



## ***Pandora :***

a risk screening tool for  
pathogens and parasites

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## Preamble

*Pandora* is a first-line risk assessment scheme for the risks posed by pathogenic and parasitic (micro)organisms. It is the counterpart of *Harmonia*<sup>+</sup>, for potentially invasive (macro)organisms. Please refer to the following document for a full explanation on *Harmonia*<sup>+</sup> and *Pandora*<sup>(+)</sup>.

D'hondt B, Vanderhoeven S, Roelandt S, Mayer F, Versteirt V, Ducheyne E, San Martin G, Grégoire J-C, Stiers I, Quoilin S, Branquart E. 2014. *Harmonia*<sup>+</sup> and *Pandora*<sup>+</sup> : risk screening tools for potentially invasive organisms. Belgian Biodiversity Platform, Brussels.



## C – Pandora : a screening procedure for pathogens

*Pandora* is a first-line risk assessment scheme for pathogenic or parasitic (micro)organisms that may cause human health concerns, economic losses and/or environmental damage. It is an adapted version of *Harmonia*<sup>+</sup>, drawing on the same concepts. In contrast to *Pandora*<sup>+</sup>, *Pandora* does not refer to a particular host organism.

The questionnaire is designed to suit (re)emerging diseases, referring to new infections that result 'from the evolution or change of an existing pathogenic agent, a known infection spreading to a new geographic area or population, or a previously unrecognized pathogenic agent or disease diagnosed for the first time and which has a significant impact on animal or public health' (OIE 2012a). This opposes to endemic diseases, which are already present in the area under assessment, and are not the focus of *Pandora*.

### c0 | Context

Questions from this module identify the assessor and the biological, geographical & social context of the assessment.

c01. Provide the name(s) of the **assessor(s)** : \_\_\_\_\_

ccomm01. Comments : \_\_\_\_\_

#### [More info:](#)

Provide a (the) name(s) for the person(s) performing the assessment.

c02. Provide the name of the **pathogen** under assessment : \_\_\_\_\_

ccomm02. Comments : \_\_\_\_\_

#### [More info:](#)

Identify the biological entity under consideration. This can be a genus, species, subspecies or any other taxon. The organism under assessment will henceforth briefly be referred to as '*The Pathogen*'.

*The Pathogen* may be a pathogen or parasite, of viral, bacterial, fungal or animal origin.

c03. Define the **area** under assessment : \_\_\_\_\_

ccomm03. Comments : \_\_\_\_\_

#### [More info:](#)

Identify the geographic entity under consideration. This can be defined as widely as from the local up to the international level. The area under assessment will henceforth briefly be referred to as '*The Area*'.

Currently, much of the guidance refers to Belgium as *The Area*. When different, it may be necessary to search for analogous information.



c04. This assessment is considering potential impacts within the following **domains** : [  the environmental domain  the cultivated plant domain  the domesticated animal domain  the human (health) domain  (an)other domain].

c04mm04. Comments : \_\_\_\_\_

More info:

A target is an entity potentially bearing impacts from *The Pathogen*. Sectors that deal with specific targets are collectively referred to as a 'domain'.

Specify your targets of interest by choosing one or more domain.

Targets from the 'environmental domain' refer to wild animals and plants, habitats and ecosystems.

Targets from the 'plant domain' refer to cultivated plants (e.g. from agriculture, forestry, horticulture; i.e. crops, pastures, horticultural stock).

Targets from the 'animal domain' refer to domesticated animals (e.g. from agriculture, aquaculture; i.e. production animals, companion animals).

Targets from the 'human domain' refer to humans, the health of which is defined as a state of complete physical, mental and social well-being (and not merely the absence of disease or infirmity).

Targets from the 'other domain' refer to targets that are not included in the domains above.

