## Harmonia+

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compute

context | introduction | establishment | spread | environmental im. | plant im. | animal im. | human im. | other im. | services | climate

- **Section A0 - Context**

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

- → **a01. Provide the name(s) of the assessors:**

Comments:

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

- → **a02. Provide the name of the organism under assessment:**

Comments:

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 Organism'*.

The questionnaire is notably designed to suit multicellular plants and animals. Note that pathogenic or parasitic micro-organisms are covered by the *Pandora*$^{(+)}$ protocol, the results of which may feed into this assessment.

- → **a03. Define the area under assessment:**

Comments:

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.

- → **a04. The Organism is:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate the current status of *The Organism* with regard to *The Area*. Absent/present refers to the presence of *The Organism* within *The Area*'s geographic boundaries (e.g. in captivity). Not established/established refers to the presence of self-sustaining populations in the wild.

This question is only for reporting purposes and does not affect the questionnaire or score calculation.

- → **a05. This assessment is considering potential impacts within the following domains:**

(an)other domain
the human (health) domain
the domesticated animal domain
the cultivated plant domain

Comments:

A target is an entity potentially bearing impacts from *The Organism*. 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.

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- ### Section A1 - Introduction

Questions from this module assess the risk for *The Organism* to overcome geographical barriers and -if applicable- subsequent barriers of captivity or cultivation. This leads to Introduction, defined as the entry of *The Organism* within the limits of *The Area* and subsequently into the wild.

- **a06. The probability for The Organism to be introduced into The Area's wild by natural means is:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Estimate the probability that individuals from *The Organism* enter *The Area*'s wild from the outside, through natural 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:

- There is a single established population of Russian ratsnake (*Elaphe schrenckii*) in the north of the Netherlands (Leewis et al. 2013). It is highly unlikely to reach Belgium from there by natural pathways. – **LOW**
- Natural dispersal of the alien House crow (*Corvus splendens*) to Belgium from the (sole European) population in the Netherlands is not so likely since the species rarely undertakes long flights (Leewis et al. 2013, GB non-native species secretariat [fact sheet]). – **MEDIUM**
- The current alien range of Raccoon dogs (*Nyctereutes procyonoides*) in Germany is very near to the Belgian border, without any geographical barrier in between. – **HIGH**
- Sacred ibis (*Threskiornis aethiopicae*) wander over great distances, thereby easily crossing boundaries, as illustrated by the finding that the Dutch population is at least partly founded by birds born in France (Lemaire 2013). – **HIGH**

- **a07. The probability for The Organism to be introduced into The Area's wild by unintentional human actions is:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Estimate the probability that individuals from *The Organism* enter *The Area*'s limits through human-mediated pathways in which *The Organism* itself is not the focus of transport (e.g. as a hitchhiker or contamination in trade or travel). Subsequent entry into the wild is assumed.

Low : ≤ 1 event expected per decade. Medium : ]1-9] events per decade. High : ≥ 10 events per decade.

Examples

- The Chinese muntjac (*Muntjacus reevesi*) is a very secretive cervid that is unlikely to act as a hitchhiker in transport. – **LOW**
- Pet dogs traveling to southern Europe may be exposed to alien ticks like *Rhipicephalus sanguineus* (Dantas-Torres 2010), which may then enter the wild after having returned home. – **MEDIUM**
- There have been a handful observations of the butterfly Geranium bronze (*Cacyreus marshalli*) in the Netherlands during the past decade. These most probably represent re-newed introductions together with *Pelargonium* plants from Southern Europe (Veling 2012). – **MEDIUM**
- Agricultural weed species regularly contaminate grain commodities, easily entering the wild at their new destination (Shimono & Konuma 2008). E.g., *Ambrosia* seeds are generally found as contaminants in products such as bird feed (CONTAM et al. 2010). – **HIGH**

- → **a08. The probability for The Organism to be introduced into The Area's wild by intentional human actions is:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Consider human-mediated pathways in which *The Organism* itself is the focus of transport and may therefore enter *The Area*'s limits (e.g. trade). Since *The Organism* may escape captivity or cultivation, estimate the combined probability that such entry and subsequent (accidental) escape or (deliberate) release leads to introduction into *The Area*'s wild.

Low : ≤ 1 event expected per decade. Medium : ]1-9] events per decade. High : ≥ 10 events per decade.

Examples

- The Russian ratsnake (*Elaphe schrenckii*) is rarely used in greenhouses or as a pet (Leewis et al. 2013). Escapes or releases from such populations may occur. – **MEDIUM**
- *Aster salignus* is a garden ornamental that is offered by horticultural professionals, though not that commonly (Vanderhoeven et al. 2011). It could enter the wild through escape or stowaway. – **MEDIUM**
- Pond sliders (*Trachemys scripta*) once proved a popular aquarium pet. As adults grew to large sizes, many pet owners intentionally released animals into the wild. – **HIGH**
- *Amelanchier lamarckii* is a garden ornamental that is very commonly offered by horticultural professionals (Vanderhoeven et al. 2011). It could enter the wild through escape or stowaway. – **HIGH**
- In Belgium, there is a limited industry in the fur of farmed American mink (*Neovison vison*). Containment of this species proves to be hard; e.g., in a Danish study, about half of the caught mink had escaped from fur farms within the two most recent months (Hammershøj et al. 2005). – **HIGH**

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context | introduction | establishment | spread | environmental im. | plant im. | animal im. | human im. | other im. | services | climate

- **Section A2 - Establishment**

Questions from this module assess the likelihood for *The Organism* to overcome survival & reproduction barriers. This leads to Establishment, defined as the growth of a population to sufficient levels such that natural extinction within *The Area* becomes highly unlikely.

- **a09. The Area provides ... climate for establishment of The Organism.**

Please select an option

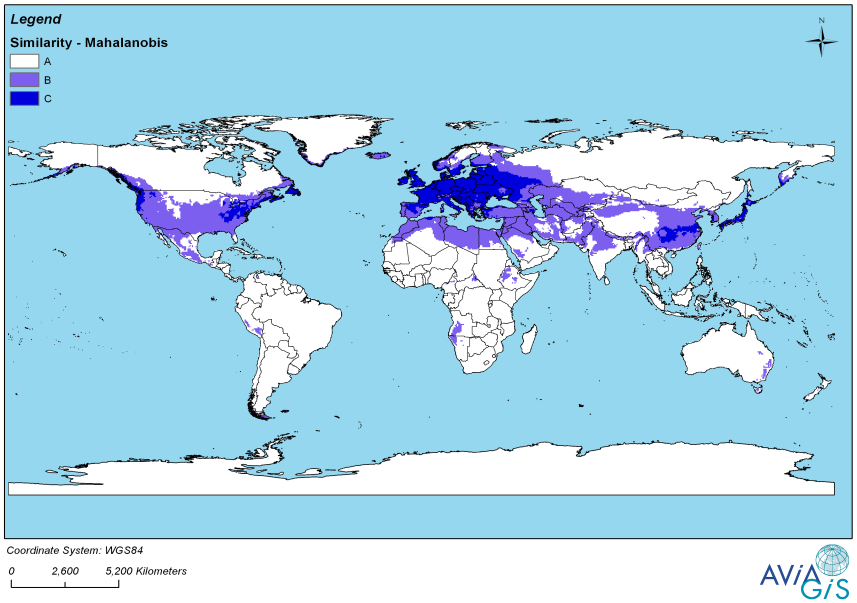
Answer provided with a Please select an option level of confidence.

