessment process.

The following should be included in the description of the translocation:

A. General description

    a. The objectives of the translocation program:
        i. Why is the translocation being undertaken?
        ii. What are the precise goals or objectives of the translocation?
        iii. Who are the proponents of this wildlife translocation?

    b. The animals:
        i. What animals are to be moved? Species, number, age, sex, sizes of groups to be moved or handled together.
        ii. Describe the population(s) from which the animals will be taken and the population(s) into which they will be introduced.
        iii. Is the species being moved rare, threatened, endangered or otherwise a subject of a conservation program? If so, explain how translocation fits in with conservation plans.
        iv. Does the translocation invoke regulations under CITES?[9]

    c. The timing of the translocation:
        i. Date, season, duration, and similar information

    d. The source and destination ecosystems:
        i. Where will the animals come from and to what location will they be moved and released? Define precise geographic locations and the habitats and ecosystems at both source and destination locations. Highlight similarities and differences between the source and the destination ecosystems, including the animal species present in each.
        ii. Are there rare, threatened, endangered or otherwise highly valued species of animals or plants in the destination ecosystem? If so, what effect, if any, will the proposed translocation have on these species or populations?

    e. The methods and veterinary protocols to be followed:
        i. Define the general procedures to be used for capture, handling, holding in captivity (e.g. quarantine), feeding, medical treatments and tests, transportation and release into the destination ecosystem.

    f. Range of potential health risks:
        i. What is the range of potential health-related risks associated with this translocation? What kinds of risks might be associated with this translocation, in broad, general categories? Make a preliminary inclusive list of all potential risks or kinds of risks, for further consideration.(See Step 3, below)

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[9] CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) is an international agreement among governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. http://www.cites.org/

     g.   Supplementary Ecological and Economic Risks:

         i.   Do the animals to be translocated themselves pose any ecological or economic risks to the destination ecosystem? Issues such as subspecies and other genetic concerns, or the potential for the translocated animals to do ecological harm to the destination ecosystem or to compete for resources with indigenous species, predator-prey equilibria, human needs, and similar issues should be listed for further consideration.

       ii.   Does the removal of the animals pose ecological or economic risks to the source ecosystem? Any potential negative impact to the populations, human economies or ecosystems of origin should be listed for further consideration.

B. Prepare a detailed description of procedures and methods to be used in the translocation program

This step requires that there be detailed planning with respect to procedures that can markedly affect the health risk assessment. The description must be of the methods and procedures that actually will be used, not of methods that would be desirable but, in the end, will not be used for various reasons. Health risks can be reduced or amplified by the methods selected. The likelihood that the translocation program will achieve its goals and objectives also may depend importantly on the exact methods and procedures used. This, in turn, also is a factor in weighing the relative risks and benefits of the proposed translocation.

Capture of animals:

How will this be done? Who will do it and what is their experience and expertise? What mortality rate is expected due to the capture procedure? What alternative methods have been considered and why has the described method been chosen?

Transportation of animals:

How will the animals be transported during the translocation? Give full details of duration, loading and unloading facilities and methods, design of transport vehicles, and similar information for all of the means of transportation to be used.

Management of animals in captivity:

Most translocation programs require that animals be held in captivity for a period of time, ranging from hours to months. Where will the animals be kept in captivity? Describe the environment in the immediate area, including other animals, the details of the holding facility, the personnel who will work with the animals and their expertise and experience. How will workers be assessed for diseases they might transmit to the animals in their care? How long will the animals be held in captivity? If animals will be held in more than one facility, give details for all facilities and the duration of captivity in each.

Nutrition:

In most translocation programs, the animals must receive food and water. Explain, in detail, the food and water that will be used, where each will be obtained, the quantities required and how each is to be processed before feeding. What method of feeding will be used (placement of feed, etc.)? What assurance is there that the selected nutritional program will be successful?

Veterinary procedures:

If animals will not be held in quarantine, explain completely why there is to be no quarantine period between capture and release.

If animals are to be quarantined, explain the rationale and objectives of quarantine.

Give details of the quarantine facilities and of procedures that will be used to prevent exposure of animals to indigenous disease-causing agents and to prevent the release into the local environment of disease-causing agents that the quarantined animals may carry. Give details of all tests for infection or disease, and for all medical treatments. Explain why each of these tests and treatments is being applied. Who will secure the necessary samples from the animals for testing? Who will carry out the tests and interpret the results, and what is the expertise or experience of these people? What tests will be done? Where will the tests be done? Is the sensitivity and specificity of the tests known, as applied to the species of animals being translocated? If animals are to be excluded or included in the translocation on the basis of tests for infection or disease, exactly how will these decisions be made and who will make them? Will groups of animals be tested and either included in, or excluded from, the translocation program as groups, or will animals be tested and judged individually? What procedures, if any, will be used to keep groups of animals or individual animals separate during captivity and transportation?

Release:

What methods or procedures will be used to introduce the animals into the destination ecosystem? Will release be immediate upon arrival, or delayed by a period of captivity at the release site? Why has the method to be used been selected? What has been the result of the use of this method in similar situations elsewhere?

Will the methods and procedures to be used result in the release at the destination location of a sufficient number of animals in a sufficiently good state of health to achieve the goals and objectives of the animal translocation program? In other words, what is the probability that the goals and objectives will be achieved? Are their significant uncertainties associated with estimating this probability? Can the uncertainty be reduced by some means?

How will the goals and objectives of the translocation program be measured? In other words, what sort of population assessments, surveys of reproductive success, etc. will be undertaken to determine whether or not the translocation program has succeeded?

C.   Consult with translocation program managers, decision-makers and stakeholders

It is essential to find out what the managers and decision makers associated with the translocation really need to know from a health risk assessment. Sometimes, decisions have already been made at a political level, or a limited range of decision options have already been established for a wildlife translocation or other activity before a health risk assessment is undertaken. For example, it may be decided already that the translocation will take place regardless of the outcome of the health risk assessment and the main focus of the risk assessment is to identify the risks and to propose ways to minimize them. It may have been decided already that only one disease or pathogen is of concern and the health risk assessment is to evaluate only risks associated that pathogen. The consultation with managers and decision-makers is to ensure that the health risk assessment addresses the real issues in their real-world context and is not a theoretical exercise that does not support the real decisions that must be made.

Step 2. Selection of consequences to be included in the risk assessment

There are many different kinds or categories of negative consequences that can be associated with the occurrence of wildlife health hazards associated with wildlife translocations or other events.

Categories of consequences or potential negative impacts

Consequences for:

- ➢ Animal health
- ➢ Animal welfare
- ➢ Human health
- ➢ Human economies
- ➢ Environments and ecological services
- ➢ Human social, cultural and psychological well-being
- ➢ Politics and governance
- ➢ National security

It is rare that all categories of potential consequences are included in an animal health risk assessment. Almost always, only a small sub-group of consequences are considered. However, it is essential that the consequences to be included are identified early in the risk assessment process and in consultation with all stakeholders. [10]

The selection of which consequences are to be considered in a risk assessment determines the content, scale and usefulness of the of the risk assessment.[10]

The protocols for animal health risk assessment followed by many national and international organisations generally fail to give sufficient attention to the selection of the consequences to be included in the risk assessment. Often, is it simply assumed that the consequences to be included are the consequences of concern to a particular agency or group, and there is no explicit selection of the consequences to be included and excluded. This may be acceptable in a risk assessment done in a very limited context, but wildlife translocations and other wildlife management activities often have numerous stakeholders with different interests and values. If, at the beginning of a risk assessment, they do not agree on which consequences will and will not be included, it is very likely that the risk assessment will be rejected after it is completed, either because important potential consequences were not addressed or because consequences of no relevance to the decision at hand were the focus of the assessment. Thus, it is essential that the consequences to be included in a wildlife health risk assessment be discussed and agreed upon by the stakeholders, including the managers and decision-makers who will use the outcome of the risk assessment, at the beginning of the risk assessment process.

In most cases, it will be decided that certain categories of consequences will be included and others will not. This provides important guidance to the risk assessment team as it proceeds with the subsequent steps of the risk assessment. It also is an important part of ensuring that the risk

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[10] Council of Canadian Academies. 2011. Health Animals, Healthy Canada: The Expert Panel on Approaches to Animal Health Risk Assessment. Ottawa. pp 88-103. Available at
http://www.scienceadvice.ca/en/assessments/completed/animal-health.aspx

assessment will address the main issues for which it is being conducted. Chapter five of the report on animal health risk assessment by the Council of Canadian Academies provides a more complete consideration of consequence selection in animal health risk assessment. [11]

Who are the stakeholders?

"Stake-holders" are all of the people and organisations who will be affected in some way by potential health hazards associated with the wildlife translocation or other wildlife activity for which the health risks are to be assessed. Stakeholders may be affected directly (e.g. a farmer's cattle die from an imported disease) or indirectly (e.g. loss of employment when an abattoir closes) by the potential health hazards.

The stakeholders will probably be different for each wildlife translocation or activity. Thus, an important component of each wildlife health risk assessment is to determine who the stakeholders are and to include them in Steps 1 and 2 of the risk assessment process (1. The Translocation Plan; 2. Selection of Consequences to be Included).

Stakeholders will include both the people and groups who will benefit from the wildlife event (the beneficiaries) and those who may be harmed by the wildlife event and its associated potential health hazards (the risk-bearers).

Potential <u>STAKEHOLDERS</u> in wild animal translocation events

- Government agencies (at source and at destination)
  - Wildlife and fish
  - Veterinary Services/Agriculture
  - Health
  - Environment
  - International Trade
  - Border Services
  - Indigenous people

- Source environment:
  - Local communities (value of wildlife)
  - Local businesses
  - Local land owners

- Destination environment
  - Local communities (value of wildlife)
  - Local businesses
  - Local land owner

- Non-Government groups (national, international)
  - Conservation
  - Hunter/Harvester
  - Heritage and history
  - Forestry
  - Fishery
  - Mining
  - Other industrial

- International Organizations
  - CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora)
  - OIE
  - FAO
  - WHO
  - IUCN

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[11]   Council of Canadian Academies. 2011. Health Animals, Healthy Canada: The Expert Panel on Approaches to Animal Health Risk Assessment. Ottawa. PP 88-103.. Available at
http://www.scienceadvice.ca/en/assessments/completed/animal-health.aspx

Step 3. Identification of health hazards[12]

Identify the potential health hazards associated with the proposed animal translocation

This step involves making a complete, inclusive list of all imaginable health hazards that might be associated with the proposed translocation. 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. This step also includes identifying sources of information about health hazards and related matters, and an assessment as to whether or not there is sufficient information to make health risk assessment possible.

A major challenge of risk assessment is finding the information needed to identify health hazards and to assess their risks.

A. Hazard identification:
a. Make a comprehensive, 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):
   i. Pathogens and diseases on the OIE List that:
      1. Exist in the source ecosystem
      2. **And** may be carried by the species to be translocated.
   ii. Other disease-causing agents that:
      1. May cause disease in the species to be translocated
      2. May cause disease in other species in the destination ecosystem

b. Make a comprehensive, inclusive list of all infectious agents and diseases present in the destination ecosystem to which the animals to be translocated may be susceptible.
   i. Include any diseases in wildlife, domestic animals or humans in the destination ecosystem that may affect the species to be translocated.

c. List the animal species in the destination ecosystem that may share infectious agents or diseases with the species to be translocated.

d. List all live biological medical preparations, such as live vaccine viruses, to which the translocated animals will be exposed and which they may carry into the destination environment.

e. List agricultural, forestry or environmental practices in the destination ecosystem, such as use of toxic pesticides on crops or for vector control of human and animal diseases, that may affect the health of the animals to be translocated and released into the destination ecosystem.

f. Define the basic nutritional and related habitat requirements of the animals to be translocated, and document whether or not the destination ecosystem will provide adequate nutrition and similar needs for the animals once they are released.

g. Evaluate the veterinary services, animal disease surveillance and control programs, wildlife services, population surveillance and census information for both source and destination environments and jurisdictions. Determine whether or not these are sufficient to furnish the information required in the risk assessment and to function in the manner specified in the Translocation Plan. (Guidelines for evaluation of veterinary services are given in the OIE *Terrestrial Animal Health Code.*)

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[12] In this Training Manual a "health hazard" is an infectious organism, a toxic substance, a nutritional problem, or any event or agent that may have a negative impact on the health of humans or animals. Most of the examples used in this Training Manual are health hazards that are infectious pathogens.

B. Make a preliminary evaluation of the potential health hazards identified
  a. Is the information that is available sufficient to proceed with a risk assessment?

      Has it been possible to compile credible, inclusive lists of potential health hazards and associated biological information, as outlined above?

      i. If the answer is "no", consider abandoning the translocation program until sufficient information can be assembled.
          1. Alternatively, acknowledge that the translocation, if it takes place, will occur without assessment of disease-associated risks, and discontinue the risk assessment process.
      ii. If the answer is "yes", proceed with health risk assessment.

  b. Emphasis should be given to diseases or infectious agents that:
      i. May be carried by the animals to be translocated from the source ecosystem to the destination ecosystem,
          AND may infect or cause disease in one or more wild or domestic animal species, or in humans, in the destination ecosystem, including the translocated animals themselves,
          AND may have significant consequences if they are introduced into the destination ecosystem.

      This criterion places particular emphasis on diseases or infectious agents that are present in the source ecosystem and absent from the destination ecosystem.

      ii. Are present in the destination ecosystem
          AND may cause significant harm to the animals that are to be translocated.

Review the subset of health hazards thus selected, and either proceed to estimate the risk associated with each one, or choose a smaller number of health hazards that appear to represent the greatest hazards, and proceed to estimate the risk associated with each.

Step 4. Assessment of health risks

Estimate the risk associated with each selected health hazard

For each health hazard selected for further assessment in Step 3, above, risk must be estimated.

These two components sometimes can be estimated in terms of numerical probability and numerical values for the magnitude of consequences. Most often, however, numerical estimation of risk will not be possible and wildlife health risk estimates will be qualitative (High, Medium, Low, etc.).

In wild animal translocations for which infectious organisms are the health hazards of concern, risk must be considered with respect to two different kinds of health concerns:

> **There are two components of risk:**
> - 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.

Risk A: The *probability* that **diseases or infectious agents will be carried by the translocated animals** into the destination ecosystem and the *magnitude* of harm that will result if this occurs.

Risk B: The *probability* that the **translocated animals will be exposed to health hazards in the destination ecosystem** and the *magnitude* of harm that will result if this occurs, including the harm done to the goals and objectives of the translocation program itself.