**C1 | Entry**

Questions from this module assess the likelihood for (re)emerging pathogenic agents to be (re)introduced into the environment of *The Area*.

c05. The probability of *The Pathogen* to be **introduced** into *The Area* is [  low  medium  high].

c05conf01. Answer provided with a [  low  medium  high] level of confidence.

c05mm05. Comments : \_\_\_\_\_

More info:

Estimate the probability that *The Pathogen* enters *The Area* from the outside, by any pathways, within the time span of a decade.

**Low** : 0-33% probability (≈ expected to occur less than once every 30 years). **Medium** : 33-66% (once every 15 to 30 years). **High** : 66-100% (within 15 years).

Examples

- + Raccoon populations can reach high prevalence for the roundworm *Baylisascaris procyonis*, also in Europe (>70% among German raccoons; Kazacos 2001). If not present already, then the ongoing spread of the mammal from Germany to Belgium will almost certainly introduce *Baylisascaris* here. – **HIGH**



Questions from this module assess the pathways necessary for exposure of pathogenic agents to targets in *The Area*.

c06. *The Pathogen* has a(n) [  low  medium  high] probability to be **maintained and spread** in *The Area*.

cconf02. Answer provided with a [  low  medium  high] level of confidence.

c06. Comments : \_\_\_\_\_

More info:

Pathogen maintenance & spread include processes of exposure, release & transmission among individual organisms (any species) or in the environment, ultimately creating a reservoir for the disease in *The Area*.

**Low** : possibilities for *The Pathogen* to establish and spread in *The Area* are limited; expected prevalence of *The Pathogen* is low. **Medium** : possibilities to establish and spread are moderate; expected prevalence is medium.

**High** : possibilities to establish and spread are good; expected prevalence is high.

Examples :

- + The sylvatic cycle for anthrax (*Bacillus anthracis*) depends on mammal and avian scavengers feeding on herbivore carcasses (Dragon & Rennie 1995). This, and other conditions do not seem to be well-met in Western Europe. – **MEDIUM**
- + *Phytophthora ramorum* is a plant pathogen, for which sporulation conditions within The Netherlands do not seem to be suited as compared to, e.g., the United Kingdom (Leewis et al. 2013). – **MEDIUM**
- + The fungus *Batrachochytrium*, the causative agent of chytridiomycosis in amphibians, is presumably present on a wide variety of substrates, including amphibians, but also waterfowl, water plants *et cetera*. These pose little barrier for the species to spread. – **HIGH**

c07. The probability for *The Pathogen* to be **transmitted** from its reservoir to individual targets is [  low  medium  high].

cconf03. Answer provided with a [  low  medium  high] level of confidence.

c07. Comments : \_\_\_\_\_

More info:

Indicate the likelihood for *The Pathogen* to spillover to target populations.

If you are considering more than one domains, choose the worst of these cases.

**Low** : transmission is highly unlikely because of a high separation in space and time. **Medium** : transmission is only likely given sufficient space and/or time. **High** : transmission is likely even with limited space and/or time.

Examples :

- + American mink (*Neovison vison*) can act as a reservoir for various diseases. In their review, Barrat et al. (2010) estimate the risk of transmitting these diseases to farmed animal targets as rather low, compared to other diseases in the wildlife species reservoir. – **LOW**
- + Diverse routes of transmission are known for emerging diseases carried by alien deer (Böhm et al. 2007). Yet, in practice, these routes may not be easily bridged from deer to human targets: cf. meat consumption, faecal contact, through livestock. – **MEDIUM**
- + Where (alien) deer and livestock share access to agricultural pastures, vector-borne, faecal-oral and urinary-oral transmission routes render transmission of pathogens to animal targets likely (Böhm et al. 2007). – **HIGH**



Questions from this module qualify the consequences of *The Pathogen* on wild animals and plants, habitats and ecosystems.

Impacts are linked to the conservation concern of targets. Native species that are of conservation concern refer to keystone species (e.g. heather, beech), threatened species (e.g. many orchids or butterflies) or emblematic species (e.g. ladybirds, squirrel). See, for example, Red Lists, protected species lists, or Annex II of the [92/43/EEC Directive](#). Ecosystems that are of conservation concern refer to natural systems that are the habitat of many threatened species. These include natural forests, dry grasslands, natural rock outcrops, sand dunes, heathlands, peat bogs, marshes, rivers & ponds that have natural banks, and estuaries (see e.g. Annex I of the [92/43/EEC Directive](#)).