Comments:

The Area's climate for survival & reproduction of *The Organism*.

This can be achieved by considering the climatic similarity between *The Area* and *The Organism*'s current range, both native and alien. Several ways exist for doing this, e.g. by consulting bioclimatic maps or constructing climate envelope models.

As a simple guidance, we have constructed a climatic similarity map for Belgium relative to the world, shown below. A detailed map for Europe can be consulted through http://ias.biodiversity.be.



*Global map of climatic similarity with Belgium, using the CRU TS3.20 set as climatic variables and the Mahalanobis distance as a similarity index (cf. Farber & Kadmon 2003). Categories A, B, C respond to [0-45%], ]45-94%[ and ]94-100%] similarity, respectively.*

Non-optimal: *The Organism*'s climatic requirements are not properly met. Its current range generally falls into category A from the map above. Sub-optimal: *The Organism*'s climatic requirements are partly met. Its current range generally falls into category B from the map above. Optimal: *The Organism*'s climatic requirements are fully met. Its current range generally falls into category C from the map above.

Examples

- Water hyacinth (*Eichhornia crassipes*) originates from Brazil, but is now found almost throughout the tropics (CABI Invasive Species Compendium). In Belgium, species survival is poor as it does not resist winter temperatures well. – **NON-OPTIMAL**
- The Himalayan striped squirrel (*Tamiops mcclellandii*) is being traded as a pet species. It is naturally found in forests of the (sub)tropic far east. – **NON-OPTIMAL**
- The turtle *Trachemys scripta elegans* is native to the Midwest of the USA, the similarity of which to Belgium is mediocre. Indeed, it seems that reproduction is hampered due to insufficient summer temperatures, here. – **SUB-OPTIMAL**
- *Ambrosia artemisiifolia* survives and reproduces within Belgium, yet recruitment seems too low for the species to persist over longer periods (Bullock et al. 2012). – **SUB-OPTIMAL**
- When considering the distribution of the squirrel *Sciurus carolinensis*, available at http://data.gbif.org/, the native (Eastern America) and alien (United Kingdom) range together suggest no climatic barrier for the species in Belgium. – **OPTIMAL**
- The native (Eastern Asia) and alien (Central Europe) range of the Raccoon dog *Nyctereutes procyonoides* (http://en.wikipedia.org/) indicate no climatic barrier for the species in Belgium. – **OPTIMAL**

- → **a10. The Area provides ... habitat for establishment of The Organism.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate the suitability of the habitats within *The Area* for survival & reproduction of *The Organism*. Habitat includes the presence of suitable food items, hosts, pollinators, seed dispersers, and (other) biotic conditions.

If *The Area* encompasses multiple habitats, consider those that are most likely suited. Thus also take the habitat specificity of *The Organism* into account.

Non-optimal : *The Area* does not provide habitat suitable to *The Organism*; some key condition is not met. Sub-optimal : *The Area* provides habitat that is only partly suited to *The Organism*. Optimal : The Area does provide habitat suitable to *The Organism*; all key biotic conditions are met.

Examples

- Plants of shingle beaches, such as *Inula chritmoides*, would not find proper habitat in Wallonia. – **NON-OPTIMAL**
- *Hyalomma aegyptium* is a tick species that is recurrently introduced in Belgium, yet not established (Obsomer et al. 2013). This is because its main host, tortoises of the genus *Testudo*, are lacking in the wild. – **NON-OPTIMAL**
- *Cyromium falcatum* is an Asian species of fern that naturally grows on rocks (Manual of the Alien Plants of Belgium). In Belgium, isolated individuals sometimes get a foothold in wall crevices. – **SUB-OPTIMAL**
- *Sarracenia* is an obligate out-crossing plant native to the Americas. The flowers require pollinators of an appropriate size and strength, which is only found in (some) native species of bumblebees. – **SUB-OPTIMAL**
- *Rosa rugosa* naturally grows in sandy dune systems of Eastern Asia. In Western Europe, it now occupies the same niches (Kelager et al. 2013). – **OPTIMAL**
- *Cochlearia danica* is a generalist, salt-tolerating plant. It Belgium, it finds prime habitat in salt-treated road(sides). – **OPTIMAL**
- The American bullfrog (*Lithobates catesbeianus*) colonizes a wide variety of lakes, ponds, reservoir, irrigation ditches and marshes (CABI Invasive Species Compendium). These habitats occur readily throughout Europe. – **OPTIMAL**
- The Asian long-horned beetle (*Anoplophora glabripennis*) is a generalist feeder of trees, thus easily finding suitable host plants. – **OPTIMAL**
- The Rhododendron cicada (*Graphocephala fennahi*) is a specialist feeder of Rhododendron, but this is a widely planted (as well as feral) ornamental in Belgium. – **OPTIMAL**

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### Section A3 - Spread

Questions from this module assess the risk of *The Organism* to overcome dispersal barriers & (new) environmental barriers within *The Area*. This leads to spread, in which vacant patches of suitable habitat become increasingly occupied from (an) already-established population(s) within *The Area*.

Note that spread is considered different from range expansions that stem from new introductions (covered by the Introduction module).

### a11. The Organism's capacity to disperse within The Area by natural means is:

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate the capacity of *The Organism* to disperse from (an) established population(s) within *The Area* to vacant habitat patches, through natural pathways. Standard and non-standard natural dispersal modes need to be considered together.

Consider only modes that act yearly, and estimate the maximum dispersal distance involved. Dispersal modes that act more rarely can be neglected.

Several types of data can be used, but their validity may differ. We advise to use the following data in decreasing order of preference (A>B>C).

The suggested cut-off values below apply to Belgium as *The Area*. Note that we consider absolute values as decisive; it is therefore normal for species from the same taxonomic group to score almost always equally.

A : Single-source dispersal - Using data on the distance covered by (propagules from) an individual. This is the preferred type of data because it disentangles true dispersal from secondary introductions or human-mediated spread.

**Very low** : ≤ 50 m per year. **Low** : ]50 m - 500 m] per year. **Medium** : ]500 m - 5 km] per year. **High** : ]5 km - 50 km] per year. **Very high** : > 50 km per year.

B : Population expansion - Using data on the distance covered by the front of The Organism's range. This is less preferred because it does not disentangle true dispersal from secondary introductions or human-mediated spread.

**Very low** : ≤ 10 m per year. **Low** : ]10 m - 100 m] per year. **Medium** : ]100 m - 1 km] per year. **High** : ]1 km - 10 km] per year. **Very high** : > 10 km per year.

C : Approximation - Without data, an estimation of The Organim's intrinsic mobility may be based on life-history traits such as size, fecundity, dispersal traits, behaviour et cetera (taking the above cut-off values into consideration).