A. Estimation of the risk associated with pathogens that may be carried into the destination ecosystem

    a) Estimate the probability that pathogens will arrive in the destination ecosystem

(This is called the "entry assessment" in the OIE *Terrestrial Animal Health Code* and "release assessment" in the IUCN guidelines).

To estimate this probability for the health hazard under consideration, the analyst must consider at least the following factors and how each may influence the probability that susceptible species (wild or domestic animals, or people) in the destination ecosystem will be exposed to the pathogen of concern.

    i. The nature of the disease-causing agent

    ii. The anticipated range and distribution of the released animals

    iii. The presence of potential pathogen vectors

    iv. Calendar period of translocation and release

    v. Primary, secondary and intermediate hosts of the disease-causing agent in the destination ecosystem: number, variety and distribution

    vi. Human and animal numbers and distribution in the destination ecosystem

    vii. Mode of transmission of the pathogen

    viii. Relevant customs and cultural practices in the destination ecosystem

    ix. Animal health legislation and compliance

    x. Biotic and abiotic factors that affect the pathogen's survival

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Guidelines

Estimating and rating qualitatively the probability that a pathogen will enter the destination ecosystem with the translocated animals.

Rating = Negligible	The probability of entry is extremely low or negligible given the combination of factors described above.
Rating = Low	The probability of entry is low but clearly possible given the combination of factors described above.
Rating = Medium	Entry is likely, given the combination of factors described above.
Rating = High	Entry is very likely or certain, given the combination of factors described above.

b) **Estimate the probability that susceptible species in the destination ecosystem will be exposed to the pathogen.**

(This is called "exposure assessment" in the OIE *Terrestrial Animal Health Code* and in the IUCN guidelines)

To estimate this probability for the health hazard under consideration, the analyst must consider at least the following factors and how each may influence the probability that susceptible species (wild or domestic animals, or people) in the destination ecosystem will be exposed to the pathogen.

    i. The nature of the pathogen

    ii. The anticipated basic reproductive number (R_0) of the pathogen

    iii. The anticipated range and distribution of the released animals

    iv. The presence of potential vectors of the pathogen

    v. Calendar period of translocation and release

    vi. Primary, secondary and intermediate hosts of the pathogen in the destination ecosystem: number, variety and distribution

    vii. Human and animal numbers and distribution in the destination ecosystem

    viii. Mode of transmission of the pathogen

    ix. Relevant customs and cultural practices in the destination ecosystem

    x. Animal health legislation and compliance

    xi. Biotic and abiotic factors that affect the pathogen's survival

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Guidelines

Estimating and rating qualitatively the probability that susceptible species in the destination ecosystem will be exposed to the pathogen

Rating = Negligible	The probability of exposure of susceptible hosts is extremely low or negligible given the combination of factors described above.
Rating = Low	The probability of exposure of susceptible hosts is low but clearly possible, given the combination of factors described above.
Rating = Medium	Exposure of susceptible hosts is likely, given the combination of factors described above.
Rating = High	Exposure of susceptible hosts is very likely or certain, given the combination of factors described above.

c) **Estimate the *magnitude of negative consequences,* in the event that the pathogen of concern is carried into the destination ecosystem by the translocated animals and infects susceptible species in that destination ecosystem.**

The factors to be considered will be different for each category of consequence included in the health risk assessment. The ranking approach given in the previous two tables can be adapted to the each of the categories of consequences to be considered.

For example, if the consequence of concern is the negative impact on wild animals in the destination ecosystem resulting from infection with a pathogen carried into the destination ecosystem by the translocated animals, the analyst should consider at least the following factors:

  i. Range and number of potential susceptible hosts (wildlife, domestic animals, humans)

  ii. Nature and severity of disease caused in each potential host species

  iii. Morbidity and mortality rates by species, age

  iv. Impact on host longevity, reproduction, susceptibility to predation

d) **Estimate the magnitude of the consequences included in the risk assessment (Step 2) on the destination ecosystem as a whole. (The example below considers broad ecological consequences but can be adapted to include other consequences.)**

To estimate the magnitude of ecological consequences, for example, the analyst must consider at least the following factors:

  i. Impact on biodiversity

  ii. Impact on material cycling, energy flow, animal and plant population and community dynamics, predator-prey relationships, soil fertility and retention, water cycles and retention, carbon retention, oxygen production

  iii. Impact on endangered or threatened species

  iv. Impact of any mitigation efforts that may result if the pathogen is introduced to the destination ecosystem

B. **Estimation of the probability that the animals being translocated will be affected by pathogens present in the destination ecosystem**

This outcome would jeopardize the success of the translocation program. If the probability is high, the objectives of the translocation program may not be achieved.

This outcome is not considered in the OIE *Terrestrial Animal Health Code* because the *Code*, by agreement among OIE members, considers only health risks to the importing nation. However, wild animals commonly are translocated for conservation purposes in programs that represent partnerships among countries. Source and destination countries often share the cost of such translocation programs, or they are borne by a third party. Health hazards in the destination ecosystem that may affect the animals being translocated are, therefore, of importance to all parties.

Health hazards that the translocated animals may encounter in the destination ecosystem must be identified during Step 3 - Identification of Health Hazards, and the risk associated with the most important of these hazards must be assessed as outlined here.

a) Estimate the probability that the translocated animals will be exposed to health hazards of concern in the destination ecosystem.

To make this estimate, the analyst must consider at least the following factors:

i. The prevalence of the pathogen or other hazard in the various host populations in the destination ecosystem

ii. The number, density, and seasonal distribution of host species in the destination ecosystem

iii. Modes of transmission of the pathogen

iv. Presence and population biology of vectors and intermediate hosts

v. Anticipated behaviour, number, density, and seasonal distribution of the translocated animals and of their progeny over time

vi. Immune status of the translocated animals

vii. Calendar period and duration of translocation and release program

viii. Effectiveness of any procedures taken to reduce the probability of exposure

ix. When non-infectious health hazards are of concern:

1. Nature, number, density and distribution of predators, hunters, physical hazards such as highways, poisonous substances (plants, botulism, pesticides, contaminants) and previous familiarity of translocated animals with these health hazards.

2. Presence and abundance of alternative prey species for important potential predators, throughout the calendar year.

Guidelines

Estimating and rating qualitatively the probability that the translocated animals will be exposed to the health hazard of concern in the destination ecosystem.

Rating = Negligible	The probability that the translocated animals will be exposed to the health hazard of concern in the destination ecosystem is extremely low or negligible, given the combination of factors described above
Rating = Low	Such exposure is unlikely but clearly possible, given the combination of factors described above
Rating = Medium	Exposure is likely, given the combination of factors described above
Rating = High	Exposure is very likely or certain, given the combination of factors described above

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b) Estimate the magnitude of consequences (Step 2) that may result if the translocated animals are exposed to the health hazard of concern.

The negative impacts of greatest concern are the potential negative consequences for the objectives and goals of the translocation program. To estimate the magnitude of these consequences, the analyst must consider at least the following factors:

   i. The nature and severity of the health hazard of concern to the translocated species

   ii. Morbidity and mortality rates due to the health hazard

   iii. The anticipated basic reproductive number (R_0) of the pathogen in this setting.

   iv. Impact on longevity, reproduction, susceptibility to predation, and overall survival and maintenance or growth of the translocated population

   v. Duration of the negative consequences on the health and survival of the translocated animals

   vi. The cost of the translocation program

   vii. Economic gain that will not be realized if the translocation is a partial or complete failure

   viii. Cost of any mitigation efforts that might be undertaken, such as re-capture or treatment

   ix. Ecological costs to the source ecosystem from removal of animals that are translocated

   x. Objectives and goals of the translocation program that will be not be realized because of the health hazard of concern (if not covered in the above list of factors)

Guidelines

Estimating and rating qualitatively ecological or economic consequences of exposure to the health hazard under consideration

Rating = Negligible	Little or no impact on the goals and objectives of the translocation program and little or no ecological or economic harm
Rating = Low	Minor impact on the goals and objectives and/or minor ecological or economic harm
Rating = Medium	Moderate impact on the goals and objectives and/or moderate ecological or economic harm
Rating = High	Severe impact on the goals and objectives and/or severe ecological or economic harm

C. Statement of risk for the individual health hazard

Write a statement of the risk associated the health hazard that has just been assessed. To make this statement, the risk assessor must weight all the evidence and decide whether the risk is negligible, low, medium or high. The assessor must explain this judgement in a clear statement.

There are no formulas for weighing the information on the probability that the health hazard will occur and the magnitude of consequences if it does occur and deciding what level of risk should be attributed to the health hazard. If both probability and magnitude are judged to be "medium", then it is likely that the risk is medium also. However, the probability of occurrence of a health hazard might be low but the magnitude of consequences high. Depending on the details of the situation under consideration, the assessor may conclude that the risk associated with this health hazard is high (consequences outweigh probability), low (probability outweighs consequences) or medium (probability and consequences given equal weight).

> The process of assessing risk A and risk B is now repeated for each health hazard selected for detailed assessment until all of the hazards selected for detailed risk assessment have been evaluated.

The assessor or assessment team must make this judgement, and write a clear statement about the level of risk and the basis for this conclusion.

Step 5. Assessment of overall health risk

Write a statement of overall risk from the potential health hazards assessed

This step in the Risk Assessment Procedure has two parts:

A. Prepare a concise statement that summarizes the estimated risks for each health hazard you have assessed individually and then makes <u>an overall assessment of the risk associated with all of the assessed health hazards</u>, considered together

The analyst must state the <u>overall</u> health risk associated with the wildlife translocation or other wildlife event:

"The health risk associated with this wildlife translocation is
_____"
(negligible, low, medium, high)

The assessor or assessment team must make this judgement, and write a clear statement explaining, in summary form, the reasons for this risk rating.

This overall rating can incorporate numerical estimates of risk where these are possible, but makes an overall qualitative rating of the combined estimated risks following the guidelines below:

Guidelines

Estimating and rating overall health risks in wild animal translocations

Rating = Negligible	The probability of any negative impact from health hazards is negligible and/or the magnitude of impact, should health hazards occur, is negligible
Rating = Low	Significant negative impact from health hazards is unlikely but clearly possible
Rating = Medium	Significant negative impact from health hazards is likely, and/or the magnitude of the negative impact could be high
Rating = High	Significant negative impact from health hazards is very likely or certain, and/or the magnitude of negative impact will be very high

B. Summarize the sources of uncertainty and their magnitude in this estimation of risk

It is essential that the overall risk assessment be accompanied by a statement about the major uncertainties the analyst encountered in carrying out the risk assessment. This will ensure transparency, as specified in the OIE Animal Health *Code*, and also is needed so that a better risk assessment can be carried out in the future if some of the uncertainties are resolved.

The analyst must provide a concise statement about the adequacy of the information that was available and was used for this health risk assessment. The statement should identify any conflicting information and how this conflict has affected the overall risk assessment, and should identify the most important areas of uncertainty in the risk assessment.

Step 6. Additional hazards and risks

Write a statement about additional hazards and risks

There may be hazards and risks associated with animal translocations that are not related to health, yet which are important to consider in overall decision-making, and which come to the analyst's attention during the health risk assessment. A statement regarding these hazards should be written as part of the health risk assessment report. The purpose of this step is to draw attention to potentially important issues associated with the wildlife translocation that fall outside of the assessment of health risks. Further consideration of these issues can then be undertaken if needed by analysts with the appropriate knowledge and background. Two examples of the kinds of non-health risks that might be noted are:

A. Ecological and economic hazards to the **destination** ecosystem associated with the presence of the translocated animals themselves.

Do the translocated animals have the potential to alter the destination ecosystem in a substantial way? Will they alter the gene pool in undesirable ways? Will they compete with other species and affect their populations? Will they alter vegetation? Will their population growth be controlled by ecological processes such as predation or food supply? Will these potential ecological changes have significant impact on human cultures or economies?

B.   Ecological and economic hazards to the source ecosystem associated with removal of the animals to be translocated

Will there be significant consequences for the source ecosystem associated with removal of the animals to be translocated? Will removal affect populations in the source ecosystem, alter predation patterns, alter vegetation, alter gene pools, or harm human cultural practices or economies?

Step 7. Reduction of risk

Make recommendations to reduce health risk

It may be possible to reduce the health risks identified by the risk assessment process by altering some of the procedures of the proposed translocation program. Choice of source and destination ecosystems, capture, handling, transportation, quarantine and release procedures, veterinary procedures such as testing for pathogens, therapeutic treatments and preventive measures such as vaccinations, numbers of animals, sizes of animal groups, and other details may be changed in ways that substantially alter health and other risks that have been identified.

Where possible, the analyst should make recommendations to reduce risk, and the risk of the relevant hazards should be re-estimated under the conditions of these recommended procedural changes.

This section sometimes is the most important component of the health risk assessment. If decision-makers choose to proceed with an animal translocation and accept the level of health risks that have been identified by risk assessment, they also often will ask that all steps be taken to reduce the health risks associated with the translocation. Thus, this section of the assessment should receive detailed attention.

A concise statement about the degree to which risk from individual health hazards and overall risk can be reduced by the recommended procedural changes should then be prepared.

Risk analysis and decision making

The decision as to whether or not to proceed with the proposed animal translocation or to make changes to the proposed translocation plan will be based partly on the formal health risk assessment but also on additional factors. Perceptions of the relative importance of the risks and benefits of the proposed translocation will be affected by social, economic and political factors as well as by the formal health risk assessment itself. The health risk assessment should provide an accurate, transparent, scientifically valid estimate of the health risks associated with the translocation so that these can be taken into consideration in decision-making and other regulatory processes.

Decision-making, and implementation of the decisions made, often are spoken of as components of "Risk Management" and "Risk Communication;" these topics are considered in the OIE *Terrestrial Animal Health Code*.

Health risk assessment – Table-top exercise in small groups

You now will work in small groups to carry out a wildlife health risk assessment following the process outlined in this Training Manual (above)

Background - Bison for Atlantis[13]

In the spring of 2008, a tourist exploring the beach below the high soil cliffs of the Mallotus Islands along the southwestern coast of the Dominion of Atlantis found what she thought was a cow's skull deeply buried in the soil sediments. The skull was retrieved and determined, by a local historian, to be that of an American Bison, proving, it was said, that bison once had been native wild animals of this isolated island nation.