Native species population declines are considered on the local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as a (near) extinction.

c08. *The Pathogen* has a [  low  medium  high ] effect on **native species individuals**.

cconf04. Answer provided with a [  low  medium  high ] level of confidence.

ccomm08. Comments : \_\_\_\_\_

[More info:](#)

Indicate the burden of illness of *The Pathogen* on individuals from native species.

Assume that an individual target becomes infected by *The Pathogen*, and estimate the consequence of this happening.

**Low** : mild signs of disease, illness is short, recovery is complete. **Medium** : moderate signs of disease, illness is prolonged, recovery is incomplete. **High** : severe signs of disease, illness is lasting or results in death, recovery is unlikely.

If no native host species exist in *The Area*, choose **Low** as an answer.



c09. *The Pathogen* has a [  no / very low  low  medium  high  very high ] effect on **native species populations**.

cconf05. Answer provided with a [  low  medium  high ] level of confidence.

c09. Comments : \_\_\_\_\_

More info:

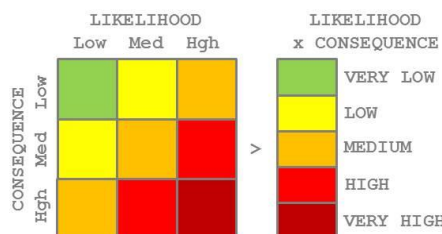
Indicate the burden of illness of *The Pathogen* on environmental targets.

Assume that *The Pathogen* becomes endemic in *The Area*. Then, estimate the likelihood for *The Pathogen* to infect some native species population within the time span of a year, and the consequence of this happening.

*Likelihood* – Ideally corresponds to the following probabilities. **Low** : 10-33% probability (≈ expected to occur less than once every 3 years). **Medium** : 33-66% (once every 1.5 to 3 years). **High** : 66-100% (more than once every 1.5 years).

*Consequence* – **Low** : at worst, limited population declines occur in species that are not of conservation concern. **Medium** : at worst, severe population declines occur in species that are not of conservation concern, or limited population declines occur in species that are of conservation concern. **High** : at worst, severe population declines occur in species that are of conservation concern.

Likelihood and consequence can then become combined as follows:



If no native host species exist in *The Area*, choose **No** as an answer.

Examples

- + The tick *Hyalomma aegyptium* is primarily hosted by *Testudo* tortoises, which are alien to Belgium but have become established here. Only rarely, *Hyalomma* is found on other hosts in Europe, such as hedgehogs and hares (likelihood = low; Paștiu et al. 2012). Such occasional infection would presumably not lead to local decline in these species (consequence = low). – **VERY LOW**
- + The plant pathogen *Phytophthora ramorum* has a very broad host range, and new infections on native species in the Netherlands are frequently observed (*Fagus*, *Quercus*; likelihood = high). Sub-optimal conditions for sporulation appear to preclude significant damage to these species (consequence = medium; Leewis et al. 2013). -- **HIGH**
- + *Batrachochytrium salamandrivorens* is a fungal pathogen of amphibians that seems to spread rapidly (likelihood = high). It is lethal, and has devastated populations of the already-rare Fire salamander in the Netherlands (consequence = high; Martel et al. 2013). – **VERY HIGH**
- + American squirrel species have introduced *Parapox* virus into Europe. This causes squirrelpox, which is lethal to the native Red squirrel (*Sciurus vulgaris*) and has contributed to their decline and local extinction (likelihood = high; consequence = high; Strauss et al. 2012). – **VERY HIGH**





## C3b | Consequence: plant targets

Questions from this module qualify the consequences of *The Pathogen* on cultivated plants (e.g. crops, pastures, horticultural stock).