Examples

- Seeds of the bog plant *Sarracenia purpurea* rarely disperse beyond 1 meter when shed; other means of dispersal are unlikely (Ellison & Parker 2002). – Data type A - **VERY LOW**
- *Spiraea douglassii* has not been observed to set seed in Belgium, its sole means of natural expansion being through reproductive growth. – Data type C - **VERY LOW**
- The Common slider (*Trachemys scripta*) is a turtle that seems to be rather resident at the local level. – Data type C - **LOW**
- *Ailanthus altissima* has fruits that can float at least 1200 m on waterways (Säumel & Kowarik 2013). – Data type A - **MEDIUM**
- When introduced outside its natural range, the natural spread of Italian crested newts (*Triturus carnifex*) and other closely related newt species averages a maximum speed of 1 km per year (Arntzen & Thorpe 1999, Arntzen & Wallis 1999). – Data type B - **MEDIUM**
- In the initial years after its introduction in 1967 in The Netherlands, the spread rate of the Egyptian goose (*Alopochen aegyptiacus*) was 3,0 km per year (Lensink 1998). – Data type B - **HIGH**
- Sacred ibis (*Threskiornis aethiopicus*) is a large bird species that easily undertakes long flights, as illustrated by the finding that the Dutch population is at least partly founded by birds born in France (Lemaire 2013). – Data type A - **VERY HIGH**
- After the removal of critical barriers in potential invasions corridors (i.e. Main-Danube canal), the invasion of the killer shrimp (*Dikerogammarus villosus*) towards Western Europe was estimated to occur at an average spread speed of 112 km per year (Leuven et al. 2009). – Data type B - **VERY HIGH**

- → **a12. The Organism's frequency of dispersal within The Area by human actions is:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate the probability of The Organism to disperse from (an) established population(s) within The Area to vacant habitat patches, through human-mediated pathways. Intentional and unintentional human dispersal modes need to be considered together.

More precisely, try to estimate the probability that human-mediated dispersal takes (propagules of) an individual > 50 km.

Low : ≤ 1 such event expected per decade. Medium : ]1-9] events per decade. High : ≥ 10 events per decade.

Examples

- The Coypu (*Myocastor coypu*) is a secretive animal that is unlikely to be taken by people and released into the environment elsewhere. – **LOW**
- *Gaillardia x grandiflora* is a showy flower that occurs rarely in the Belgian coastal dunes (http://waarnemingen.be). Yet it is not so likely that fertile seeds from these populations are taken by people and are moved to suitable wild habitat elsewhere. – **LOW**
- Deliberate capture of alien amphibians like the Bullfrog (*Lithobates catesbeianus*) or Italian crested newt (*Triturus carnifex*) often results in release (or escape) at the new location. – **MEDIUM**
- Adults and eggs of the Spanish slug (*Arion lusitanicus)* are regularly found with transported goods, such as garden material, pellets, crates and containers (Leewis et al. 2013). – **HIGH**

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- ### Section A4a - Impacts: environmental targets

Questions from this module qualify the consequences of *The Organism* 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. Similarly, limited ecosystem change is considered as transient and easily reversible; severe change is considered as persistent and hardly reversible.

- ### → a13. The Organism has a(n) ... effect on native species, through predation, parasitism or herbivory:

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* can locally affect native species through its feeding habits (predation, parasitism or herbivory).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the consequence of it feeding on targets.

**Low** : at worst, *The Organism* causes limited population declines in species that are not of conservation concern. **Medium** : at worst, *The Organism* causes severe population declines in species that are not of conservation concern, or limited population declines in species that are of conservation concern. **High** : at worst, *The Organism* causes severe population declines in species that are of conservation concern.

Choosing **Inapplicable** omits the question from calculation.

Examples

- Predation has no meaning if *The Organism* is a plant. – **INAPPLICABLE**
- The bug *Nysius huttoni* is a polyphagous bug native to New-Zealand that now occurs in the Netherlands, often at very high densities (>$10^6$ $ha^{-1}$). It has been found on various plant species, but all of these are very common weeds (Smit et al. 2007). – **LOW**
- The cicada *Graphocephala fennahi* exclusively (and not severely) feeds on alien *Rhododendron ponticum*. – **LOW**
- The Harlequin ladybird (*Harmonia axyridis*) predates on a variety of native ladybird species and this has been linked to their concurrent decline (Hautier et al. 2011, Adriaens et al. 2012). – **HIGH**

- ### → a14. The Organism has a (...) effect on native species, through competition:

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* can locally affect native species through competition. This includes competition for plant pollinators and competition that is mediated through allelopathic chemicals.

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the consequence of competition.

Low : at worst, *The Organism* causes limited population declines in species that are not of conservation concern. Medium : at worst, *The Organism* causes severe population declines in species that are not of conservation concern, or limited population declines in species that are of conservation concern. High : at worst, *The Organism* causes severe population declines in species that are of conservation concern.

Examples

- The preferred microhabitat of the alien moss *Orthodontium lineare* at the foot of certain tree species does not harbor native mosses, avoiding any effect (Sparrius 2013). – **LOW**
- Outbreaks of Minute duckweed (*Lemna minuta*) result in dense floating mats at the water surface, but these are usually limited in time and space. Competition with native macrophytes is poorly documented but seems to be less severe than with other invasive aquatic plants. – **MEDIUM**
- *Rosa rugosa* forms very dense stands in coastal dune grasslands or scrub, where little opportunity remains for other plants to grow. – **HIGH**

- → **a15. The Organism has a(n) (...) effect on native species, through interbreeding:**

Please select an option

Answer provided with a Please select an option level of confidence.

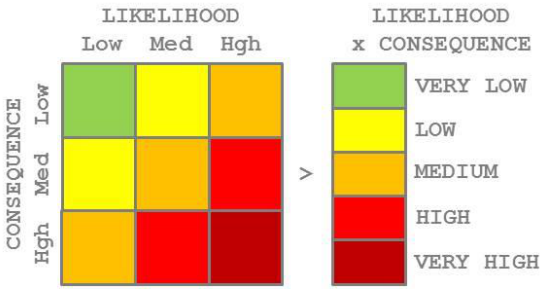
Comments:

Indicate whether *The Organism* can locally affect native species through genetic effects, such as hybridisation or introgression (the production of fertile hybrids that backcross with their parents to form hybrid swarms).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the likelihood (frequency) for The Organism to show interbreeding 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* – Low : at worst, *The Organism* causes limited losses of genetic integrity in species that are not of conservation concern. Medium : at worst, *The Organism* causes severe losses of genetic integrity in species that are not of conservation concern, or limited losses of genetic integrity in species that are of conservation concern. High : at worst, *The Organism* causes severe losses of genetic integrity in species that are of conservation concern.




If the likelihood to interbreed is nil, choose No as an answer.

Examples

- The North American beaver (*Castor canadensis*) and Eurasian beaver (*Castor fiber*) are not genetically compatible and cannot interbreed to create a hybrid subspecies (likelihood = nil). – **VERY LOW**
- Canada geese (*Branta canadensis*) may hybridise with other geese (likelihood = medium), but there are few native breeding geese in Western Europe, and most reported incidences have been with other feral species (consequence = low GB non-native species secretariat [risk analysis]). – **LOW**
- Current hybridisation with the Italian crested newt (*Triturus carnifex*) puts the native crested newt (*Triturus cristatus*) –an already-threatened & protected species– at risk in the Netherlands (van Delft 2012). – **VERY HIGH**

- → **a16. The Organism has a (...) effect on native species, by hosting pathogens or parasites that are harmful to them.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Identify all pathogens or parasites that are known to be considerably hosted by both *The Organism* and the targets under consideration, and estimate the risk that these may pose to the targets.

Pathogens (parasites) may be of viral, bacterial, fungal or animal origin, and may either be endemic (already present within *The Area*) or (re)emerging (new or returning).

If no shared pathogens between *The Organism* and targets are known, or there is good reason to assume that no shared pathogens exist, choose Very low as an answer.

Pathogenicity is a complex issue, for which a lot of data needs to be compiled. We advise to use the following sources in decreasing order of preference (A>B>C>D).

A : Pandora$^+$ – In analogy to this risk assessment, we have created a screening tool for pathogens that directly refers to *The Organism* as a host.