The finding generated much interest and launched a popular movement to have bison restored to Atlantis. This cause was taken up by the international NGO Bison Conservation International. During national elections in 2013, the winning political party had made re-introduction of bison a feature of its electoral campaign and the Ministry of Tourism was instructed to develop a re-introduction plan for approval and implementation by 2016. The Ministry of Tourism has proposed the following re-introduction plan:

Ministry of Tourism Bison Re-introduction Plan

<u>Objective of Bison Re-introduction Program</u>:

To establish a herd of at least 400 wild American bison (plains subspecies) on the Mallotus Islands of the Dominion of Atlantis:

- Bison to be free of all OIE-listed pathogens
- Bison population to be self-sustaining, requiring no food or other care provided by humans
- Bison to be accessible for public viewing and for a small sustainable annual harvest by hunting

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Health risk assessment

The proposal to establish a herd of bison in The Dominion of Atlantis has alarmed some groups in the country. In particular, the livestock and food industries, which are very important to the national economy, are concerned about possible importation of pathogens that would affect international trade in animals or animal products. Accordingly, the country's Chief Veterinary Officer has assigned her OIE Focal Point for Wildlife to carry out a health risk assessment on the

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[13] *Atlantis* is not a real country. It does not exist. It was invented for teaching purposes. See Appendix 1 for basic information about *Atlantis*

proposed translocation of American bison to Atlantis, following the OIE/CWHC Guidelines[14] for such health risk assessment.

Related issues

Other groups have raised additional concerns about this translocation.

- The highly-specialized sheep industry of the Mallotus Islands does not think the habitat can support both sheep and bison, and wants no bison to be placed on these islands. Sheep are particularly important to the Atlantis economy. An ancient breed of sheep was brought to Atlantis by Vikings in the 8th Century (Current Era) and has persisted on the Mallotus Islands since that time. They have a unique rich dark yellow fleece, now of great commercial value, and produce 4-6 lambs per ewe per year while grazing year round without supplemental feed. They also are world-renowned as a dairy breed for production of exquisite and unique sheep milk cheeses.

- Calliope International, an animal rights and welfare group, is concerned that the bison will not survive on the Mallotus Islands, citing a failed attempt at introduction of bison from the same source herd to similar habitat in Canada, on Brunette Island, Newfoundland, in 1964; most of these animals died from falling off cliffs in winter. They propose that the bison be re-introduced, instead, to national parks or protected areas on the mainland part of Atlantis.

- The Anguille Original Peoples Council and the Atlantis Natural History Club both have expressed doubt that bison were formerly part of the native fauna of Atlantis (there is no word for "bison" in the Anguille language) and concern for the conservation of Dirk's Storm Petrel (*Oceanodroma vanlunii*), a small (50 g) marine bird with a global population of only 1000 breeding adults, all of which nest in shallow burrows on the grassland of the Mallotus Islands. This grassland nesting habitat is maintained by the grazing of sheep. This storm petrel also is the totem[15] the Anguille people.

- The Golden Fleece Sheep Breeders Association of Atlantis is concerned that the release of bison will cause the Mallotus Islands to be classified as a national park or nature reserve, a change in land classification that they feel would result in exclusion of their sheep from the islands, which would end the 1300 years of unique association of this special breed of sheep with these islands.

- An American firm, Aggregate Exports Inc., has filed a legal claim to the mineral rights to these islands, which are composed 85% of construction-grade stone aggregate (gravel). The firm plans to export all of this material over the next 50 years, reducing the islands to a series of underwater reefs. Reclassification of the islands as a park or reserve could exclude such mineral extraction, already blocked temporarily by law suits filed against the American firm by the Golden Fleece Sheep Breeders Association and the Anguille Original Peoples Council. The proposed extraction of stone aggregate would create approximately 200 high-salaried year-round jobs for 50 years, which would contribute an estimated total of $2 billion to the local economy over that period 50-year period. The Business Association of the regional town and commercial centre, Fastbuck, supports the extraction of stone aggregate as the best option for the Mallotus Islands.

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[14] Included in the Training Manual, and on line at
http://www.cwhc-rcsf.ca/wildlife_health_topics/risk_analysis/
[15] Totem: Cultural symbol of the people and with which the people feel a deep spiritual attachment

Your boss, the Chief Veterinary Officer of Atlantis, has assigned you to carry out a health risk assessment of the bison translocation plan proposed by the Ministry of Tourism.

You have 2 hours to complete this assignment.

☞ Step 1. – The translocation plan (30 minutes)

Read the Translocation Plan Carefully
(5 minutes)

Bison for Atlantis:
Translocation plan

Thirty (30) American bison (plains subspecies) will be moved from Elk Island National Park in western Canada to the Mallotus Islands in Atlantis, each year for five years (150 animals over 5 years). The methods used to select, transport and release these bison will be the same as used in previous, successful translocations of bison from the Park to locations within Canada and to eastern Russia (http://www.cbc.ca/news/canada/calgary/story/2013/03/29/calgary-elk-bison-alberta-russia.html)

- Animals will be selected during annual winter trapping and held in a double-fenced pen out of contact with other Park ungulates for 60 days before transport out of the Park (health quarantine)

- All animals will be tested for exposure to *Mycobacterium bovis* and *Brucella abortus* while in quarantine. The program will be terminated if there is a positive test from any animal.

- All animals will receive two treatments with a broad-spectrum anti-parasite drug to reduce or eliminate internal and external parasites.

- Animals will range in age from 8 months to 4 years, 30% male, 70% female.

- In April each year, the animals will be loaded into transport crates, trucked to the Edmonton International Airport (60 km drive) and sent by air to Bigtown International Airport in Atlantis (6 hour flight). They will be sent by truck immediately to the town of Fastbuck and then by ferry to one of three release sites on each of the three main islands. Total travel time is estimated to be 18 hours.

  o All animals moved each year will be released at one site so as to retain the social relations established within the group during the quarantine period

- Each release site will consist of a fenced paddock enclosing 5 hectares of grassland habitat, shelter and a natural water source. Good-quality hay will be provided and the gates of the enclosure will remain closed for 60 days after arrival. Then the gates will be opened but hay will be provided for another 2-4 weeks until the bison move away and do not return for food or shelter.

- A veterinarian will travel with the bison, remain on site for the first week after arrival and inspect the animals weekly until they disperse from the release site.

- All animals will be marked individually with subcutaneous transponders. Four mature cows will be fitted with GPS collars so the location of the animals can be tracked remotely.

- Aerial surveys of the bison will be conducted once every 3 months following release and this will continue until stable behaviour and numbers are established and documented.

NEXT – Inform yourselves about:
- The Source Ecosystem
- The Destination Ecosystem

by reading the pages below **(20 minutes)**

To save time:

- Half of each small working group can read about the Source and half about the Destination (10 minutes).

- Then explain the main features of the Source and the Destination ecosystems to the other members of the group (5 minutes each = 10 minutes).

Then move on to Step 2………

Source ecosystem: Elk Island National Park, Canada

Location: Elk Island National Park is located 27 km east of the city of Edmonton (population 820,000) on the northern Great Plains in Canada (see map, above). It is 194 km² in total area and is completely enclosed by a 2 m high perimeter fence which prevents movement in or out of the park by large ungulates. It is surrounded by agricultural land (mostly grain crops and beef cattle).

Geology: This Park is located on sedimentary soils typical of the Great Plains of North America. The terrain is one of slightly mounded flat prairie.

Vegetation: The Park is in a soil and vegetation zone known as "parkland," which is the transition zone between open grassland to the south and the forest to the north. Currently, the park is mostly forest, dominated by trembling aspen and white spruce, interspersed with fescue grassland meadows.

Diets of plains bison in Elk Island National Park

Season	Grasses (%)	Sedges (%)	Forbs (%)	Woody Plants (%)
Spring	29	65	6	0
Winter	18	82	0	0

Animals: Elk Island National Park is famous for its easily-seen dense and co-mingling populations of large ungulates: American bison (*Bison bison* – 1-5 per km²), elk (*Cervus elaphus* 3-5 per km²), moose (*Alces alces* 1-5 per km²), and both mule and white-tailed deer (1-3 per km² in total).

Large ungulate populations in elk Island National Park	
Plains bison	450
Moose	110
Elk	345
Mule and white-tailed deer	306

There are no predators of bison, elk or moose in the park, and the population size of each of these species is controlled by removal of animals from the park population as required to prevent destruction of habitat.

The plains bison herd was established from bison purchased by the Government of Canada from private American herds in 1907. There have been no new introductions of bison or elk since the early 1900s.

Human activities: The Park is visited by thousands of people each year. There is no physical separation (no fences or barriers) between Park visitors and the wild animals in the Park. Hiking and nature viewing are the principal reasons people come to the Park. Immediately outside the park, the main activity is farming, both crops and livestock.

Destination ecosystem: the Mallotus Islands
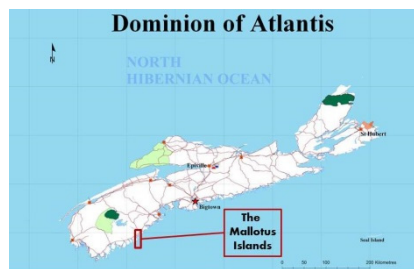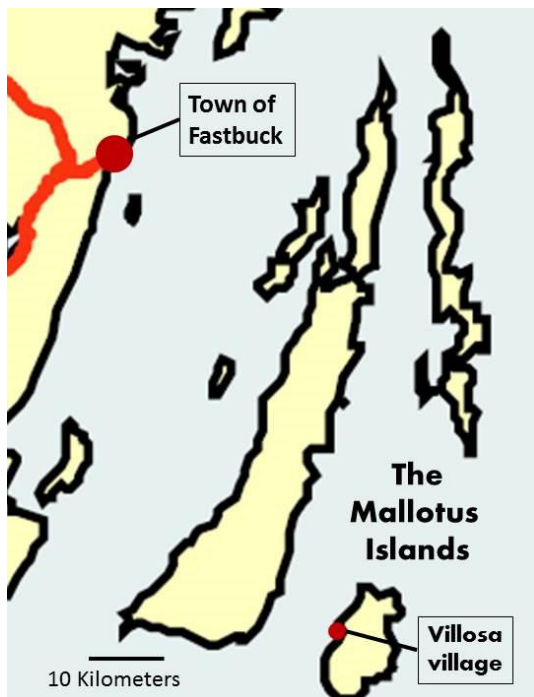
Location: The Mallotus Islands consist of three main islands and many smaller ones, all 15-20 km from the southwest coast of the Dominion of Atlantis. The three largest islands are approximately 10 x 50 km (50,000 hectares), 5 x 25 km (12,500 hectares) and 8 x 15 km (12,000 hectares) in size (maps above).

Geology: The islands are flat-topped mounds of stone aggregate (gravel), generally 100-300 meters above sea level, with steep cliff edges formed either of the stone aggregate or of underlying sandstone which is exposed in some areas (photo above). Topsoil is a rich but stony, sandy loam, averaging 50 cm in thickness.

Vegetation: The dominant vegetation is a mixture of grasses and sedges that grow abundantly on the thick and fertile topsoil layer. Grazing by sheep has prevented woody vegetation from growing on the extensive grassland areas. Willows dominate areas along streams, and slopes commonly are covered by a native species of spruce tree.

Animals:

- Domestic sheep are the dominant mammal on the islands. About 65,000 hectares (87% of the land surface) of the three main islands consists of grassland and are used for grazing sheep. There are approximately 130,000 sheep on the three main islands.

- There are no other wild or domestic ungulates or carnivores. There are no rodents. Domestic dogs are used to herd sheep but are strictly controlled.

- Wild birds are abundant, especially ground-nesting marine birds which require nesting areas free of mammalian predators. Of particular note are the breeding populations of Dirk's Storm Petrel (*Oceanodroma vanlunii*). These birds nest in shallow burrows in the grassland zones on each of the three main islands. These are the world's only breeding colonies of this species. In total, there are about 1000 adults of this species on the islands; their nest burrows are distributed somewhat randomly across the 65,000 hectares of grassland and are found only on grassland. About 40,000 (40% of the population) of the native Atlantis Goose nest on the islands and live there year round.

Human activities:

- The smallest of the three main islands is reserved for sheep dairy production and Villosa, a village of about 500 people, is located there. The people of Villosa tend and milk the sheep and process the milk. These dairy sheep are housed in winter and are fed grain in addition to grazing.

- There are no permanent settlements on the other two islands. Sheep on these islands are raised for meat and for their deep yellow fleece. Sheep owners are licensed and permitted to manage specified numbers of sheep on these islands, which are managed as a cooperative. Several sets of permanent buildings are present along the coast to serve as temporary residences and work stations.

- Fishing was an important economic activity around these islands in the past, but fish stocks disappeared about 50 years ago and commercial fishing is neither permitted nor profitable.

- Tourism is a major economic activity. Hiking on the islands to view birds and the ancient breed of sheep, boat tours of the islands, and direct access to the artisanal cheese and fleece products of the islands brings 30,000 visitors to the islands each year and contributes much to the economy of Villosa and of the regional commercial centre of Fastbuck (approximately $20 million is spent each year in the region by island tourists).

- Goose hunting is permitted for 6 weeks each year and approximately 500 hunters each spend about $1200 in the region annually ($600,000 annual total).

- Wildlife management activities provide approximately 10 full-time jobs for biologists, technicians and clerical staff. Salaries, transportation, materials and related activities result in expenditure of about $2.5 million each year in the region by government.

Step 2 – Selection of consequences to be included in the health risk assessment (15 minutes)

The stakeholders

To evaluate and then select which categories of consequences will be included in a health risk assessment, it is necessary to identify and understand the stakeholders associated with the proposed wildlife translocation or other wildlife event.

Review the background information about the translocation on pages 33-34 and the description of the Destination Ecosystem on pages 35-37. From this information, make a list (below) of each stakeholder group you can identify and the concern that each stakeholder has about the proposed translocation **(7 minutes)**

Name of Stakeholder Group	Stakeholders concerns or interests	Category of Consequences

The potential consequences

Below is a list of several different categories of potential negative consequences that the health risks associated with a wildlife translocation or other wildlife event might have for different segments of human society (stakeholders). This list was introduced and discussed previously on pages 18-19 of this Training Manual.

Decide which category or categories of consequences each stakeholder group is concerned about. Write these categories of consequences in the list you made of the main stakeholders and their concerns (above) **(8 minutes)**.