It deals with both the quality of individual plants and the yield of plant populations.

c10. *The Pathogen* has a(n) [  inapplicable  low  medium  high ] effect on **individual plants**.

cconf06. Answer provided with a [  low  medium  high ] level of confidence.

ccomm10. Comments : \_\_\_\_\_

### More info:

Indicate the burden of illness of *The Pathogen* on individual plants.

Assume that an individual target becomes infected by *The Pathogen*, and estimate the consequence of this happening.

**Low** : mild signs of disease, illness is short, recovery is complete. **Medium** : moderate signs of disease, illness is prolonged, recovery is incomplete. **High** : severe signs of disease, illness is lasting or results in death, recovery is unlikely.

If *The Pathogen* is not a plant pathogen, choose **Inapplicable** (this omits the question from calculation). If no cultivated plant host species exist in *The Area*, choose **Low** as an answer.



c11. *The Pathogen* has a(n) [  inapplicable  no / very low  low  medium  high  very high] effect on plant populations.

cconf07. Answer provided with a [  low  medium  high] level of confidence.

ccomm11. Comments : \_\_\_\_\_

More info:

Indicate the burden of illness of *The Pathogen* on plant quality or yield.

Several types of data can be used, outlined below. We advise to use the following data in decreasing order of preference (A>B>C).

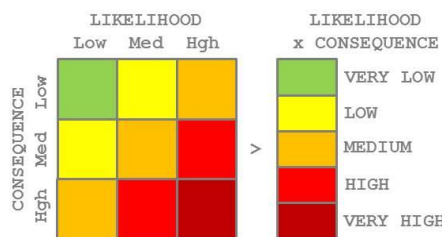
If *The Pathogen* is not a plant pathogen, choose **Inapplicable** (this omits the question from calculation). If no cultivated plant host species exist in *The Area*, choose **No** as an answer.

A : Likelihood x Consequence – Assume that *The Pathogen* becomes endemic in *The Area*. Then, estimate the likelihood for *The Pathogen* to infect some plant target population within the time span of a year, and the consequence of this happening.

Likelihood : Ideally corresponds to the following probabilities. **Low** : ]0-33% probability (≈ expected to occur less than once every 3 years). **Medium** : 33-66% (once every 1.5 to 3 years). **High** : 66-100% (more than once every 1.5 years).

Consequence : Refers to the signs of disease, duration of illness and recovery. **Low** : mild signs of disease, illness is short, recovery is complete. **Medium** : moderate signs of disease, illness is prolonged, recovery is incomplete. **High** : severe signs of disease, illness is lasting or results in death, recovery is unlikely.

Likelihood x Consequence : Likelihood and consequence can then become combined as follows:



B : Monetary – If available, costs of the disease to the government and agricultural sector may be used as a proxy.

C : Expert opinion – If no appropriate data is available at all, a direct estimate is needed through expert opinion.

Examples

- + *Batrachochytrium* is not a plant pathogen, but an animal pathogen. – **INAPPLICABLE**
- + The plant pathogen *Phytophthora ramorum* has a very broad host range, and new infections in the Netherlands are frequently observed (likelihood = high). Some ornamental species like *Rhododendron* and *Camellia* suffer leaf and branch die-back; mortality is regularly observed in *Viburnum* (consequence = high). – Data type A - **VERY HIGH**



## C3c | Consequence: animal targets

Questions from this module qualify the consequences of *The Pathogen* on domesticated animals (e.g. production animals, companion animals).

It deals with both the well-being of individual animals and the productivity of animal populations.

c12. *The Pathogen* has a(n) [  inapplicable  low  medium  high] effect on the health (physical well-being and welfare) of **individual animals**.

cconf08. Answer provided with a [  low  medium  high] level of confidence.

ccomm12. Comments : \_\_\_\_\_

### More info:

Indicate the burden of illness of *The Pathogen* on individual animals.

Assume that an individual animal becomes infected by *The Pathogen*, and estimate the consequence of this happening.