If you have used *Pandora*$^+$ for one or more individual pathogens, select the pathogen with the highest score for the environmental domain impact (see output for 'Entry x Exposure x Environmental IMPACTS' using the default methods). We suggest the following cut-off values.

**Very low** : 0. **Low** : ]0-0.25]. **Medium** : ]0.25-0.50]. **High** : ]0.50-0.75]. **Very high** : ]0.75-1.00].

B : OiE – The World Organisation for Animal Health's working group on wildlife diseases has issued a list of important diseases for which surveillance is advisable.

Consult this list at http://www.oie.int/wahis_2/public/wahidwild.php# and count the number of shared infectious agents. We suggest the following cut-off values.

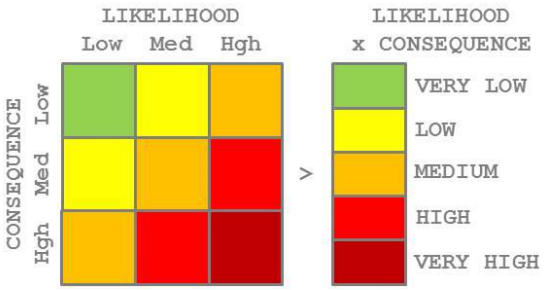
**Very low** : The Organism is known to host pathogens, but none are on the list. **Low** : 1 or 2. **Medium** : 3 or 4. **High** : 5 or 6. **Very high** : 7 or higher.

C : WILDTOOL – WILDTOOL is a flexible system for assessing the risk that wildlife-borne pathogens may pose to different target groups within Belgium (Tavernier et al. 2011). It is available at http://wildtool.var.fgov.be. See addendum D for further instructions.

Consider the risks that pathogens borne by *The Organism* may pose to 'wildlife'. Consider the pathogen that yields the highest score and apply the following cut-off values.

**Low** : pathogen not in top-15. **High** : pathogen in top-15.

D : Short-cut version – In case of serious data absence, select the worst of the shared pathogens, and try to estimate the likelihood of harm (i.e., the likelihood to become more prevalent and exposed to targets, in case of endemic diseases; or the *likelihood* to enter and be exposed to targets, in case of [re]emerging diseases) and the consequence of harm (as in previous questions).




Examples

- A panel of six experts assessed the risk of the amphibian-infecting fungus *Batrachochytrium dendrobatidis* using the *Pandora*$^+$ protocol, yielding an overall risk score of 0.84. (The alien Bullfrog acts as a resistant vector for this pathogen.) – Data type A - **VERY HIGH**

- → **a17. The Organism has a (...) effect on ecosystem integrity, by affecting its abiotic properties.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* can affect particular ecosystems by interacting with its physical, chemical or structural properties. Properties may pertain to soil (through processes such as erosion, sedimentation or litter mineralization), water (e.g. O2, turbidity, pH, salinity), nutrient pools (e.g. eutrophication), vegetation structure, light et cetera.

The changes in these properties may cause changes in the composition and/or rate of succession of communities that share the same habitat.

Assume that *The Organism* becomes widespread within The Area. Then, estimate the consequence of such abiotic change.

**Low** : at worst, *The Organism* causes easily reversible process changes in ecosystems that are not of conservation concern. **Medium** : at worst, *The Organism* causes hardly reversible process changes in ecosystems that are not of conservation concern, or easily reversible process changes in ecosystems that are of conservation concern. **High** : at worst, *The Organism* causes hardly reversible process changes in ecosystems that are of conservation concern.

Examples

- Outbreaks of Minute duckweed (*Lemna minuta*) result in dense floating mats at the water surface, reducing light penetration and gas exchanges. However, outbreaks are usually limited in time and space and are favoured by increased levels of water eutrophication that already affects vegetation itself. – **MEDIUM**
- As *Rhododendron ponticum* can completely dominate the understory of forests in the British Isles, tree regeneration becomes prevented, ultimately interrupting tree canopy layer. – **HIGH**
- The Coypu (*Myocastor coypus*) is a South American rodent that escaped from fur farms, and now occurs in the wild in Southern Europe. The animals dig large burrows in the banks of rivers and canals, also suppressing reed beds. – **HIGH**

- → **a18. The Organism has a (...) effect on ecosystem integrity, by affecting its biotic properties.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* can affect particular ecosystems by (cascading) effects in the food web, pollination, dispersal et cetera.

Assume that *The Organism* becomes widespread within The Area. Then, estimate the consequence of such biotic change.

Low : at worst, *The Organism* causes easily reversible process changes in ecosystems that are not of conservation concern. Medium : at worst, *The Organism* causes hardly reversible process changes in ecosystems that are not of conservation concern, or easily reversible process changes in ecosystems that are of conservation concern. High : at worst, *The Organism* causes hardly reversible process changes in ecosystems that are of conservation concern.

Examples

- The encroachment by the alien moss *Campylopus introflexus* in the Dutch dunes has been suggested as a causal agent for the disappearance of the Tawny pipit (*Anthus campestris*) by decreasing arthropod availability (van Turnhout 2005). – **HIGH**
- *Helicorophium curvispinum* is a species of amphipod crustacean that causes river bed substrates to be inaccessible to many other animals, such as mussels, and this eventually cascades into negative effects on diving ducks that prey on these (Leewis et al. 2013). – **HIGH**
- Plants that form monospecific populations in ecosystems of conservation concern cause assemblages of phytophagous organisms to be replaced. – **HIGH**

Harmonia+

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## Harmonia+

Harmonia+ is a first-line risk assessment scheme for potentially invasive species. It present a series of questions concerning an organism, the answers of which need to be provided by one or more assessors. Harmonia+ is described in full here http://ias.biodiversity.be/harmoniaplus. Additional information is described by D'hondt et al. (manuscript).

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compute

context | introduction | establishment | spread | environmental im. | **plant im.** | animal im. | human im. | other im. | services | climate

- **Section A4b - Impacts: plant targets**

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

For the questions from this module, consequence is considered 'low' when *The Organism*'s presence in (or on) a population of target plants is sporadic and/or causes little damage. Harm is considered 'medium' when *The Organism*'s development causes local yield (or plant) losses below 20%, and 'high' when losses range > 20%.

- → **a19. The Organism has a(n) (...) effect on plant targets, through herbivory or parasitism.**

Please select an option

Answer provided with a Please select an option level of confidence.

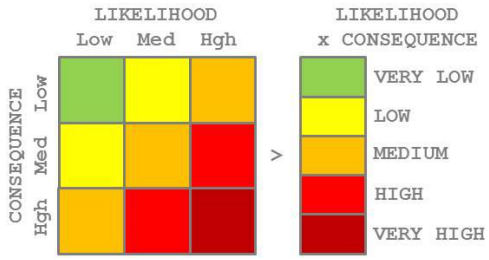
Comments:

Indicate whether *The Organism* can affect plant quality (vitality) or yield through its feeding habits (herbivory or parasitism).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to feed on targets (likelihood) and the consequence of this happening.

*Likelihood* - Ideally corresponds to the following probabilities. **Low** : expected to affect less than 1/3th of plant target populations. **Medium** : 1/3-2/3th of populations. **High** : more than 2/3th of populations.

*Consequence* - **Low** : at worst, quality or yield is decreased with ≤ 5% within a population. **Medium** : ≤ 20% at worst. **High** : > 20% at worst.




Choosing **Inapplicable** omits the question from calculation.