Categories of consequences
Consequences for:

➢ Animal Health

➢ Animal Welfare

➢ Human Health

➢ Human Economies

➢ Environments and Ecological Services

➢ Human Social, Cultural and Psychological well-being

➢ Politics and Governance

➢ National Security

What potential negative consequences do you think are most important to include in this wildlife health risk assessment for moving bison to Atlantis? Make a list of up to 5 potential categories of negative consequences you think are most important and place them in order of importance (in your opinion), with the most important listed first.

1. _____

2. _____

3. _____

4. _____

5. _____

Compare your list with the lists of the other people in your group. **Together as a group**, <u>select the three categories of consequences</u> you think are most important to include in this wildlife health risk assessment, and make notes on why these are more important than the others.

1. _____

2. _____

3. _____

<u>Explain your reasons</u> for making these choices: (Make notes to yourself here)

Step 3 – Identification of health hazards (20 minutes)

In this step of any Health Risk Assessment, you would normally use books, journals and on-line sources, and spend many hours, to look up all known infectious and other pathogens you might find in animals in the source and destination ecosystems, as outlined below:

Make a comprehensive, 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). Include:

- Pathogens and diseases on the OIE List that:
    - Exist in the source ecosystem
    - **And** may be carried by the species to be translocated.
- Other disease-causing agents
    - That may cause disease in the species to be translocated
    - That may cause disease in other species in the destination ecosystem

Make a comprehensive, inclusive list of all infectious agents and diseases present in the destination ecosystem to which the animals to be translocated may be susceptible.

Include any diseases in wildlife, domestic animals and humans in the destination ecosystem that may affect the species to be translocated.

For this workshop, this information is being provided to you.

Read carefully the following information about health hazards (infectious pathogens) associated with this wildlife translocation **(10 minutes)**

Bison for Atlantis - Animal health hazards

Source ecosystem: Elk Island National Park

A.   Infectious pathogens in Bison in Elk Island National Park

Table 1. Pathogens Associated with Bison from Elk Island National Park[1]

Pathogen Name	Disease	Species	Detection Method	Prevalence (%)
Bovine Virus Diarrhea Virus	Bovine virus diarrhea (BVD)	Bison	Serology	47%
Brucella abortus	Bovine brucellosis	Bison	Culture, serology	Present from 1940-1972; now absent[2]
Dictyocaulus viviparous	Lungworm	Bison	Necropsy	Unknown
Eimeria sp.	Coccidiosis	Bison	Fecal floatation	67%
Ovine Herpesvirus – 2	Malignant catarrhal fever (MCF)	Bison	PCR	Absent[3]
Morexella bovis	Infectious keratoconjunctivitis	Bison	Culture	Unknown
Mycobacterium bovis	Bovine tuberculosis	Bison	Skin test	Absent[4]
Nematodirus sp.	Gastrointestinal nematode	Bison	Fecal floatation	47%
Nematodirella sp.	Gastrointestinal nematode	Bison	Fecal floatation	Unknown
Oesophagostrum sp.	Gastrointestinal nematode	Bison	Fecal floatation	Unknown
Ostertagia sp.	Gastrointestinal nematode	Bison	Fecal floatation	Unknown

[1] Based on real and invented data.

[2] See estimate of confidence in the absence of infection, below

[3] In 2005, one group of 10 bison removed from the Park herd was placed on a private farm, which also raised domestic sheep. Nine of the 10 bison died acutely from sheep-associated Malignant Catarrhal Fever (Ovine Herpesvirus-2) during their first spring (lambing season) on the farm. However, Ovine Herpesvirus 2 has never been detected in any animals in the Park.

[4] Bison originating from this herd, but which were removed from it in 1908 and subsequently co-mingled with cattle, were found to be infected with *M. bovis* in the 1920s. *M bovis* has never been detected in bison within Elk Island National Park.

B. **Testing to show absence of *M. bovis* and *B. abortus***

1. Many bison in the Park are trapped each winter in large enclosures and sampled and tested for various pathogens. All animals taken out of the Park are tested in this way.

2. Based on such testing, Canada's national veterinary service considers the bison in the Park to be free of infection with both *Brucella abortus* and *Mycobacterium bovis.*

Tests used to detect *B. abortus* and *M bovis* in Park bison in recent years

Disease	Test	Sensitivity (%)	Specificity (%)	Validated in Bison
Brucellosis	cELISA	94.5 ± 4.7	97.4 ± 0.91	Yes
	FPA	94.5 ± 4.7	99.5 ± 0.25	Yes
Tuberculosis	CFTT	80.0 ± 5.0	97.0 ± 2.0	No

FPA: *Fluorescence Polarization Assay, cELISA: Capture Enzyme-Linked Immunosorbent Assay, CFTT: Caudal Fold Tuberculin Test. (Coetser 2012)*

C. **Estimate of statistical confidence in freedom from *B abortus* and *M. bovis***

1. *Mycobacterium bovis*

   a) The Caudal Fold Tuberculin Test (CFTT) is used as a screening test; it has a sensitivity of 80% and specificity of 97% in cattle. This test has not been validated in bison.

   b) Assuming the test performs in bison as it does in cattle, and assuming a minimum expected prevalence of 5%, 301 individuals would need to be tested and found negative in order to be 95% confident the herd is free of tuberculosis.

      i. The calculation was made using FreeCal Software (Ausvet 2012).

      ii. *Test data are available for 127 plains bison in the park.* Thus, the available data set is too small to allow for lower estimates of prevalence, given the poor sensitivity of the diagnostic test (CFTT).

   c) Surveillance for tuberculosis in plains bison in the Park by autopsy and various tests has never detected infected animals.

   d) Elsewhere, in bison herds infected with bovine tuberculosis (*M. bovis*) and in which the density of animals is lower than in the Park, the prevalence of infection with *M. bovis* generally is in the range of 30-50%, well within the range of detection by the surveillance program in the Park. If *M. bovis* were present in the Park, a prevalence of 30-50% would be expected and would be detected with the test used.

2. *Brucella abortus*

   a) The Fluorescence Polarization Assay (FPA) was used as a screening test for the detection of brucellosis in bison. This test has been validated for use in bison and has a sensitivity of 94.5% and specificity of 99.5% in this species.

b) Assuming a minimum expected prevalence of 5%, 112 individuals would need to be tested and found negative in order to be 95% confident the herd is free of brucellosis.

  i. This calculation was made using FreeCal Software (Ausvet 2012).

c) No antibodies to *B. abortus* were detected in samples from the 227 Plains Bison tested for Brucellosis between 2009 and 2011. This sample size exceeds the minimum required sample size to detect infection if prevalence is 5% or higher. So, the Park can be 95% confident that the prevalence of bovine brucellosis in the herd is less than 5%.

d) Elsewhere, in bison herds infected with bovine brucellosis (*B. abortus*) and in which the density of animals is lower than in the Park, the prevalence of infection with *B. abortus* generally is in the range of 12-100%, well within the range of detection by the surveillance program in the Park. If *B. abortus* was present in the Park, infection prevalence of 12% or higher would be expected, and would be detected with the tests used.

Destination ecosystem – Mallotus Islands, Dominion of Atlantis

Sheep have been present in high density on these islands for over 1000 years. Veterinary records extend back only about 150 years, but no large-scale epidemics of infectious diseases ever have been recorded.

A. Infectious pathogens known to be present in on the Mallotus Islands

Pathogen Name	Disease	Species	Detection method	Prevalence (%)
Avian Bornavirus	Encephalitis	Wild geese	PCR	unknown
Dictyocaulus filaria	Pneumonia	Sheep	Direct	40%
Mannheimia haemolytica	Pneumonia and mastitis	Sheep	Culture	unknown
Mycoplasma ovipneumoniae	None	Sheep	Culture	28%
Newcastle Disease Virus	Encephalitis	Cormorant	Culture	unknown
Ovine Herpes virus-2	None	Sheep	PCR	83%
Sarcocystis canis	Encephalitis	Grey Seal	PCR	unknown
Teladorsagia circumcinta	Stomach nematode	Sheep	Fecal flotation	80%
Trichostrongylus colubriformis	Intestinal nematode	Sheep	Fecal flotation	40%
Batrachochytrium dendrobatidis	None	Bull Frog	PCR	90%

No sheep on the Mallotus Islands has ever been found infected with a pathogen on the OIE list of reportable pathogens. No sheep have been imported to these islands in the past 1100 years. Periodic testing over the past 50 years for *Brucella*, morbilliviruses, FMD virus, sheep pox, Psoroptes mites, and other ovine pathogens of concern to international trade all have had negative results.

NOW – Work together as a group. <u>Evaluate which health hazards (infectious pathogens) may represent significant health risks</u> in this bison translocation and which may be of lower concern. Make your notes on the table below: **(10 minutes)**

Hazard	Important Health Risk? Yes or No	Explain your evaluation
Bovine Viral Diarrhea Virus		
Brucella abortus		
Dictyocaulus viviparous		
Eimeria sp.		
Morexella bovis		
Mycobacterium bovis		
Nematodirus sp.		
Nematodirella sp.		
Oesophagostrum sp		

Hazard	Important Health Risk? Yes or No	Explain your evaluation
Ostertagia sp.		
Avian Bornavirus		
Dictyocaulus filaria		
Mannheimia haemolytica		
Mycoplasma ovipneumoniae		
Newcastle Disease Virus		
Ovine Herpesvirus-2		
Sarcocystis canis		
Teladorsagia circumcinta		
Trichostronyulus colubriformis		
Batrachochytrium dendrobatidis		

Now, choose the three health hazards which represent the highest potential risks in the proposed translocation of bison to Atlantis. (5 minutes)

You do not have time or budget to do a full risk assessment of all 20 of these potential health hazards.

- Which of the 20 are the most important health hazards?
- If you must choose only 3 of these health hazards on which to do a complete risk assessment, which three will you select?

    1.   _____

    2.   _____

    3.   _____

WHY has your group chosen these three health hazards? (Make notes to yourself, here, on the main reasons for your choices)

Step 4 – Risk assessment for selected health hazards (30 minutes)

In Step 3, above, you selected 3 pathogens for complete risk assessment.

There will be opportunity to discuss your choices during the workshop.

To complete this practice Health Risk Assessment with everyone working on the same health hazards, evaluate the risks posed by the following three pathogens:

Mycobacterium bovis **(cause of bovine tuberculosis)**

Brucella abortus **(cause of bovine brucellosis)**

Ovine Herpesvirus-2 (cause of sheep-associated malignant catarrhal fever)

Estimation of the risk associated with pathogens that may be carried into the destination ecosystem with the bison

Estimate the probability each pathogen will arrive in the destination ecosystem (entry assessment). See guidelines on next page (below). (5 minutes)

Probability that each pathogen will arrive with bison on the Mallotus Islands		
Pathogen	**Probability**	**Explain and justify your Probability Rating**
M. bovis		
B. abortus		
OvHerpes-2	Does not apply	Does not apply

Guidelines

Estimating and rating qualitatively the probability that a pathogen will enter the destination ecosystem with the translocated animals.

Rating = Negligible	The probability of entry is extremely low or negligible
Rating = Low	The probability of entry is low but clearly possible.
Rating = Medium	Entry is likely.
Rating = High	Entry is very likely or certain

Estimate the probability that susceptible species in the destination ecosystem will be <u>exposed</u> to the pathogen if it arrives with the bison (exposure assessment). (**3 minutes**)

Probability that susceptible animals will be <u>exposed</u> to each pathogen on the Mallotus Islands		
Pathogen	**Probability**	**Explain and justify your Probability Rating**
M. bovis		
B. abortus		
OvHerpes-2	Does not apply	Does not apply

Estimate the <u>magnitude of negative consequences</u> in the event that the pathogen of concern is carried into the destination ecosystem by the translocated animals and infects susceptible species in that destination ecosystem. Do this <u>for the three categories of consequences you chose to include in this assessment</u> in Step 2 (Above, page 38). **Write your estimates on the table on page 50 (below) (10 minutes)**

Guidelines

Estimating and rating qualitatively the magnitude of consequences

Rating = Negligible	The pathogen would have negligible impact on health or on other categories of consequences.
Rating = Low	There would be a minor impact on health or on other categories of consequences.
Rating = Medium	There would be a moderate impact on health or on other categories of consequences.
Rating = High	The pathogen would have severe impact on health or on other categories of consequences.

Magnitude of negative consequences if a translocated pathogen infects susceptible hosts on the Mallotus Islands			
Pathogen	**Your Categories of Consequences[16]**	**Magnitude rating**	**Explain of your rating**
M. bovis	1.		
	2.		
	3.		
B. abortus	1.		
	2.		
	3.		
OvHerpes-2	1.	Does not apply	Does not apply
	2.	Does not apply	Does not apply
	3.	Does not apply	Does not apply

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[16] Use the three categories of consequences you selected in Step 2

Estimation of the risk that the animals being translocated (the bison) will be affected by pathogens present in the destination ecosystem

These risks jeopardize the success of the translocation program. If these risks are high, the objectives of the translocation program may not be achieved.

Estimate the probability that the translocated animals (bison) will be exposed to health hazards of concern <u>in the destination ecosystem</u> (exposure assessment) (**5 minutes**)

Probability that the bison will be <u>exposed</u> to each pathogen on the Mallotus Islands		
Pathogen	**Probability**	**Explain and justify your Probability Rating**
M. bovis	Does not apply	Does not apply
B. abortus	Does not apply	Does not apply
OvHerpes-2		

Estimate the magnitude of consequences (Step 2) that may result if the translocated animals (the bison) are exposed to the health hazards of concern. (**5 minutes**)

Magnitude of negative consequences if bison are exposed to each pathogen on the Mallotus Islands			
Pathogen	**Your Categories of Consequences[17]**	**Magnitude rating**	**Explanation of your rating**
M. bovis	1.	Does not apply	Does not apply
	2.	Does not apply	Does not apply
	3.	Does not apply	Does not apply
B. abortus	1.	Does not apply	Does not apply
	2.	Does not apply	Does not apply
	3.	Does not apply	Does not apply
OvHerpes-2	1.		
	2.		
	3.		

---

[17] Use the three categories of consequences you selected in Step 2

Final Assessment of Health Risks associated with each of the pathogens selected for complete risk assessment:

In the table below, write in your assessment of the health risk associated with each of the three pathogens you have assessed completely. Use a qualitative, 4-point classification of risk: **Negligible, Low, Medium, High**

Health Risk Assessment for each pathogen assessed in detail:		
Pathogen	**Health Risk**	**Short explanation of your risk assessment**
M. bovis		
B. abortus		
OvHerpes-2		

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Step 5. Assessment of overall health risk (10 minutes)

Taking into account your total assessment of the risks associated with all three health hazards, what is your assessment of the <u>overall health risk</u> associated with the proposed translocation of bison to Atlantis?