**Low** : mild signs of disease, illness is short, recovery is complete. **Medium** : moderate signs of disease, illness is prolonged, recovery is incomplete. **High** : severe signs of disease, illness is lasting or results in death, recovery is unlikely.

If *The Pathogen* is not an animal pathogen, choose **Inapplicable** (this omits the question from calculation).

### Examples

- + *Phytophthora* is not an animal pathogen, but a plant pathogen. – **INAPPLICABLE**
- + Feline viral rhinotracheitis in cats may be severe in some cases (e.g. in kittens). – **MEDIUM**
- + Rabies is deadly to cattle. – **HIGH**



c13. *The Pathogen* has a(n) [  inapplicable  no / very low  low  medium  high  very high] effect on the health (physical well-being and welfare) or production of **animal populations**.

cconf09. Answer provided with a [  low  medium  high] level of confidence.

ccomm13. Comments : \_\_\_\_\_

More info:

Indicate the burden of illness of the pathogen on animal populations (cf. the industry).

Several types of data can be used, outlined below. We advise to use the following data in decreasing order of preference (A>B>C).

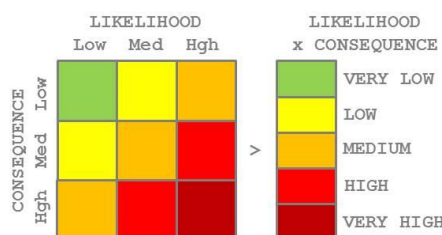
If *The Pathogen* is not an animal pathogen, choose **Inapplicable** (this omits the question from calculation). If no domesticated animal host species exist in *The Area*, choose **No** as an answer.

A : Likelihood x Consequence – Assume that *The Pathogen* becomes endemic in *The Area*. Then, estimate the likelihood for *The Pathogen* to cause an infection in targets, and the consequence of this happening.

Likelihood : Ideally refers to the *incidence* of disease (the number of new cases arising in a population over a given period). E.g., **low** : <1 infections per 100,000 animals per year; **medium** : 1-100 ; **high** : >100 (based on Havelaar et al. 2010). Alternatively, one may use *prevalence* as a proxy.

Consequence : Refers to signs of disease, duration of illness and recovery. **Low** : mild signs of disease, illness is short, recovery is complete. **Medium** : moderate signs of disease, illness is prolonged, recovery is incomplete. **High** : severe signs of disease, illness is lasting or results in death, recovery is unlikely.

Likelihood x Consequence : Likelihood and consequence can then become combined as follows:



B : Monetary – If available, costs of the disease to the government and agricultural sector may be used as a proxy. These include costs of control (culling, vaccination, compensation) and the loss of breeding animals, lost returns and damage to the market. E.g. at the scale of the Netherlands (Havelaar et al. 2010): **very low** : < 0.1 M Euro per year; **low** : < 1 M ; **medium** : 1-10 M ; **high** : 10-100 M ; **very high** : > 100 M.

C : Expert opininon – If no appropriate data is available at all, a direct estimate is needed through expert opinion.

Examples

- + *Phytophthora* is not an animal pathogen, but a plant pathogen. – **INAPPLICABLE**
- + The (inter)national economic consequences of Rabies disease in 2008 for France were estimated low by Dufour et al. (2011). – Data type C - **LOW**
- + The total direct costs of the Classical Swine Fever Outbreak in Belgium of 1997 (Limburg Province) were estimated at about 11 M Euro (Mintiens et al. 2001). – Data type B - **HIGH**
- + Foot-and-mouth disease may take on very severe epidemiological proportions, as exemplified by the 2001 United Kingdom outbreak, where 2,000 cases of the disease were reported on farms across the country, and 10 million sheep and cattle were killed preventively (Dufour et al. 2011). – Data type C - **VERY HIGH**
- + The net costs of the bluetongue BTV8 epidemic of 2006 and 2007 in the Netherlands were estimated at 32 M Euro (2006) and 164-175 M Euro (2007) by Velthuis et al. (2010). – Data type B - **VERY HIGH**
- + The overall cumulative incidence for the Bluetongue virus outbreak of 2007 in Belgium was estimated at 11.5% (cattle populations) and 7.5% (sheep; likelihood = high). Clinical signs are diverse; mortality is typically 10-20% but may reach 70% in individual flocks (consequence = high; Méroc et al. 2009). – Data type A - **VERY HIGH**



### C3d | Consequence: human targets

Questions from this module qualify the consequences of *The Pathogen* on humans.