Examples

- Predation has no meaning if *The Organism* is a carnivorous animal. – **INAPPLICABLE**
- *Arceuthobium minutissimum* is a parasitic plant that is (almost) exclusively hosted by *Pinus wallichiana*, which is a very rare ornamental in Belgium (likelihood = low, consequence = medium). -- **LOW**
- The bug *Nysius huttoni* is native to New-Zealand, where it is a significant agricultural pest (consequence = high). The species now occurs in Belgium and the Netherlands, but it seems to be currently confined to waste ground, roadsides and abandoned fields instead of crops (likelihood = low; Smit et al. 2007, Bonte et al. 2010). – **MEDIUM**
- The Horse chestnut leafminer (*Cameraria ohridella*) has become very prevalent among its host tree, which is a highly planted ornamental (likelihood = high). It does not kill trees, but causes severe defoliation and decrease of reproductive effort (Thalmann et al. 2003; consequence = medium.) – **HIGH**

- → **a20. The Organism has a(n) (...) effect on plant targets, through competition.**

Please select an option

Answer provided with a Please select an option level of confidence.

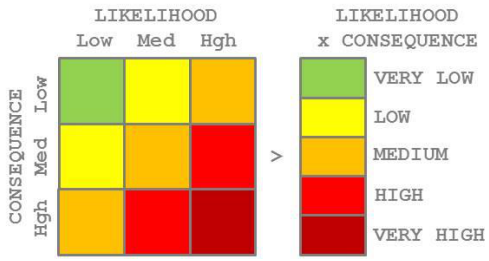
Comments:

Indicate whether *The Organism* can affect plant quality or yield through competition. This includes competition for plant pollinators and competition that is mediated through allelopathic chemicals.

Assume that *The Organism* becomes widespread within The Area. Then, estimate the frequency for *The Organism* to compete with targets (likelihood) and the consequence of this happening.

Likelihood – Ideally corresponds to the following probabilities. **Low** : expected to affect less than 1/3th of plant target populations. **Medium** : 1/3–2/3th of populations. **High** : more than 2/3th of populations.

Consequence – **Low** : at worst, quality or yield is decreased with ≤ 5% within a population. **Medium** : ≤ 20% at worst. **High** : > 20% at worst.




If *The Organism* is not a plant, choosing **Inapplicable** (this omits the question from calculation).

Examples

- Competition is irrelevant if *The Organism* is an animal. – **INAPPLICABLE**
- *Anthoxanthum aristatum* is an alien grass that behaves primarily as a weed in rye crops (Manual of the Alien Plants of Belgium; likelihood = high). It is an annual species that does not behave aggressively (consequence = low). – **MEDIUM**
- *Ambrosia artemisiifolia* is an alien herb that grows in disturbed soils, including arable lands, plenty of which are available in Belgium (likelihood = high). The species amounts up to 1000 plants m-2 in the French Drôme, leading to losses of 20-80% for sunflower (Bruzeau 2007 in Bullock et al. 2012; consequence = high). – **VERY HIGH**

- → **a21. The Organism has a(n) (...) effect on plant targets, by interbreeding with related organisms or with the target itself.**

Please select an option

Answer provided with a Please select an option level of confidence.

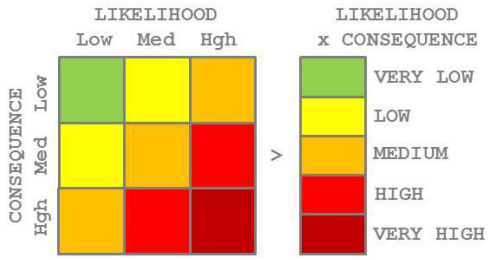
Comments:

Indicate whether *The Organism* can affect plant quality or yield through genetic mechanisms, such as hybridisation or introgression. This can either be with the target itself, or with related organisms that thereby increase the threats posed by them (weeds developing into 'superweeds'; Ellstrand & Schierenbeck 2000, Campbell et al. 2006).

Assume that *The Organism* becomes widespread within The Area. Then, estimate the likelihood (frequency) for *The Organism* to show interbreeding 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 – **Low** : at worst, quality or yield is decreased with ≤ 5% within a population. **Medium** : ≤ 20% at worst. **High** : > 20% at worst.




If the likelihood to interbreed is nil, choose **No** as an answer. If *The Organism* is not a plant, choose **Inapplicable** (this omits the question from calculation).

Examples

- Interbreeding is irrelevant if *The Organism* is an animal. – **INAPPLICABLE**
- In France, cultivated varieties of sunflower (*Helianthus annuus*) are prone to hybridization with introduced populations of wild-type sunflower (same species; likelihood = high). Here, local densities of weedy sunflowers can decrease crop yield to more than 50% (consequence = high; Muller et al. 2009). – **VERY HIGH**

- → **a22. The Organism has a (...) effect on plant targets, by affecting the cultivation system's integrity.**

Please select an option

Answer provided with a Please select an option level of confidence.

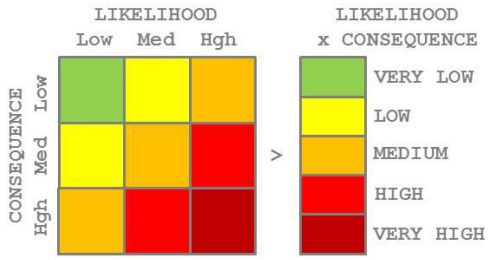
Comments:

Indicate whether *The Organism* can affect plant quality or yield by affecting properties of the system: i.e., by affecting nutrient cycles, hydrology, the physical habitat, food webs, *et cetera*.

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to affect cultivation systems (likelihood) and the consequence of this happening.

*Likelihood* – Ideally corresponds to the following probabilities. **Low** : expected to affect less than 1/3th of plant target populations. **Medium** : 1/3–2/3th of populations. **High** : more than 2/3th of populations.

Consequence – **Low** : at worst, quality or yield is decreased with ≤ 5% within a population. **Medium** : ≤ 20% at worst. **High** : > 20% at worst.




Examples

- In Spain, the aquatic plant *Eichhornia crassipes* affects irrigation farming practices by blocking channels (Téllez et al. 2008; consequence = high). However, these practices are less important in Belgium, and established populations are not expected to build-up to a similar extent due to less-suited climatic conditions (likelihood = low). – **MEDIUM**
- The tree *Prunus serotina* is now a common colonizer of suitable, clear-cut areas in forests (likelihood = high). Its presence may cause temporary freezing of ecological successions, leading to mid-term succession dominance and a slow-down of forest recovery (Closset-Kop et al. 2007, Decocq 2007, Chabrerie et al. 2010; consequence = medium). – **HIGH**

- ➔ **a23. The Organism has a(n) (...) effect on plant targets, by hosting pathogens or parasites that are harmful to them:**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Identify all pathogens or parasites that are known to be considerably hosted by both *The Organism* and the targets under consideration, and estimate the risk that these pathogens may pose to the targets.

Pathogens (parasites) may be of viral, bacterial, fungal or animal origin, and may either be endemic (already present within *The Area*) or (re)emerging (new or returning).

If no shared pathogens between *The Organism* and targets are known, or there is good reason to assume that no shared pathogens exist, choose **Very low** as an answer. Choosing **Inapplicable** omits the question from calculation.

Pathogenicity is a complex issue, for which a lot of data needs to be compiled. We advise to use the following sources in decreasing order of preference (A>B>C).

A : *Pandora*$^{+}$ – In analogy to this risk assessment, we have created a screening tool for pathogens that directly refers to The Organism as a host.