Your Assessment:

Guidelines	
Estimating and rating overall health risks in wild animal translocations	
Rating = Negligible	The probability of any negative impact from health hazards is negligible and/or the magnitude of impact, should health hazards occur, is negligible
Rating = Low	Significant negative impact from health hazards is unlikely but clearly possible
Rating = Medium	Significant negative impact from health hazards is likely, and/or the magnitude of the negative impact could be high
Rating = High	Significant negative impact from health hazards is very likely or certain and/or the magnitude of negative impact will be very high

Explain and justify your overall risk assessment:

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List the main sources of uncertainty and their magnitude of in this estimation of risk.

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Step 6. Additional hazards and risks

In an animal health risk assessment, there may be hazards and risks associated with the proposed animal translocation that are not related to health but that are important to consider in the overall decision. A statement about these hazards should be included in the final risk assessment.

In this exercise, we will omit Step 6. We will consider additional hazards and risks in a second exercise on multi-criteria decision analysis, later in the workshop.

Step 7. Reduction of risk – (5 minutes)

During this health risk assessment, have you noted any procedures or possible changes in the translocation plan that might reduce the risks you have found to be associated with this translocation of bison to Atlantis?

List any ways you think the health risks associated with this proposed wildlife translocation could be reduced:

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Wildlife health risk assessment and decision-making

You have just completed a qualitative wildlife health risk assessment for your Chief Veterinary Officer (CVO) for translocating bison from Canada to Atlantis. The CVO has delivered your risk assessment to the Minister of Agriculture and Aquaculture, and the Minister has brought it to the Prime Minister and the Council of Ministers.

➢ The Prime Minister is not pleased with the result. You have highlighted problems her political party had not considered when they promised to bring bison to Atlantis during the last election

➢ The Minister of Tourism is not happy because your report predicts that the Ministry's translocation plan will fail.

➢ The Minister of Agriculture and Aquaculture is pleased that you say there are no health risks of importance to agriculture in the proposed translocation, but is very concerned about the effect the translocation might have on the sheep industry.

➢ The Minister of Natural Resources is not pleased with your report. That Ministry hopes to make a new national park on the Mallotus Islands for the bison and thereby gain prestige and a larger budget.

➢ The Minister of Industry thinks the report should be taken very seriously as showing why bison should not be put on the Mallotus Islands. This ministry supports mining the Mallotus Islands for construction-grade aggregate.

➢ All the stakeholder groups which opposed the translocation point to your report as an important document that should be accepted and should result in a decision <u>not</u> to bring bison to the Mallotus Islands.

➢ All the stakeholder groups which support bringing bison to the Mallotus Islands think your report should be ignored because it provides no proof that the translocation will fail or have other significant negative impacts.

From time to time, an OIE Focal Point for Wildlife, or other wildlife health specialist, may be asked to help the CVO, the Ministry or the Government to make a decision about a wildlife translocation, or some other wildlife event, in which health risks are only one of several different categories of concerns, and in which all concerns must be taken into account.

One approach to analysing the different issues, views, opinions, values, benefits and negative consequences associated with an issue, and to making a decision on how best to proceed, is a process called Multi-criteria Decision Analysis (MCDA).

The next section of this Training Manual introduces MCDA as an approach and a tool that can be used to support decisions that must be made about complex issues such as the translocation of bison to Atlantis.

This is only a brief introduction to MCDA. Workshop participants who may want to learn more about applying this approach can do so readily from free on-line resources and the published literature.

Multi-criteria decision analysis (MCDA): Decision support for complex issues

Multi-criteria decision analysis – What is it?

Through the health risk assessment process, several management or decision alternatives may be identified, for example, to translocate animals or not to translocate animals, or to translocate them to a different place. Such alternative actions will vary in the risks each may pose to wildlife health and each alternative will very also in a wide array of other political, environmental, financial and social factors. In order to select the 'best' possible alternative decision option(s)) while accounting for these multiple factors, a process known as multi-criteria decision analysis (MCDA) can be very helpful.

MCDA is a structured approach to decision-making that considers multiple factors (criteria), including animal health risks, in the decision-making process. It identifies the different criteria that are to be considered in making a particular decision and clarifies how giving more and less emphasis to different decision criteria can alter the ranking among the decision options under consideration. It enables evaluation of, and selection between, different decision options or solutions to problems by considering different criteria and different perspectives.

MCDA can be used to:

1) identify a single preferred decision among several alternatives
2) generate a short list of alternative decisions that can then be further considered
3) rank all of the possible decision options from best to worst
4) distinguish acceptable from unacceptable decision options.

The MCDA approach recognises that there is not one unique solution to most problems; rather it provides a structure for comparison of decision alternatives that enables better and more informed decisions to be made. The MCDA process also provides a transparent mechanism for including and organizing opinions from multiple stakeholder groups that may have very different and conflicting views.

At a basic level, MCDA is a series of pair-wise comparisons (comparing each decision option with each alternative decision option according to several different criteria). To make these comparisons, the criteria that are important to a particular decision must be identified, as must all the possible alternatives decisions (different possible actions or solutions) to be considered in the. The criteria and alternative decisions are organized into a matrix, and each alternative-criterion pair is given a score. Each criterion is also given a relative weight; criteria may be weighted equally or some can be given greater weight than others (i.e. considered more important in the decision-making process). After factoring in how the criteria are to be weighted, the score for each alternative-criterion pair is compared with all the other alternative-criterion scores in the matrix. Since this large number of pair-wise comparisons can be quite complicated to calculate and view on paper, computer programs have been developed to carry out these multiple comparisons and to organize and display the results.

What to do and how to do it – The process of MCDA

There are 8 key steps in MCDA[18]:

1. **Define the problem**
2. **Identify the stakeholders**
   a. Who will be affected by this decision? Consider both direct and indirect impacts.
3. **Identify the alternative** decisions to be considered
   a. Make a list of the possible decision alternatives (options). Include all alternatives that are reasonable or possible, and include the perspectives of the different stakeholders (identified in Step 2).
4. **Identify and define the decision criteria**
   a. Identify the criteria that will influence the decision (e.g. cost, animal health risks, human health risks, wildlife conservation, etc...). It is important to be objective and to identify all of the criteria that will be used to compare and select among the alternative decisions being considered.
   b. Clearly define and describe each decision criterion.
5. **Weight the decision criteria**
   a. Determine if any of the decision criteria are more important than others for the decision under consideration. Here, it is important to consider the different perspectives of the stakeholders; the various stakeholder groups will undoubtedly assign different weights (levels of importance) to several of the criteria.
6. **Establish how each criterion can and will be measured**
   a. Criteria can be measured quantitatively or qualitatively. Determine the best method of measuring each criterion (e.g. yes or no; a 4 point scale; a measured continuous value such as cost or number of days or annual mortality rate; etc...) and whether the most desirable score for a particular criterion will be a high score (e.g. safety) or a low score (e.g. cost).
   b. If a criterion includes two or more components; each of these components must be measured separately.
7. **Score each criterion-alternative pair**
   a. Assign a score to each criterion-alternative pair. This consists of assigning a value to a criterion for every alternative decision under consideration; if there are 5 alternative decisions then each criterion will have 5 scores. The range of possible score values depends on the measures selected in Step 6.
   b. When a criterion is made up of multiple components, each component is scored individually for every alternative. Once all the components within a criterion are scored, the scores are summarised together so that each criterion-alternative pair has a single score for that criterion. This may be done, for example, by adding up the individual scores or taking an average value.
8. **Analyse the data**
   a. For every alternative decision, there now is a score for each criterion. The final analysis consists of assessing all of the scores in all of the criteria for each of the alternative decisions, and ranking the alternative decisions on the basis of these scores and on the weights that were assigned to each criterion. For simple problems with few alternative decisions and few criteria, this can be done by hand on paper. However, computer programs greatly facilitate this analysis. The selection of the "best" alternative remains subjective and will be influenced by the perspective of the decision-maker and how the decision-maker weights the criteria. However, the analysis shows how these weights are being applied, and which criteria are most

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[18] Adapted from Valérie Hongoh. 2013. Aide multicritère (et multiacteurs) à la décision (AMCD). Université de Montréal.

influential in ranking the alternative decisions. The analysis can be carried out several times, with different weights applied to the criteria, to assess how these changes in weight will alter the outcome (the ranking among the alternative decisions).

These eight steps usually are done in the order in which they are presented above, but the steps can be repeated and changed as more or different information is obtained. The process of MCDA must remain transparent, however. All the steps (the problem, the alternative decisions, the criteria, the weight given to each criterion, etc...) must be understood by all stakeholders and by the decision-makers. Each step, including all the changes made if the step is reviewed and revised, should be described and communicated to the stakeholders and decision-makers.

Example of MCDA

We make many decisions everyday based on multiple criteria. Even when making simple decisions, for example, what shirt to wear or what to eat for lunch, usually more than one factor (criterion) is considered. When selecting a food item from a menu, the cost, the number of calories, the balance of nutrients as well as the taste might be considered. Whether an individual selects a salad, or fried fish or curry or cake depends on which of these criteria are more important to that person that day.

Making decisions when there is only one stakeholder (just an individual) can be difficult enough. When more stakeholders are involved, the decision-making process becomes more complex. This is when a structured approach, such as that provided by MCDA, is most useful.

Consider a basic example: Your office is going to buy a new field vehicle – which vehicle should be purchased? Below, we walk through the eight MCDA steps:

1. *Define the problem:*
   What vehicle should be purchased for field work?

2. *Identify the stakeholders:*
   Field staff, senior government officials, and local office managers

3. *Identify the alternatives:*
   Economy car, sports car, rugged truck with large cargo-space, van with room for many people

4. *Identify and define the decision criteria:*
   Cost to purchase, fuel efficiency, four-wheel drive, cargo space, passenger capacity, and safety

5. *Weight the decision criteria:*
   How the criteria are weighted will depend on the perspective of each stakeholder and may differ among stakeholders. Below are examples of which criteria might be most (or least) important to the three different stakeholder groups:

   Field staff – four-wheel drive and cargo space are most important, followed by safety, passenger capacity, fuel efficiency and cost
   Senior government officials – cost is most important, followed by safety, fuel efficiency, passenger capacity, four-wheel drive and cargo space
   Local office managers – safety is most important, followed by cost, fuel-efficiency, passenger capacity, four-wheel drive, and cargo space

6. *Establish how to measure each criterion:*
Below are some examples of measures that could be used for each criterion; what measures ultimately are used will depend on the information that is available.

Cost of purchase – the price as a currency value (e.g. pula, rand, dollar, euro)

Fuel efficiency – kilometres/litre or miles/gallon

Four-wheel drive – yes or no

Cargo space – cubic metres or cubic feet

Passenger capacity – number of seats

Safety – this could be provided as a relative safety rating available from an independent consumer group, from the manufacturer, from insurance companies, government, or other sources, and would likely be a 5 or 10 point scale.

It is also important to decide what the preferred score would be for each criterion. For example, with respect to cost, the lowest price probably is the most desirable. For cargo space, the highest value likely is the most desirable

7. *Score each criterion-alternative pair*
Provide a score for each criterion-alternative pair using the measures identified in Step 6 (above).

MCDA Table 1: Evaluating the alternatives*

Alternatives (vehicles to choose among)	Decision Criteria					
	Cost (Euro (€))	Fuel (L/100km)	Four-wheel drive (Y or N)	Cargo (m³)	Passenger (Number)	Safety (5 pt scale, 5 is the most safe)
(Target)	*(Minimize)*	*(Minimize)*	*(Y)*	*(Maximize)*	*(Maximize)*	*(Maximize)*
Economy	10,000	5	N	0.5	5	4
Sports	30,000	9	N	0.2	4	5
Rugged truck	19,000	14	Y	1.32+	5	4
Van	24,000	11	N	0.3+	8	5

*The coloured cells indicate the preferred alternative with respect to each criterion considered alone;
+ indicates that this is the minimum cargo space; the truck can be loaded with more and seats in the van can be removed to increase cargo space (but reduce passenger capacity)

8. *Analyse the data:*
At its core, analysis of the data in MCDA is a series of pair-wise comparisons. For each criterion, a score is given for each alternative decision (vehicle), and each score is then compared with all the other scores. In this example, there are 4 scores for each criterion (one for each alternative) and so there are 6 unique comparisons for every criterion. Often this comparison is done using a computer program because the analysis can quickly become complicated.

In Table 1, the best score for each criterion is highlighted. Doing a visual comparison, three of the vehicle alternatives are preferred for two criteria: the economy car scores best for cost and fuel efficiency, the rugged truck is preferred for cargo space and four-wheel drive ability, and the van has the best scores for number of passengers and safety.

Now, consider the perspective of the different stakeholders. The field staff would likely select the rugged truck because it scored best against the criteria that were most important to the field staff (four-wheel drive and cargo space). However, a senior government official would likely prefer the economy car and the local office manager would prefer the van, because those vehicle alternatives scored best for the criteria that were most important to each of those stakeholders. Each stakeholder has good reasons for their preferred choice of vehicle.

But how can MCDA help a decision-maker to make a final decision?

The answer lies in how well each alternative (vehicle type) scores for each criterion and in considering how important (weight) each criterion is to each stakeholder group. Is space for five passengers really enough even though space for eight would be better, or is four-wheel drive truly not needed even though it would be convenient? Because this analysis can quickly become complicated, the final analysis is often done by entering the scores (Step 7) and the weights to be given to each criterion (Step 5) into a computer software program to help rank the alternatives (the four different vehicles) and make an overall decision. Such an analysis requires that the weight to be given to each criterion be decided. However, the computer analysis also permits the analyst to carry out the analysis using different weightings of the criteria to determine how the views of the different stakeholders will affect the outcome.

By using a computer program to do the analysis, threshold or minimum /maximum values and other preference values can be assigned for each criterion, and the differing preferences of each of the stakeholder groups can be viewed and manipulated as part of the analysis. For example, the field staff may have determined an absolute requirement that a vehicle have room to carry 4 passengers. If a vehicle scores below this threshold value (i.e. only room for 3 passengers), the score compares less favourably than if a vehicle carried more passengers. The higher number of passengers is always preferred but the difference between 3 and 5 passengers is analysed differently than the difference between 5 and 7 passengers because both 5 and 7 are above the threshold of 4.