It deals with human health, being defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (definition adopted from the WHO; [World Health Organization](#)).

c14. *The Pathogen* has a(n) [  inapplicable  low  medium  high] effect on the health (physical, mental or social well-being) of **individual humans**.

cconf10. Answer provided with a [  low  medium  high] level of confidence.

ccomm14. Comments : \_\_\_\_\_

#### More info:

Indicate the burden of illness of *The Pathogen* on individual humans.

Assume that an individual human becomes infected by *The Pathogen*, and estimate the consequence of this happening.

**Low** : hospitalization is rare, work loss is < 2 days, no persisting handicaps, low amounts of stress. **Medium** : hospitalization is rare, work loss of > 5 days is rare, few persisting handicaps, medium amounts of stress. **High** : hospitalization is frequent, work loss of > 5 days is frequent, persisting handicaps occur, high amounts of stress (based on Krause et al. 2008).

If *The Pathogen* is not an animal pathogen, choose **Inapplicable** (this omits the question from calculation). If *The Pathogen* does not infect humans, choose **No** as an answer.

#### Examples

- + *Phytophthora* is not an animal pathogen, but a plant pathogen. – **INAPPLICABLE**
- + Most cases of Salmonellosis last four to seven days, with people recovering without treatment. – **LOW**
- + Worms of the waterfowl-transmitted genus *Trichobilharzia* are essentially considered as not harmful to man, though very unpleasant (cf. swimmers' itch; mental stress). – **MEDIUM**
- + Early symptoms of tick-transmitted Lyme borreliosis are fairly mild, though delayed or inadequate treatment can lead to more serious symptoms. – **MEDIUM**
- + Generally, the effects of parrot fever (*Chlamydia psittaci*) on humans are moderate. – **MEDIUM**
- + If untreated, rabies leads to death in humans. – **HIGH**



c15. *The Pathogen* has a(n) [  inapplicable  no / very low  low  medium  high  very high] effect on the health (physical, mental or social well-being) of the **human population**.

cconf11. Answer provided with a [  low  medium  high] level of confidence.

ccomm15. Comments : \_\_\_\_\_

More info:

Indicate the burden of illness of *The Pathogen* on human populations.

Several types of data can be used, outlined below. We advise to use the following data in decreasing order of preference (A>B>C>D).

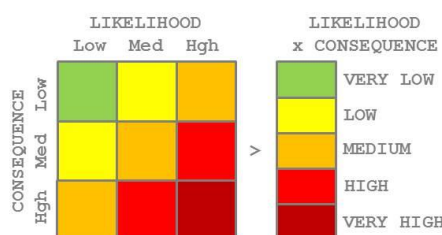
If *The Pathogen* is not an animal pathogen, choose **Inapplicable** (this omits the question from calculation). If *The Pathogen* does not infect humans, choose **No** as an answer.

A : Likelihood x Consequence – Assume that *The Pathogen* becomes endemic in *The Area*. Then, estimate the likelihood for *The Pathogen* to cause an infection in humans, and the consequence of this happening.

Likelihood : Ideally refers to the *incidence* of disease (the number of new cases arising in a population over a given period. E.g., **low** : <1 infections per 100,000 humans per year; **medium** : 1-100 ; **high** : >100 (based on Havelaar et al. 2010). Alternatively, one may use *prevalence* as a proxy.