If you have used *Pandora*$^{+}$ for one or more individual pathogens, select the pathogen with the highest score for the plant domain impact (see output for 'I x E x S x plant IMPACTS' using the default methods). We suggest the following cut-off values.

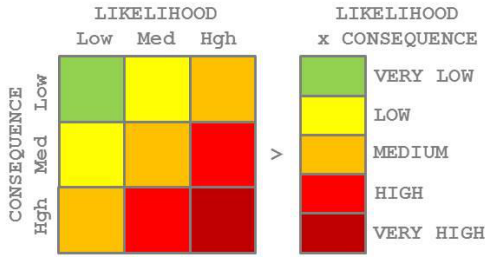
**Very low** : 0. **Low** : ]0–0.25]. **Medium** : ]0.25–0.50]. **High** : ]0.50–0.75]. **Very high** : ]0.75–1.00].

B : EPPO – The list of pests that are recommended for regulation, as issued by the European & Mediterranean Plant Protection Organization may be used as a source.

Consult the EPPO list at http://archives.eppo.int/EPPOStandards/PM1_GENERAL/pm1-_02%2822%29_A1A2_2013.pdf and consider the shared prokaryotes, fungi, viruses and nematodes (but not the other groups) from the A1 and A2 lists.

**Very low** : no shared pathogens known or assumed. **Low** : shared pathogens known or assumed, but not on the lists. **Medium** : ≥ one A2-listed species. **High** : ≥ one A1-listed species. **Very high** : ≥ one A2-listed species and ≥ one A1-listed species.

C : Short-cut version – In case of serious data absence, select the worst of the shared pathogens, and try to estimate the likelihood of harm (i.e., the likelihood to become more prevalent and exposed to targets, in case of endemic diseases; or the likelihood to enter and be exposed to targets, in case of [re]emerging diseases) and the consequence of harm (as in previous questions).




Examples

- *Monochamus alternatus* is a species of beetle that acts as a vector of three *Bursaphelenchus nematode* species, one of which is on the A2 list of EPPO (Cooperative Agricultural Pest Survey). – Data type B - **MEDIUM**
- *Pseudopityophthorus* beetles are important vectors of the A1-listed pathogen *Ceratocystis* (Rexrode & Jones 1970). – Data type B – **HIGH**

Harmonia+

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## Harmonia+

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compute

context | introduction | establishment | spread | environmental im. | plant im. | **animal im.** | human im. | other im. | services | climate

- **Section A4c - Impacts: animal targets**

Questions from this module qualify the consequences of *The Organism* 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.

- → **a24. The Organism has a(n) (...) effect on individual animal health or animal production, through predation or parasitism.**

Please select an option

Answer provided with a Please select an option level of confidence.

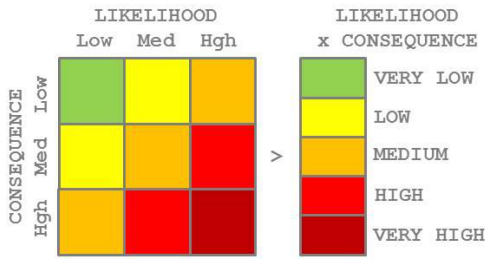
Comments:

Indicate whether *The Organism* affects animal targets by feeding on them (predation or parasitism).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to feed on targets (likelihood) and the consequence of this happening.

*Likelihood* - Ideally corresponds to the following probabilities (based on Havelaar et al. 2010). **Low** : incidence <1 per 100,000 animals per year. **Medium** : 1-100 per 100,000 animals per year. **High** : >100 per 100,000 animals per year.

*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.




Choosing **Inapplicable** omits the question from calculation.

Examples

- Predation has no meaning if *The Organism* is a plant or herbivorous animal. – **INAPPLICABLE**
- *Rhipicephalus sanguineus* is a (sub)tropical to Mediterranean tick that primarily feeds on dogs, thereby acting as a nuisance (Dantas-Torres 2010; likelihood = medium, consequence = low). – **LOW**
- American mink (*Neovison vison*) rarely kills domestic poultry, ducks and geese (likelihood = low, consequence = high; Harrison & Symes 1989). – **MEDIUM**
- The Asian hornet (*Vespa velutina*) exclusively feeds on honeybees (likelihood = medium), which support a specific, yet vulnerable economy (consequence = high). –**HIGH**
- Varroa mites (*Varroa destructor*) have contributed largely to the global decline of honeybee colonies. - **VERY HIGH**

- → **a25. The Organism has a (...) effect on individual animal health or animal production, by having properties that are hazardous upon contact.**

Please select an option

Answer provided with a Please select an option level of confidence.

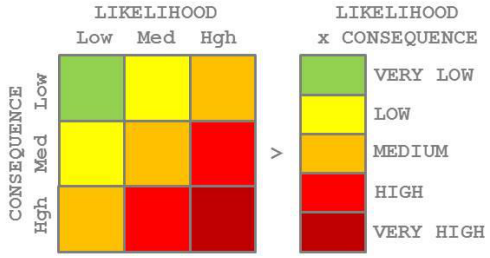
Comments:

Indicate whether *The Organism* has biological, physical and/or chemical properties that are harmful upon contact with the targets (e.g. through toxins or allergens). This also includes events where animals may perform aggressive behaviour. (Note that parasitism is dealt with elsewhere, as is pathogen transmission.)

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to come in contact with the targets (likelihood) and the consequence of this happening.

*Likelihood* – Ideally corresponds to the following probabilities (based on Havelaar et al. 2010). **Low** : incidence <1 per 100,000 animals per year. **Medium** : 1–100 per 100,000 animals per year. **High** : >100 per 100,000 animals per year.

*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.




Examples

- Raccoons (*Procyon lotor*) may behave aggressively towards dogs, e.g. by biting when feeling threatened (likelihood = low, consequence = medium). – **LOW**
- *Conium maculatum* is a poisonous plant that only marginally occurs in grasslands. It is avoided during grazing, but may contaminate hay (likelihood = low). When eaten, it may be lethal to cattle (Galey et al. 1992; consequence = high). – **MEDIUM**
- When grazing on common grounds, livestock may come into contact with (alien) geese, their feathers or droppings (likelihood = high). However, this does not invoke any direct harm (consequence = low). – **MEDIUM**
- Pollen of Ragweed (*Ambrosia artemisiifolia*) are widespread (likelihood = high) and can cause clinically manifested allergenic reactions in dogs, being second only to house dust mites (Ognjenovic et al. 2013; consequence = medium). – **HIGH**

- → **a26. The Organism has a(n) (...) effect on individual animal health or animal production, by hosting pathogens or parasites that are harmful to them.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Identify all pathogens or parasites that are known to be considerably hosted by both *The Organism* and the targets under consideration, and estimate the risk that these pathogens may pose to the targets.

Pathogens (parasites) may be of viral, bacterial, fungal or animal origin, and may either be endemic (already present within *The Area*) or (re)emerging (new or returning).

If no shared pathogens between *The Organism* and targets are known, or there is good reason to assume that no shared pathogens exist, choose **Very low** as an answer. Choosing **Inapplicable** omits the question from calculation.

Pathogenicity is a complex issue, for which a lot of data needs to be compiled. We advise to use the following sources in decreasing order of preference (A>B>C>D).

A : *Pandora*$^{+}$ – In analogy to this risk assessment, we have created a screening tool for pathogens that directly refers to *The Organism* as a host.

If you have used *Pandora*$^{+}$ for one or more individual pathogens, select the pathogen with the highest score for the animal domain impact (see output for 'I x E x S x animal IMPACTS' using the default methods). We suggest the following cut-off values.