The use of a computer program for analysis will be demonstrated in the next example

Take home message – *there is no one correct choice among the alternative field vehicles. The best choice of field vehicle is a balance among the alternatives identified, the criteria selected and the perspectives of the stakeholders involved in the decision, which give different weight to the different criteria. MCDA permits the decision-maker to see all of these factors clearly, and thus make a decision informed by this information.*

Using MCDA in a complex wildlife issue

You have carried out an animal health risk assessment for moving bison from a national park in Canada to the Mallotus Islands of Atlantis. However, there are many criteria in addition to the potential health risks that the Government of Atlantis must take into account when deciding whether or not to proceed with this wild animal translocation. We will now try using MCDA to analyse this issue to help the decision-makers to arrive at a decision that takes into account all of the concerns of all of the stakeholders, including the wildlife health risks that have been assessed.

Step 1 – Define the problem:

In order to achieve an acceptable solution, the problem and its context need to be fully understood[19]. To help identify and define the problem, it is useful to describe why the MCDA is being done and what objectives it is meant to achieve[20]. It is also helpful to consider whether all the stakeholder groups would agree with the definition of the problem.

Problem: Some citizens of Atlantis advocate that the bison translocation should take place and the Government has indicated support for the translocation. However, some branches of the Government and several groups of citizens oppose the translocation, and a health risk assessment has determined that most or all of the bison will die soon after they are placed on the Mallotus Islands because of a disease carried by the sheep on those islands. The objective of the MCDA is to analyse the full range of concerns in favour of, and opposed to, the translocation of bison, to determine what alternatives may exist in terms of possible actions to be taken and decisions to be made, and to present the outcome of this analysis to government decision-makers to inform their work.

Step 2 – Who are the stakeholders?

Stakeholders are people and organizations who have an interest in the problem and want to influence the decision process. All of these individuals and groups should be involved in the decision-making process and should provide input into what decision alternatives will be considered, which criteria will be considered and how the criteria will be weighted. This isn't an easy process; getting all the stakeholder input can be difficult and time consuming. However, the more complete and inclusive the MCDA process is, the more likely it is that the decision(s) arrived at through the MCDA process will be accepted by the various groups.

During the risk assessment process, some of the key stakeholder groups that might wish to influence decisions about the translocation of bison to Atlantis were identified (text box below).

<div style="border:1px solid">

Bison Translocation Stakeholders

Golden Fleece Sheep Breeders Association	Fastbuck Business Association
Ministry of Environment/Wildlife	Atlantis Natural History Club
Ministry of Agriculture/CVO	Bison Conservation International
Ministry of Tourism	Political party in power
Goose hunters	Aggregate Exports Inc.
Anguille Original Peoples Council	Calliope International

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[19] Belton and Stewart. 2002. Multiple Criteria Decision Analysis: An Integrated Approach. Kluwer Academic Publishers, Massachusetts

[20] Lloyd. 1978. Don't Define the Problem. *Public Administration Review*, **38**: 283-286

GROUP DISCUSSION (10 minutes):

- Are there any other stakeholders to add to this list?

- Which stakeholders are likely to benefit most from the proposed translocation of bison and which stakeholders are likely to experience the most significant negative consequences?

- Are there some groups that could be categorised together because they have similar concerns and perspectives?

Using the table below, indicate which of the concerns is/are most important to each stakeholder group by inserting an 'X' in the appropriate cell. An example is provided for the first stakeholder group "Golden Fleece Sheep Breeders Association" (change this, if you disagree with where the two "x" are placed).

Concerns of stakeholder groups:

	Bison health and conservation	Mineral extraction (short term financial gain)	Tourism (long-term economic stability)	Culture (aboriginal, farming tradition, etc.)	Natural history and ecology of the Mallotus Islands	Sheep health and production
Golden Fleece Sheep Breeders Association				X		X
Ministry of Environment/Wildlife						
Ministry of Agriculture/CVO						
Ministry of Tourism						
Goose hunters						
Anguille Original Peoples Council						
Fastbuck Business Association						
Atlantis Natural History Club						
Bison Conservation International						
Political party in power						
Aggregate Exports Inc.						
Calliope International						

In the textbox below, a list of 5 categories of stakeholders to consider for the duration of the MCDA exercise is provided. Each category includes stakeholder groups with shared values and perspectives regarding the bison to Atlantis.

Grouped Stakeholder List:

1. **Sheep farming**

   a. Golden Fleece Sheep Breeders Association

   b. Ministry of Agriculture/CVO

2. **Culture and environmental protection**

   a. Anguille Original Peoples Council

   b. Atlantis Natural History Club

   c. Ministry of Environment/Wildlife

3. **Tourism**

   a. Ministry of Tourism

   b. Goose hunters

   c. Political party in power

4. **Business**

   a. Aggregate Exports Inc.

   b. Fastbuck Business Association

5. **Bison conservation & welfare**

   a. Bison Conservation International

   b. Calliope International

Step 3 - Identify the decision alternatives

"Decision alternatives" are the different potential solutions to a problem, the different decisions that could be made. What are the different actions that could be taken to address the concerns of the different stakeholders with respect to the proposed bison translocation?

GROUP DISCUSSION (10 minutes)

During the previous exercise on health risk assessment, various options to reduce health risks were discussed. What are some other alternatives (solutions or options) with respect to importing bison to Atlantis that would reduce some of the health and non-health concerns of the stakeholder groups that the Government of Atlantis could consider?

For each of the stakeholder groups listed below, identify 1 alternative or modification to the original translocation plan that could reduce that group's main concern about the proposed bison translocation.

1. Sheep farming:

....

....

2. Culture and environmental protection:

....

....

3. Tourism:

....

....

4. Business:

....

....

5. Bison conservation and welfare:

....

....68...

In the textbox below is a list of decision alternatives such as you may have developed just now. This list will be used for the rest of this MCDA exercise.

Final list of decisions alternatives:

A. Do not translocate bison to Atlantis

B. Translocate the bison as described in the translocation plan

C. Translocate the bison but fence off the main breeding areas (grasslands) used by Dirk's Storm Petrels to prevent bison from entering these areas

D. Translocate the bison and remove all the sheep

E. Translocate fewer bison and only place them on the largest of the Mallotus Islands and remove the sheep from that island

F. Translocate the bison to mainland Atlantis, not to the Mallotus Islands

Step 4 – Identify and define the decision criteria

Now that the possible decision alternatives have been determined, identify and define the decision criteria that will be used to choose among these decision alternatives. **Criteria are the features that can be used to distinguish between what would be a good choice and a bad choice for the problem at hand.** The characteristics of a good distinguishing criterion for use in MCDA are 1) that it can be clearly and concisely defined, 2) it can be measured and 3) it discriminates between the different decision alternatives that are being considered (i.e. different alternative decisions will score differently according to the criterion).

Criteria that are broad or general often do not work well. It is important to include a range of criteria that represents the perspectives and concerns of all of the stakeholders. However, analysis becomes very difficult when a large number of criteria are included in a MCDA[21]. Thus, it is important to choose criteria very carefully so as to achieve a small number of criteria that are clearly defined, measurable and discriminate among the alternative decisions being considered.

SMALL GROUP WORK: Identify and define the decision criteria for translocation of bison to Atlantis (15 minutes)

Each small group will choose or be assigned to represent one of the five stakeholder groups (Table on Page 66). Each small group is to work together and make a list of decision criteria that are important to that stakeholder group and which can distinguish among the decision alternatives (Page 68) that have been selected for this MCDA analysis. Consider the key areas of concern with the bison translocation for the stakeholder group your table has been assigned, and develop a short list of useful criteria to distinguish among the alternatives from that stakeholder perspective. Put your list of criteria in the appropriate cells in the table below (some cells may be left empty if the stakeholder group you represent does not have some of the listed concerns).

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[21] Al-Rashdan, Al-Kloub, Dean, Al-Shemmeri. 1999. Environmental impact assessment and ranking the environmental projects in Jordan. *European Journal of Operational Research*, Vol. **118**; 30-45

Stakeholder Group Assigned: _____

Concerns	Decision criteria
Bison health and conservation	
Mineral extraction (short term financial gain)	
Tourism (long term economic stability)	

Culture, natural history and ecology of the Mallotus Islands	
Sheep health and production	

Once you have a list of decision criteria, review that list to determine if some of the criteria really are the same or very similar to each other. This may permit you to combine some criteria into a single criterion, thereby shortening the list of criteria to be included in the MCDA and improving the performance of the MCDA analysis.

GROUP DISCUSSION: Finalise the list of criteria (15 minutes)

One table (representing one of the stakeholder groups) will be selected to present their list of decision criteria. The other tables will then be invited to add to or edit this list. Through facilitated discussion, all the suggestions from each group will be combined and a final list of decision criteria developed. The criteria in the final list also can be grouped into themes or categories of concerns.

Final list and description of decision criteria that we will include in this MCDA:

Category of concern	Criteria
Health	Infectious disease risk to sheep
	Infectious disease risk to bison
	Welfare of bison
Economic	Cost of translocation
	Income gain to The Mallotus Islands
	Mineral extraction
Socio-ecological	Loss of existing habitat for wildlife (Dirk's Storm Petrel and Atlantic goose)
	Loss of sheep range
	Impact on Anguille culture
	Loss of sheep farming culture

Step 5 – Weight the decision criteria

Weighting is a way to assign a relative importance to each decision criterion. There is no correct way to do this because different stakeholder groups often view the importance of the different decision criteria quite differently. In the MCDA analysis, more or less emphasis (weight) can be given to different criteria to reflect one perspective about the relative importance of the different criteria, and the results can be analysed. Then the weight can be changed to reflect the views of a different group of stakeholders, the results analysed again and the outcomes of the two analyses can be compared. This helps decision-makers see the impact of different weight assignments and of selection among decision alternatives.

Step 6 – Establish how to measure each criterion

In MCDA, a measurable value must be assigned to each criterion for each decision alternative. These measures can include numbers, such monetary values, various scales and categories, presence or absence, and other kinds of continuous or categorical measures. It must be possible and feasible to assign a value to each criterion for each decision alternative that is objective and unaffected by any particular perspective.

In step 4, 10 decision criteria were identified. These criteria may be measured differently, but it must be possible to measure each one objectively. Some criteria may be measured by adding up a number of components; for example, to arrive at the total cost of an action, all the component costs will be added together as the measure of the criterion "total cost." Other criteria might be measured as the average or mean of a set of measurements, or the measure may simply be that the criterion is present or absent. In some situations, complex formulas are used to combine the component parts of a given criterion. Whatever measures are chosen for use, each must be objective and repeatable (not individual judgements or opinions), and the measurement process must be transparent so that the stakeholders and decision-makers understand how each criterion is being measured, and agree that each measure is appropriate.

☞ SMALL GROUP WORK: <u>Weight</u> the decision criteria and establish how to <u>measure</u> each one (20 minutes)

<u>Weight</u> the decision criteria (MCDA Step 5)

Each small group (table) will be <u>assigned to represent one of the stakeholder groups</u> and will assign weight to each criterion based on that stakeholder group's perspective.

On each work table, there are 100 beans or small objects and, on a large piece of paper, there is a tabulation listing all of the decision criteria, grouped together in major categories. First, divide the beans up among the 3 major categories of decision criteria we are using in this MCDA exercise: health, economics and socio-ecological criteria. In other words, put a proportion of the beans in each major category to reflect the overall importance (weight) of that category, according to the perceptions and views of the stakeholder group your table has been assigned to represent. The result will be 3 uneven piles of beans, for example perhaps 15, 30 and 55 beans in the different piles.

Once you have made this initial decision about weighting the criteria, subdivide the three piles of beans among the specific decision criteria included in each major category, again to reflect the relative importance (weight) of each criterion from the perspective of your assigned stakeholder group. The result will be 10 small piles of beans, one pile for each decision criterion.

Record the number of beans in the pile associated with each of the 10 decision criteria. This records the relative weight you have assigned to each decision criterion. Put this number in the "weight" row in the table below.

Decide how to <u>measure</u> each criterion (MCDA Step 6)

Within your small groups, discuss how the 10 different decision criteria we are using could be measured. Write how your group would measure each criterion in the last row of the table below. Remember that, for some criteria, there may be several components to measure and include together in the overall measure for that criterion.

Weighting and measuring the decision criteria

	Health		Economics			Socio-Ecological			
	Infectious disease risk to sheep	Infectious disease risk to bison	Welfare of bison	Cost of translocation	Annual Income to the islands	Mineral extraction	Loss of wildlife habitat	Loss of sheep range	Impact on Anguille culture	Loss of sheep farming culture
Weight Assigned:										
How Criterion will be Measured:										

Example of how weights might be assigned by different stakeholders (these weights will be used in our data analysis)

Stakeholder groups	Criteria									
	Health			Economics			Socio-ecological			
	Sheep	Bison	Welfare	Cost	Mineral	Income	Habitat	Range	Anguille	Farmer
Bison conservation and welfare	5%	25%	20%	5%	7.5%	7.5%	7.5%	7.5%	7.5%	7.5%
Sheep farming	10%	10%	5%	5%	10%	10%	10%	15%	5%	20%
Tourism	7.5%	7.5%	5%	10%	10%	30%	10%	10%	5%	5%
Business	5%	5%	5%	5%	40%	5%	5%	20%	5%	5%
Culture and environmental protection	5%	5%	5%	5%	10%	5%	25%	5%	30%	5%

*Final measures used for each criterion are provided in step 7 (below)

Step 7 – Score each decision alternative-criterion pair

Using the measures for each decision criterion that were identified in step 6, each decision alternative-criterion pair now must be scored. "Scoring" means that a measured value for each criterion is determined for each of the decision alternatives that have been included in this analysis. In this MCDA exercise, we have included six alternatives and 10 decision criteria. Thus, for each of these six alternatives, a measured value must be assigned to each of the 10 decision criteria. For example, for alternative A - "do not translocate bison to Atlantis"- the value for the criterion "infectious disease risk to bison" will be "Negligible". For alternative B - "translocate the bison according to the original translocation plan" - the value of this same criterion will be "High" (based on the health risk assessment done earlier in this Workshop).

Scoring can be the most time-consuming part of an MCDA. Determining each score requires data and information from multiple sources: peer-reviewed literature, government reports and documents, historical records, and other sources.

Some of the data that are needed to score objectively each alternative-criterion pair may not exist or be very hard to obtain. When this occurs, it may be necessary to review the decision alternatives and the criteria, and find a different criterion that can be measured and will represent the same issue or stakeholder concern. It also is possible to carry out the MCDA using a criterion for which a precise objective measure is not possible for every alternative-criterion pair. This is achieved by including in the score a measure of the uncertainty associated with each such imprecise measure (more about uncertainty at the end of the Training Manual).