Consequence : Refers to symptoms, duration of illness, recovery and the amount of stress involved. **Low** : hospitalization is rare, work loss is < 2 days, no persisting handicaps, low amounts of stress. **Medium** : hospitalization is rare, work loss of > 5 days is rare, few persisting handicaps, medium amounts of stress. **High** : hospitalization is frequent, work loss of > 5 days is frequent, persisting handicaps occur, high amounts of stress (based on Krause et al. 2008).

Likelihood x Consequence : Likelihood and consequence can then become combined as follows:



B : Monetary – If available, costs of the disease to the government and health sector may be used as a proxy.

C : Mortality – An estimate of the case-fatality rate. E.g. **very low** : < 0.001 % ; **low** : < 0.01 % ; **medium** : 0.01-0.1 % ; **high** : 0.1-1 % ; **very high** : > 1 % (based on Krause et al. 2008).

D : Expert opinion – If no appropriate data is available at all, a direct estimate is needed through expert opinion.

Examples

- + *Phytophthora* is not an animal pathogen, but a plant pathogen. – **INAPPLICABLE**
- + Bluetongue virus is a pathogen of ruminants, not of humans. – **NO**
- + Raccoons are ubiquitous hosts of the roundworm *Baylisascaris procyonoides*. Human infection may be through ingestion of soil-borne eggs or contact with faeces, e.g. children’s exploratory behavior (likelihood = low). Baylisascariasis typically results in fatal disease or severe sequelae (consequence = high). – Data type A - **MEDIUM**
- + In 2003, 617 cases of West-Nile Virus infection were reported among the 700,000 inhabitants or so of North Dakota state (likelihood = medium). 94 of these cases (15%) were classified as cases of neuroinvasive disease (forms of meningitis, encephalitis or acute flaccid paralysis), with some related deaths (consequence = high; Carson et al. 2006). – Data type A – **HIGH**

C3e | Consequence: other targets

Questions from this module qualify the consequences of *The Pathogen* on targets not considered in modules B3a-d.

c16. *The Pathogen* has a(n) [  inapplicable  low  medium  high] effect on international **trade and tourism**.

cconf12. Answer provided with a [  low  medium  high] level of confidence.

ccomm16. Comments : \_\_\_\_\_

[More info:](#)

Indicate whether *The Pathogen* may indirectly invoke complications for free trade or tourism.

Examples

- + The 2004 H5N1 epidemic had a clear negative impact on international tourist arrivals to Asian countries, though to a lesser degree than the SARS epidemic did (McAleer et al. 2010, Kuo et al. 2008). – **MEDIUM**
- + The 2003 SARS epidemic severely impacted international tourist arrivals to Asian countries (McAleer et al. 2010). – **HIGH**
- + The emergence of the lethal influenza strain H1N1 resulted in the estimated loss of almost a million overseas visitors to Mexico around 2009 (Rassy & Smith 2013). – **HIGH**

c17. *The Pathogen* has a(n) [  inapplicable  low  medium  high] effect on **public attention and perception**.

cconf13. Answer provided with a [  low  medium  high] level of confidence.

ccomm17. Comments : \_\_\_\_\_

[More info:](#)

Indicate whether presence of *The Pathogen* may attract disproportional reactions from the general public and media.

Examples

- + Anthrax (*Bacillus anthracis*) was used in a bioterrorism attack in September 2001, the reporting of which was covered in the news worldwide. Drawing on this connotation of fear, new occurrences of anthrax are likely to receive disproportionate attention. – **HIGH**

C4 | Comments

Use the following field to provide any comments or additions you may have on the assessment performed.

ccomm18. Comments : \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



## Addendum – Mathematical framework

Please refer to the following reference for all details concerning the mathematical underpinnings shown below.

D'hondt B, Vanderhoeven S, Roelandt S, Mayer F, Versteirt V, Ducheyne E, San Martin G, Grégoire J-C, Stiers I, Quoilin S, Branquart E. 2014. *Harmonia*<sup>+</sup> and *Pandora*<sup>+</sup> : risk screening tools for potentially invasive organisms. Belgian Biodiversity Platform, Brussels.