**Very low** : 0. **Low** : ]0–0.25]. **Medium** : ]0.25–0.50]. **High** : ]0.50–0.75]. **Very high** : ]0.75–1.00].

B : OiE – The list of notifiable diseases issued by the World Organisation for Animal Health could be used as a source.

Consult the OiE list at http://www.oie.int/animal-health-in-the-world/oie-listed-diseases-2013/ and count the number of shared pathogens. We suggest the following cut-off values.

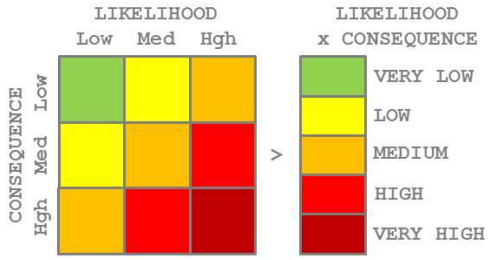
**Very low** : *The Organism* is known to host pathogens, but none are notifiable. **Low** : 1 or 2. **Medium** : 3 or 4. **High** : 5 or 6. **Very high** : 7 or higher.

C : WILDTOOL – WILDTOOL is a flexible system for assessing the risk that wildlife-borne pathogens may pose to different target groups within Belgium (Tavernier et al. 2011). It is available at http://wildtool.var.fgov.be. See addendum D for further instructions.

Consider the risks that pathogens borne by *The Organism* may pose to 'production animals' or 'companion animals'. Consider the pathogen that yields the highest score.

**Low** : pathogen not in top-15. **High** : pathogen in top-15.

D : Short-cut version – In case of serious data absence, select the worst of the shared pathogens, and try to estimate the *likelihood* of harm (i.e., the likelihood to become more prevalent and exposed to targets, in case of endemic diseases; or the likelihood to enter and be exposed to targets, in case of [re]emerging diseases) and the consequence of harm (as in previous questions).




Examples

- Plants may be considered irrelevant candidate hosts for pathogens of animal targets. – **INAPPLICABLE**
- The pigeon-infecting *Argas reflexus*, an alien tick to Belgium, readily bites chickens and horses (Obsomer et al. 2013) and is known to host pathogens that may cause borreliosis and piroplasmosis (Fain 1990). Yet, these pathogens are not on the notifiable list. – **VERY LOW** - Data Type B.
- Fallow deer, alien to Western Europe, is a known competent host of the following notifiable disease agents: bovine tuberculosis, foot-and-mouth disease, epizootic haemorrhagic disease, and bovine viral diarrhoea (Böhm et al. 2007). – **MEDIUM** - Data Type B.
- When it comes to horses as targets, Canada geese are a known host for three notifiable diseases: Eastern and Western Equine Encephalitis, and West Nile Virus (Fraser & Fraser 2010). – **MEDIUM** - Data Type B.
- When it comes to all livestock species as targets, Canada geese are a known host for six notifiable diseases. Apart from the three listed above, this includes *Mycoplasma*, avian influenza and Newcastle disease (Fraser & Fraser 2010). – **HIGH** - Data Type B.
- From the list of pathogens that are borne by Canada geese (as listed by Fraser & Fraser 2010), Eastern equine encephalitis virus is the highest- ranked in a WILDTOOL-generated list, i.e. 2nd (following the instructions from addendum D). – **VERY HIGH** – Data Type C.

Harmonia+

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## Harmonia+

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compute

context | introduction | establishment | spread | environmental im. | plant im. | animal im. | **human im.** | other im. | services | climate

- **Section A4d - Impacts: human targets**

Questions from this module qualify the consequences of *The Organism* 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 World Health Organization).

- → **a27. The Organism has a(n) (...) effect on human health, through parasitism.**

Please select an option

Answer provided with a Please select an option level of confidence.

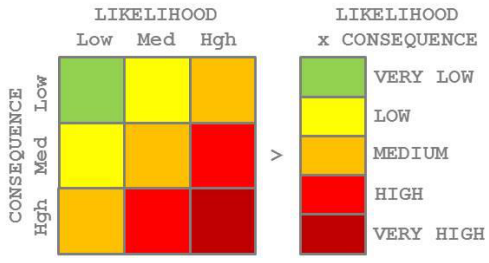
Comments:

Indicate whether *The Organism* has the capacity to feed on humans and whether this may cause harm to the physical, mental or social well-being of humans (biting and having blood meals, causing irritation).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to parasitize humans (likelihood) and the consequence of this happening.

*Likelihood* - Ideally corresponds to the following probabilities (based on Havelaar et al. 2010). **Low** : incidence <1 per 100,000 humans per year. **Medium** : 1-100 per 100,000 humans per year. **High** : >100 per 100,000 humans per year.

*Consequence* - Refers to the symptoms, duration of illness, recovery, or the amount of stress involved (cf. Krause 2008). **Low** : medical consultation is rare, no work loss, no persisting handicaps, low amounts of stress. **Medium** : medical consultation is frequent, work loss of 1-5 days may occur, persisting handicaps rare, medium amounts of stress. **High** : medical consultation is common, work loss of > 5 days may occur, persisting handicaps may occur, high amounts of stress.




Choosing **Inapplicable** omits the question from calculation.

Examples

- Parasitism has no meaning if *The Organism* is a plant or herbivorous animal. – **INAPPLICABLE**
- *Rhipicephalus sanguineus* is primarily a parasite of dogs, but can also parasitize humans, particularly during the summer (Dantas-Torres 2010; likelihood = medium, consequence = medium). – **MEDIUM**
- Where dense populations build up, the Asian tiger mosquito (*Aedes albopictus*) can develop into an aggressive daytime stressor in their search for human blood (likelihood = medium; consequence = high). – **HIGH**

- → **a28. The Organism has a (...) effect on human health, by having properties that are hazardous upon contact.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* has biological, physical and/or chemical properties that, upon contact, affect the physical, mental or social well-being of humans (e.g. through toxins or allergens). This also includes events where animals may perform aggressive behaviour. (Note that parasitism is dealt with elsewhere, as is pathogen transmission.)

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to come into contact with humans (likelihood) and the consequence of this happening.

*Likelihood* – Ideally corresponds to the following probabilities (based on Havelaar et al. 2010). **Low** : incidence <1 per 100,000 humans per year. **Medium** : 1-100 per 100,000 humans per year. **High** : >100 per 100,000 humans per year.

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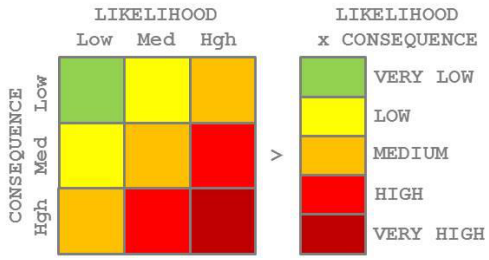



Examples

- Shrubs such as *Gleditsia triacanthos* are very thorny, so that people working with them (likelihood = low) can get easily injured (consequence = medium). – **LOW**
- The saliva of some alien tick species can be paralyzing (consequence = high), but this seems to be very rare in Europe (Obsomer et al. 2013; likelihood = low). – **MEDIUM**
- Asian predatory wasps (*Vespa velutina*) sting people, but only when they feel severely disturbed (likelihood = medium; consequence = medium). – **MEDIUM**
- The alien mushroom *Leucocoprinus birnbaumii* is not harmful upon contact, but is poisonous if eaten (Boomsluiter 2013; likelihood = low, consequence = high). – **MEDIUM**
- The Black widow spider (*Latrodectus mactans*) is venomous to humans (cf. physical well-being) and generally causes strong reactions of fear (cf. mental and social well-being; likelihood = medium, consequence = high). – **HIGH**
- Sap of hogweed *Heracleum mantegazzianum* may cause serious irritation upon contact with the skin (likelihood = medium, consequence = high). – **HIGH**
- Pollen of ragweed *Ambrosia artemisiifolia* may evoke allergenic, hay fever-like reactions in a substantial percentage of the human population (likelihood = high; consequence = high). – **VERY HIGH**

- → **a29. The Organism has a(n) (...) effect on the health of human targets, by hosting pathogens or parasites that are harmful to them.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Identify all pathogens or parasites that are known to be considerably hosted by both *The Organism* and the targets under consideration, and estimate the risk that these pathogens may pose to the targets.