But what if there are no objective data to score a criterion and do the analysis? In this situation, scoring sometimes can be done by seeking expert opinion or opinion from a stakeholder panel. This does not mean simply going out on the street and asking individuals their opinion; precise methods have been developed to reliably gather information from subject experts[22,23] or key informants[24,25](stakeholders). These methods ensure that if another group were to solicit the same experts or key informants, they would get the same information as the first group: the process is repeatable.

Since the score is based on an objective measure of each criterion for each of the decision alternatives being considered, it is not affected by stakeholder concerns or opinions. Stakeholder concerns and opinions are reflected in the selection of decision alternatives and the decision criteria to be included in the analysis, and in the relative weight given to each criterion. In the MCDA, scores would be changed during the analysis only if new information became available that actually changed how a criterion was measured or the data that were used in generating the score value. For example, if it was discovered that the cost of some component of one alternative had been left out of the measure of total cost of that alternative, then the new cost item would be included and the score of the criterion "total cost" for that alternative would be changed.

In order to save time during this workshop, scores for each of the decision alternative-criterion pairs in this MCDA exercise have been calculated in advance. These scores are based on the information provided in the translocation plan or have been fabricated to be in keeping with the fictitious translocation scenario being used in the workshop. In the tables below, the scores for each decision alternative-criterion pair are shown. Below each table is a short summary of how the scores were determined.

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[22] Gustafson, Gustafson, Antognoli, Remmenga. 2013. Integrating expert judgement in veterinary epidemiology: example guidance for disease freedom surveillance. *Prev. Vet. Med.*, **109**(1-2):1-9.

[23] Martin, Burgman, Fidler, Kuhnert, Low-Choy, McBride, Mengerson. 2012. Eliciting expert knowledge in conservation science. *Conserv. Biol.*, **26**(1):29-38.

[24] Luyet, Schlaepfer, Parlange, Buttler. 2012. A framework to implement stakeholder participation in environmental projects. *J. Environ. Manage*, **111**:213-9.

[25] Bell, Morse, Shah. 2012. Understanding stakeholder participation in research as part of sustainable development. *J. Environ. Manage*, **101**:13-22.

Training Manual on wildlife health risk assessment in support of decisions and policies

Scores for the health criteria

	Health Criteria		
Criteria:	Disease threats to endemic species (sheep)	Disease threats to imported species (bison)	Animal welfare (bison)
Measure:	4-point scale (0=negligible; 1=low; 2=medium; 3=high) Risk assessment - judgement	scale (0=negligible; 1=low; 2=medium; 3=high) Risk assessment - judgement	scale (0=negligible; 1=low; 2=medium; 3=high)
Components:	Probability of introduction	Probability of exposure	Probability that the habitat cannot sustain bison
	Probability of exposure	Magnitude of consequence	
	Magnitude of consequence		
Desired effect:	Minimise	Minimise	Minimise
Alternatives			
A: Do not translocate bison	0=Negligible	0=Negligible	0=Negligible
B: Translocate bison as proposed	Negligible	High	Medium
C: Fence off the sea bird colonies and/or restrict bison movement	Negligible	High	Low
D: Translocate bison as proposed and remove sheep	Negligible	Medium	Medium
E: Translocate fewer bison and only place them on the largest of the Mallotus Islands	Negligible	Medium	Medium
F: Translocate bison to parks and protected areas on the main island of Atlantis	Negligible	Negligible	Negligible

Each component within each health criterion was measured using a 4-point scale (0=negligible, 1=low, 2=moderate, 3=high) based on the health risk assessment carried out previously. As described in the health risk assessment, for each criterion, the component scores were combined and an overall score was assessed.

Scores for the economic criteria

Criteria:	Economic Criteria		
	Translocation Cost	Economic concerns - mineral extraction	Mallotus Islands - annual income
Measure:	$1 M = $1,000,000	scale (0=negligible; 1=low; 2=medium; 3=high)	$1 M = $1,000,000
Components:		Probability that mineral extraction will occur	Goose hunting
			Sheep farming
			Tourism
Desired effect:	Minimise	Minimise/Maximise	Maximise
Alternatives			
A: Do not translocate bison	$0 M	3=High	Goose hunting = $0.6 M Sheep farming = $7 M Tourism=$20 M Overall score=0.6+7+20=$27.6 M
B: Translocate bison as proposed	$5 M	Low	$32.3 M
C: Fence off the sea bird colonies and/or restrict bison movement	$8 M	Low	$32.45 M
D: Translocate bison as proposed and remove sheep	$12 M	Low	$18.3 M
E: Translocate fewer bison and only place them on the largest of the Mallotus Islands	$4 M	Medium	$29.45 M
F: Translocate bison to parks and protected areas on the main island of Atlantis	$3 M	High	$25.6 M

In scoring the annual income of the Mallotus Islands (final column in the table above), three different components were measured: the annual income from goose hunting, the annual income of the sheep farming from the sale of cheese, fleece and woollen products, and the annual income from tourism. The scores of these components were summed together to provide a measure of the total annual income. For example, in alternative A (do not translocate bison), the annual income would remain the same as it is now: $600,000 generated annually from goose hunting, $7,000,000 from sale of sheep products and $20,000,000 from tourism. These measures were added together for an annual income of $27,600,000. For the other two economic criteria, there was only 1 component and so no calculations were required.

Training Manual on wildlife health risk assessment in support of decisions and policies

Scores for the socio-ecological criteria

	Socio-ecological Criteria			
Criteria:	**Wildlife Habitat**	**Sheep Range**	**Cultural concerns - Anguille People**	**Cultural concerns - Sheep farmers**
Measure:	scale (0=negligible; 1=low; 2=medium; 3=high)	scale (0=negligible; 1=low; 2=medium; 3=high) Average	scale (0=negligible; 1=low; 2=medium; 3=high)	scale (0=negligible; 1=low; 2=medium; 3=high)
Components:	Seabirds	Sheep	Anguille People	Sheep Breeders
	Magnitude of consequences on ecosystem (specifically seabird habitat)	Magnitude of consequences on ecosystem (specifically sheep rangelands)	Magnitude of consequences on culture (specifically about the petrel and the Anguille people)	Magnitude of consequences on culture (loss of way of life and rare breed of sheep)
		Probability that land will be reclassified as national park (loss of range)		
Desired effect:	Minimise	Minimise	Minimise	Minimise
Alternatives				
A: Do not translocate bison	0=Negligible	Score each component Sum component scores: 0+0=0 Calculate an average: 0/2=0 0=Negligible	0=Negligible	0=Negligible
B: Translocate bison as proposed	High	Medium	High	High
C: Fence off the sea bird colonies and/or restrict bison movement	Low	Medium	Low	High
D: Translocate bison as proposed and remove sheep	High	High	High	High

E: Translocate fewer bison and only place them on the largest of the Mallotus Islands	Medium	Low	Medium	Low
F: Translocate bison to parks and protected areas on the main island of Atlantis	Negligible	Negligible	Negligible	Negligible

Each socio-ecological criterion was measured using a 4-point scale (0=negligible, 1=low, 2=moderate, 3=high). For the criterion "sheep range," the component scores were summed together and an average score was calculated. The average scores were rounded to the nearest whole number so that the overall criterion was also measured using a 4-point scale (e.g. if the average score was 3.5, the score given for the criterion overall was 4=High). Example calculations are provided in the table for alternative A; for all the other socio-ecological criteria there was only 1 component and so no calculations were required.

Step 8 – Analyse the data

In principle, the final analysis of the decision alternatives, according to the scores and the weights given to those criteria, can be done by drawing several different tables that show the outcomes obtained from different ways of assigning weight to the criteria. However, as with statistical analysis, computer programs are available to make such analysis much easier. We have selected one such computer program, called *Promethee*,[26] to illustrate how data are analysed in MCDA in order to guide decision-making and also to show the utility of computer-based analysis.

Introduction to Promethee

Several computer software programs are available to analyse the data in a MCDA. Some of these are available free of charge and some are commercial products. *Promethee* will be used in this workshop to illustrate how the criteria are scored, weighted and analysed to evaluate decision options.

The Promethee/Gaia software is available free of charge and can be obtained at: http://www.promethee-gaia.net/software.html

An excellent user guide for *Promethee* is available in many languages: http://www.promethee-gaia.net/local.html.

To illustrate the data analysis step of MCDA (Step 8) using computer-assisted analysis, all of the data about the decision alternatives, decision criteria, weights and scores arrived at in Steps 1-7 in this MCDA exercise have been entered into the *Promethee* computer program in advance.

The image below shows a screen from *Promethee* with all of the decision criteria, decision alternatives, weights and stakeholder groups entered. The stakeholder groups are shown in the tabs at the bottom of the screen (bison conservation and welfare is selected and displayed on this screen image), the decision criteria are indicated across the top, with their corresponding units of measure immediately below. The weight given to each decision criterion is shown in the "Preferences" section of the screen. Finally, each of the decision alternatives being considered is listed in the bottom left-hand corner, and the corresponding scores for each decision alternative-criterion pair have been entered across the screen to the right of each.

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[26] Behzadian, Kazemzadeh, Albadvi, Aghdasi. 2010. PROMETHEE: A comprehensive literature review on methodologies and applications. European Journal of Operational Research. 200: 198-215.

| Bison conservation ..	Sheep disease	Bison disease	Bison welfare	Translocation	Mineral	Income	Habitat	Range	Anguille	Sheep farmers
Unit	4-point	4-point	4-point	$1 000 000	4-point	$1 000 000	4-point	4-point	4-point	4-point
Cluster/Group	♦	♦	♦	■	■	■	●	●	●	●
Preferences										
Min/Max	min	min	min	min	min	max	min	min	min	min
Weight	5.00	25.00	20.00	5.00	7.50	7.50	7.50	7.50	7.50	7.50
Preference Fn.	Usual	Usual	Usual	V-shape	Usual	Linear	Usual	Usual	Usual	Usual
Thresholds	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute	absolute
– Q: Indifference	n/a	n/a	n/a	n/a	n/a	$1.00	n/a	n/a	n/a	n/a
– P: Preference	n/a	n/a	n/a	$2.00	n/a	$2.00	n/a	n/a	n/a	n/a
– S: Gaussian	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Statistics										
Minimum	1.00	1.00	1.00	$0.00	2.00	$18.30	1.00	1.00	1.00	1.00
Maximum	1.00	4.00	3.00	$12.00	4.00	$32.45	4.00	4.00	4.00	4.00
Average	1.00	2.67	2.17	$5.33	2.83	$27.62	2.50	2.33	2.50	2.67
Standard Dev.	0.00	1.25	0.90	$3.82	0.90	$4.82	1.26	1.11	1.26	1.37
Evaluations										
Do not translocate	Negligible	Negligible	Negligible	$0.00	High	$27.60	Negligible	Negligible	Negligible	Negligible
Translocate	Negligible	High	Medium	$5.00	Low	$32.30	High	Medium	High	High
Fence birds	Negligible	High	Low	$8.00	Low	$32.45	Low	Medium	Low	High
Remove sheep	Negligible	Medium	Medium	$12.00	Low	$18.30	High	High	High	High
Fewer bison	Negligible	Medium	Medium	$4.00	Medium	$29.45	Medium	Low	Medium	Low
To Atlantis	Negligible	Negligible	Negligible	$3.00	High	$25.60	Negligible	Negligible	Negligible	Negligible

Actions: 6 (6 active)   Criteria: 10 (10 active)   Scenarios: 5 (5 active)   Locale: Belgium [$/.]   Saved

Did you notice that the score is the same for all of the alternatives under the criterion "sheep disease" (first column in the image above)? Because the value is the same for all alternatives, this decision criterion is not helping to select among the decision alternatives and could be removed from the analysis.

Once all the information about decision criteria, weights, decision alternatives and scores has been entered into the software, various analyses can be performed in *Promethee.* Below, the relative preference, or rank, for each of the alternatives is shown for each stakeholder group and for all groups combined together ("Overall"); these figures are called 'Walking Weights' in *Promethee.*
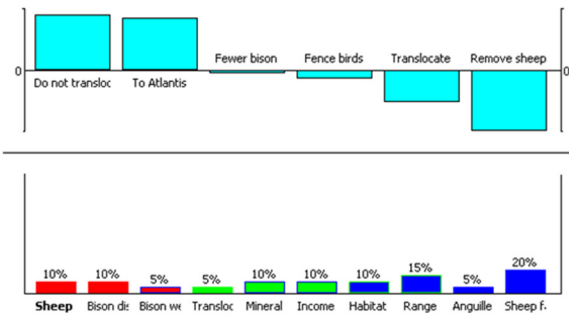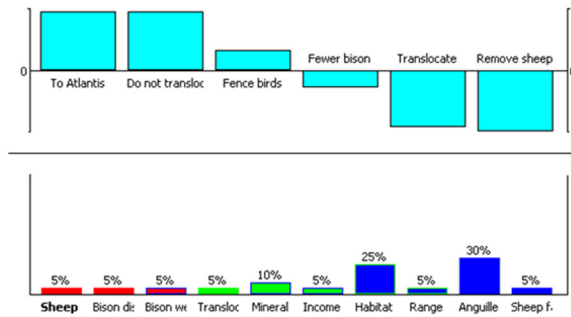
Bison conservation and welfare:
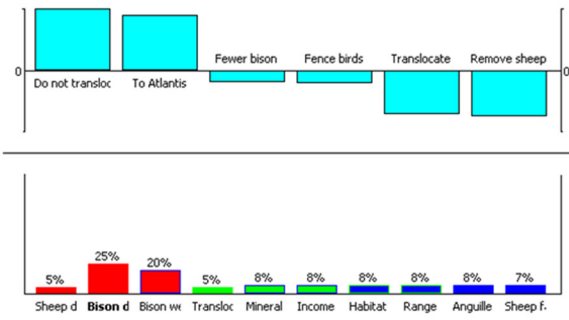
Business:
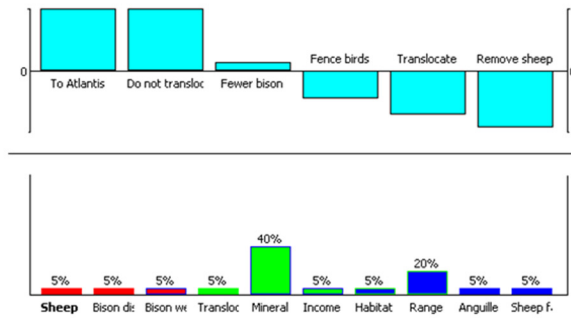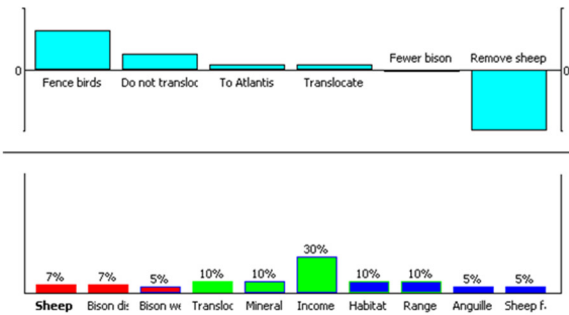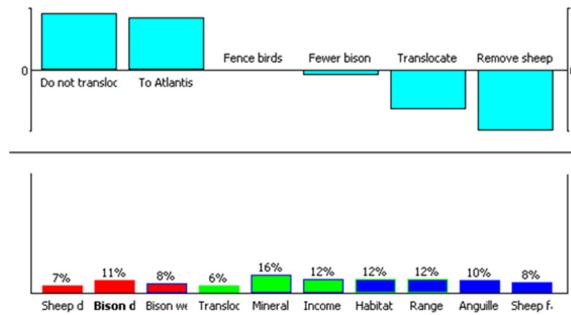

Sheep farming:


## Culture and environment:

Tourism:

Overall:

For all stakeholder groups and for "overall", the least preferred decision alternative is to remove the sheep from the islands. The most preferred decision alternative, however, varies between the stakeholder groups. From the perspective of bison conservation and sheep farming, the most preferred decision alternatives are 1) not to translocate the bison at all or 2) not to translocate them to the Mallotus Islands. From the perspective of big business and culture/environment, the same two decision alternatives are preferred, but in a different order; their preference is for bison to be translocated to mainland Atlantis (not to the islands). From the tourism perspective, the preference is to translocate the bison but to fence off the birds.