### Score aggregation

#### Within modules

Two possibilities for module score calculation are given. The choice should reflect the assessors' objectives and conceptual approach of the invasion process.

Arithmetic mean : the arithmetic mean (average) of the (re-scaled) ranks is taken. This approach allows for questions to be given different weights.

Maximum : the maximum of the (re-scaled) ranks is taken. This approach does not allow for questions to be given different weights.

Please select the method of calculation.

- |                                     |   |
|-------------------------------------|---|
| • Entry score :                     | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Exposure score :                  | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Environmental consequence score : | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Plant consequence score :         | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Animal consequence score :        | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Human consequence score :         | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |
| • Other consequence score :         | <input type="radio"/> Arithmetic mean <input type="radio"/> Maximum |

#### Among modules

##### ***Aggregation of Entry & Exposure***

Several possibilities exist to combine the Entry score & Exposure score.

Geometric mean : the geometric mean of the module scores is taken. This approach allows for modules to be given different weights. Zeros are allowed, which yield a mean of zero.

Product : the product of the module scores is taken. This approach does not allow for questions to be given different weights.

Please select the method of calculation.

- |                          |  |
|--------------------------|--|
| • Entry-Exposure score : | <input type="radio"/> Geometric mean <input type="radio"/> Product |
|--------------------------|--|

##### ***Aggregation of consequence***

The Environmental consequence score (EC), Plant consequence score (PC), Animal consequence score (AC), Human consequence score (HC) & Other consequence score (OC) can become aggregated in different ways.

Maximum : the maximum of EC, PC, AC, HC and OC is taken. This approach does not allow for different weights to be given.

Arithmetic mean : the arithmetic mean (average) is taken. This approach allows for domains to be given different weights.





Please select the method of calculation.

- Consequence score :  Maximum  Arithmetic mean

### Overall risk

The Entry-Exposure score (see above) and the Consequence score (see above) may become aggregated by taking the product. This yields an ultimate score for the Invasion risk posed by the organism assessed.

## Weighting

### Within modules

You can provide the weights by filling in the following table. Weights are equal by default.

Q	Keyword	Weight	Q	Keyword	Weight
<b>Entry</b>			<b>Consequence: animal targets</b>		
c05	introduced	n/a	c12	individual animals	_____
<b>Exposure</b>			c13 animal populations _____		
c06	maintained and spread	_____	<b>Consequence: human targets</b>		
c07	transmitted	_____	c14	individual humans	_____
<b>Consequence: environmental targets</b>			c15 human population _____		
c08	native species individuals	_____	<b>Consequence: other targets</b>		
c09	native species populations	_____	c16	trade and tourism	_____
<b>Consequence: plant targets</b>			c17 public attention and perception _____		
c10	individual plants	_____			
c11	plant populations	_____			

### Among modules

#### Aggregation of Entry & Exposure

These modules can be given different weights, which may affect the calculation of the geometric mean (see above). Weights are equal by default.

You can provide the weights by filling in the following table.

Module	Weight
c1 <b>Entry</b>	_____
c2 <b>Exposure</b>	_____

#### Aggregation of consequence

These modules can be given different weights, which may affect the calculation of the arithmetic mean (see above). Weights are equal by default.

You can provide the weights by filling in the following table.

Module	Weight
C3a <b>Consequence: environmental targets</b>	_____
C3b <b>Consequence: plant targets</b>	_____
C3c <b>Consequence: animal targets</b>	_____
C3d <b>Consequence: human targets</b>	_____
C3e <b>Consequence: other targets</b>	_____



## Addendum – References

Note : this is a the full reference list taken from

D'hondt B, Vanderhoeven S, Roelandt S, Mayer F, Versteirt V, Ducheyne E, San Martin G, Grégoire J-C, Stiers I, Quoilin S, Branquart E. 2014. *Harmonia*<sup>+</sup> and *Pandora*<sup>+</sup> : risk screening tools for potentially invasive organisms. Belgian Biodiversity Platform, Brussels.

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