If the political party in power is determined to introduce bison to the Mallotus Islands, then not translocating the bison or translocating them to mainland Atlantis are no longer possible decision alternatives. In this case, the analysis can be redone immediately using only the 4 remaining decision alternatives. In this situation and for all stakeholders combined ("overall"), fencing off the important petrel breeding grounds is slightly preferred to translocating fewer bison and placing them only on the largest of the Mallotus Islands (image below).
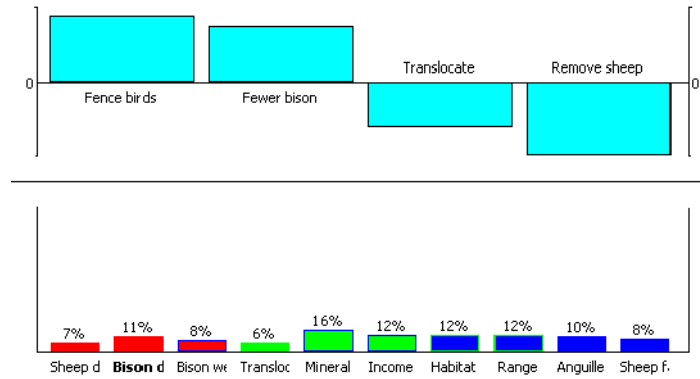
Assuming that the government has already decided that bison will be translocated to the Mallotus Islands, what is the best alternative to mitigating (reducing) the health and non-health concerns of the various stakeholder groups? The image above suggests that fencing off the important bird areas is slightly preferred over translocating fewer bison. To help make a final decision, the weights or scores given to each criterion can be reassessed. For example, in the overall analysis above, the criterion 'Bison Disease' was given a weighting of 11%. What happens if this weighting is increased to 20%? The ranking of decision alternatives after this change in weighting is shown in the image below: now translocating fewer bison is preferred to fencing off the important bird areas.

A final decision will ultimately be made through discussion and debate among the key stakeholders and decision-makers about the appropriate weights and scores for all the criteria.
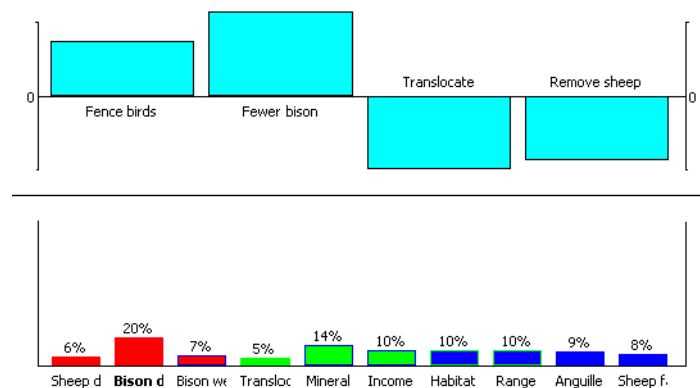
Uncertainty in MCDA

In MCDA, especially for wildlife, there often will be a degree of uncertainty about some or all of the scores and weights attributed to the different decision criteria, and about how the decision criteria can be measured. Managing uncertainty in MCDA is its biggest challenge[27]; if the inputs (weights, scores, etc...) are uncertain, then the ranking of the decision alternatives also is uncertain: "garbage in = garbage out".

Sensitivity analysis is the most common way of assessing uncertainty in MCDA. Basically, sensitivity analysis is an analytical method to quantify how variation in the information entered into MCDA (scores assigned or weights attributed to the different decision criteria) affects the

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27 Felli and Hazen. 1998. Sensitivity analysis and the expected value of perfect information. *Medical decision making*, **18**(1):95-109.

ranking of the decision alternatives.[26] There are various ways of doing a sensitivity analysis in MCDA; two of the more common are 1) changing the scores and 2) changing the weights.[28] [29]

1. **Changing the scores**

   When scoring the alternative decision-criterion pairs, you can provide a range of values rather than just one value (i.e. the score could be as low as *x* or as high as *y*). First one, then the other, of these different values (*x* or *y*) can be entered as the score and the analysis program will show how the outcome changes, depending on the score entered. If the ranking of the alternatives changes a lot, then perhaps it will be necessary to gather more data to reduce the level of uncertainty in your estimates of these particular criterion score values; alternatively, less weight could be attributed to this criterion so that it has less influence on the model outcome (see below). If the ranking of alternatives does not change much when the score is changed from *x* to *y*, then this criterion has relatively little influence on the overall ranking of alternatives; it may not be critical to your decision making process and you can carry on with the analysis despite the uncertainty you know exists in the measure of this criterion. You also could consider eliminating a criterion if making a large change to its scores does not change the outcome of the analysis very much.

2. **Changing the weights of the criteria**

   Changing the weight given to each criterion is a common way of doing a sensitivity analysis in MCDA. The weight given to each criterion is typically a subjective assignment and depends on the make-up of the various stakeholder groups and their level of influence on the decision-makers. As was shown above, increasing the weight given to the criterion about bison disease affected which alternative was most preferred overall. There is no precise method for attributing weight to a criterion other than ensuring that as many stakeholders as possible are involved in assigning the weights. In the same way as different scores were compared, the impact of different weights can be analysed to assess how uncertainty in weight assignment affects the ranking of the alternatives.

In the two informal methods of dealing with uncertainty presented above, each score or weight is changed individually. More formal sensitivity analysis methods that can measure the effect of changing multiple and different parameters at the same time have been developed for various MCDA computer programs[25]. These approaches are beyond the scope of this Workshop.

A less common way of dealing with uncertainty is to include uncertainty as a separate criterion[30] that is scored for each decision alternative. As a unique criterion, uncertainty can have many components. For example, an uncertainty score could be given to each of the other decision criteria and an overall uncertainty score for each decision alternative could be calculated from all the individual scores together (this overall uncertainty score could be a sum, an average or other calculated measure). As a separate criterion, uncertainty can then be weighted according to the level of uncertainty that the different stakeholder groups are willing to accept.

Conclusion

MCDA is not magic. But, like health risk assessment, it offers a way of organizing, assessing and ranking multiple criteria associated with a particular question or decision. MCDA deals with a

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[28] Hyde. 2006. Uncertainty Analysis Methods for Multi-Criteria Decision Analysis. Accessed Oct 3, 2013: http://digital.library.adelaide.edu.au/dspace/bitstream/2440/63152/1/02whole.pdf

[29] Hyde, Maier, Colby. 2003. Incorporating Uncertainty in the PROMETHEE MCDA Method. *J Multi-Crit Decis Anal.*, **12**:245-59.

[30] Messerschmidt *et al.* 2011. Developing a Priority Setting Tool for the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS)

wider range of factors than just health risks, but health risks will be important criteria in many wildlife-related management decisions. The health risk assessment provides the objective basis for measuring and scoring health criteria in MCDA.

MCDA does not determine what decision is "right" or "best." Its outcome always depends on the stakeholder perspectives that are included and excluded, which decision criteria are included and how the decision criteria are weighted. MCDA provides a systematic structure that clarifies and organises all of the components of complex decision problems - the stakeholder groups, decision alternatives under consideration, and the decision criteria on which the decision will be made - and it provides a means of looking at the impact of giving different weights to different criteria. In this way, it provides a transparent analytical framework that permits decisions to be made in a fully-informed manner.

MCDA can be used to rank alternatives in many different contexts. For example, MCDA can be used to rank pathogens and diseases for targeted surveillance in a region. When resources are limited, it may be necessary to focus targeted surveillance efforts on a small number of pathogens, and MCDA can be used to identify the best choices for investment in targeted surveillance based on the alternatives and the criteria that reflect the possibilities and the needs of a given country or region. In this application of MCDA, the various candidate pathogens are the decision alternatives. The selection criteria might include the current burden of illness attributed to each pathogen, known or expected pathogen prevalence, economic implications of the pathogen, cost of surveillance for the pathogen, and so on (see text box below). By using MCDA in this way, there is transparency regarding the decision process and the stakeholders have a clear understanding of the reasons for a decision to include certain pathogens in a surveillance program and not others.

MCDA for priority setting:

MCDA can be used to rank a list of alternatives and thus to establish priorities among a set of alternatives. One example is **ranking pathogens for inclusion in targeted surveillance programs.**

To use MCDA for ranking or prioritizing pathogens in wild animals for surveillance, the alternatives identified would be a list of candidate pathogens. The criteria included in the MCDA would reflect the objectives of the surveillance program. For example, if the objective was to monitor the prevalence of known zoonotic pathogens in a country or region, then criteria related to public health risks would be used. These decision criteria could include measures of human exposure (e.g. prevalence in wildlife that are hunted for food and/or estimates of how often these animals are consumed,) as well as measures of the potential human health impacts (e.g. morbidity/mortality rates associated with the pathogen and/or potential for long term illness). If the surveillance objective was to detect pathogens of importance to livestock, the decision criteria would focus on the potential exposure to and impact on domestic animals. Other criteria also can be included, such as potential economic impacts (e.g. trade or tourism), or social or cultural concerns.

References that use MCDA to prioritise pathogens:

1) Ruzante *et al*. 2010. A Multifactorial Risk Prioritization Framework for Foodborne Pathogens. Risk Analysis 30(5):724-42.

2) Henson *et al*. A Multi-Factorial Risk Prioritization Framework for Food-borne Pathogens. Available from: http://ssrn.com/abstract=989768

3) Messerschmidt *et al*. 2011. Developing a Priority Setting Tool for the Canadian Integrated Program for Antimicrobial Resistance Surveillance (CIPARS).

Appendix 1: The *Dominion of Atlantis*

General Information

(This country does **not** exist)

The *Dominion of Atlantis* is a parliamentary democracy with a capitalist economy.

Economy

- Mostly self-sufficient in food production, 10% export balanced by 10% import
- Main sources of wealth:
  - Agricultural products
    - Major exports of poultry, cheese, farmed mink pelts and wine
    - Sheep are particularly important. An ancient breed of sheep was brought to Atlantis by Vikings in the 8th Century BCE and has persisted on the Mallotus Islands since that time. They have a unique rich dark yellow fleece, now of great commercial value, and produce 4-6 lambs per ewe per year while grazing year round without supplemental feed. They also are world-renowned as a dairy breed for production of exquisite and unique sheep milk cheeses.
  - Forest products for export
  - Tourism
    - Wildlife viewing, seaside and forest natural environments, hunting and fishing
    - Important wildlife populations for tourism include
      - White-tailed Deer – 30,000
      - Moose – 2,000
      - Bald Eagles – 800
      - Black Bears – 3000
  - Commercial seafood harvest for export (finfish & shellfish)
  - Wind and tide-generated electricity
  - Banking (tax haven)

Location: An island in the North Hibernian Ocean (see map on last page)

Human Population:

- 946,000 people
  - 40% rural
  - 60% in urban centres,

- 43% in the capital city of Bigtown
- Wealth: Median Annual Family Income: US$30,000

Size: ~ 56,000 km² (~ 130 km x 560 km)

Climate: North Temperate

- Average summer temperature = +21C
- Average annual extreme temperatures: -10C to +28C
- Annual precipitation: 1,500 mm, (300mm as snow in winter)

Social Infrastructure:

- Relevant National Ministries/Departments:
    - Ministry of Health
        - Medical laboratory in Bigtown
        - 16 Regional Hospitals
    - Ministry of Agriculture & Aquaculture
        - Veterinary diagnostic lab in Epiville
        - 10 Regional Offices
    - Ministry of Natural Resources (Fish and Wildlife Department)
        - 18 Regional Offices
    - Ministry of Environment (Jurisdiction over Wilderness Areas and National Parks
        - 6 Regional Offices
    - Ministry of Ocean Resources (jurisdiction over ocean fish and marine mammals)
        - 18 Regional offices
    - Ministry of Tourism
        - Fishing, Hunting & Ecotourism Guide License Department
- Aboriginal Government
    - Anguille Original People's Council – Government for 20,000 aboriginal people which controls all resources on 5,000 km² of Atlantis, mostly adjacent to parks and wilderness areas. Special hunting and fishing rights extend to the whole country.
- Universities:
    - Harrison Lewis National University (20,000 students, Bigtown)
        - Includes Atlantis Veterinary College
    - 6 small (500 to 4000 students) regional universities distributed across country
- Non-Government Organizations:
    - National Farmers Association
    - Atlantis Natural History Club (naturalists)
    - National Fish and Game Association (recreational hunters and fishermen)
    - National Fishermen's Union (commercial ocean fisheries)
- Calliope International (animal rights and welfare association)