Pathogens (parasites) may be of viral, bacterial, fungal or animal origin, that are naturally transmissible from animals to humans and vice versa (i.e. zoonotic). They may either be endemic (already present within *The Area*) or (re)emerging (new or returning).

If no shared pathogens between *The Organism* and targets are known, or there is good reason to assume that no shared pathogens exist, choose **Very low** as an answer. Choosing **Inapplicable** omits the question from calculation.

Pathogenicity is a complex issue, for which a lot of data needs to be compiled. We advise to use the following sources in decreasing order of preference (A>B>C>D).

A : *Pandora*$^{+}$ – In analogy to this risk assessment, we have created a screening tool for pathogens that directly refers to *The Organism* as a host.

If you have used *Pandora*$^{+}$ for one or more individual pathogens, select the pathogen with the highest score for the human domain impact (see output for 'I x E x S x animal IMPACTS' using the default methods). We suggest the following cut-off values.

**Very low** : 0. **Low** : ]0-0.25]. **Medium** : ]0.25-0.50]. **High** : ]0.50-0.75]. **Very high** : ]0.75-1.00].

B : other protocols – Several protocols exist that prioritize zoonotic pathogens and provide lists of them. They differ in many aspects (for one thing, they are rarely restricted to wildlife-borne diseases) but may still be found useful. Such studies are provided by, e.g., Cardoen et al. (2009), Krause et al. (2008) and Havelaar et al. (2010).

If you have access to any of such studies, consider the risks of the respective pathogens. When considering multiple pathogens, consider the one with the highest score. We suggest the following guidance.

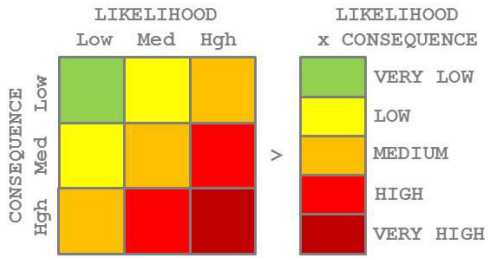
**Very low** : no shared pathogens known or assumed. **Low** : within the lower quartile of the presented scores. **Medium** : $3/4^{th}$ - $2/4^{th}$ . **High** : $2/4^{th}$ - $1/4^{th}$ . **Very high** : within the upper quartile of the presented scores.

C : WILDTOOL – WILDTOOL is a flexible system for assessing the risk that wildlife-borne pathogens may pose to different target groups within Belgium (Tavernier et al. 2011). It is available at http://wildtool.var.fgov.be. See addendum D for further instructions.

Consider the risks that pathogens borne by *The Organism* may pose to 'man'. Consider the pathogen that yields the highest score.

**Low** : pathogen not in top-15. **High** : pathogens in top-15.

D : Short-cut version – In case of serious data absence, select the worst of the shared pathogens, and try to estimate the *likelihood* of harm (i.e., the likelihood to become more prevalent and exposed to targets, in case of endemic diseases; or the likelihood to enter and be exposed to targets, in case of [re]emerging diseases) and the *consequence* of harm (as in previous questions).




Examples

- Plants may be considered irrelevant candidate hosts for pathogens of human targets. – **INAPPLICABLE**
- Using the *Pandora*+ protocol, a panel of three experts assessed the human risk of rabies (re)emergence by Raccoon dogs in Belgium to be (on average) 0.22. No other pathogens were assessed, however. – Data type A - **LOW**
- Of the pathogenic agents hosted by Raccoon dogs, *Echinococcus* is the one ending up highest in WILDTOOL, on rank 12. – Data type C - **MEDIUM**

Harmonia+

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## Harmonia+

Harmonia+ is a first-line risk assessment scheme for potentially invasive species. It present a series of questions concerning an organism, the answers of which need to be provided by one or more assessors. Harmonia+ is described in full here http://ias.biodiversity.be/harmoniaplus. Additional information is described by D'hondt et al. (manuscript).

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compute

context | introduction | establishment | spread | environmental im. | plant im. | animal im. | human im. | other im. | services | climate

- **Section A4e - Impacts: other targets**

Questions from this module qualify the consequences of *The Organism* on targets not considered in modules A4a-d.

- **a30. The Organism has a (...) effect on causing damage to infrastructure.**

Please select an option

Answer provided with a Please select an option level of confidence.

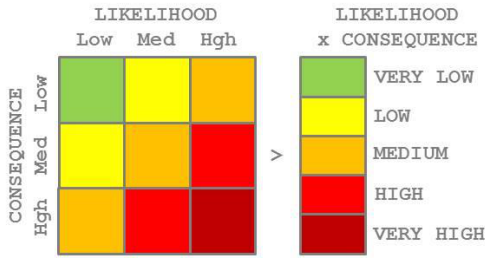
Comments:

Indicate whether *The Organism* affects infrastructure or the way it is used. Infrastructure includes real property (immovable property; terrains and their vegetation cover, buildings, wells, dams, ponds, mines, canals, roads, et cetera) and personal property (movable property).

Assume that *The Organism* becomes widespread within *The Area*. Then, estimate the frequency for *The Organism* to come in contact with infrastructure (likelihood) and the consequence of this happening (damage).

*Likelihood* - Ideally corresponds to the following probabilities (based on Havelaar et al. 2010). **Low** : incidence <1 per 100,000 items per year. **Medium** : 1-100 per 100,000 items per year. **High** : >100 per 100,000 items per year.

*Consequence* - **Low** : completely reversible. **Medium** : partly reversible. **High** : irreversible.




Examples

- Alien squirrel species sometimes nibble on plastics (likelihood = low), damaging bits of personal property (consequence = medium). – **LOW**
- If large stands of Himalayan balsam (*Impatiens glandulifera*) build up on canal banks (likelihood = medium), its sudden disappearance at the end of the season may invoke a peak of soil erosion (consequence = medium). – **MEDIUM**
- Growth of the mushroom *Allopsalliota geesterani* has the capacity to lift up paving stones (Boomsluiter 2013; likelihood = medium, consequence = medium). – **MEDIUM**
- Canada geese (*Branta canadensis*) readily colonise a variety of waterbodies in urban landscapes (likelihood = high), deteriorating the appeal of its shores for recreation with their droppings (consequence = medium). – **HIGH**
- Giant salvinia (*Salvinia molesta*) readily colonises a variety of waterbodies of interest to humans (likelihood = high). Monospecific stands can entirely block waterways, hindering anglers and boaters, and cause severe water loss through evaporation (consequence = high). – **VERY HIGH**

Harmonia+

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## Harmonia+

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compute

context | introduction | establishment | spread | environmental im. | plant im. | animal im. | human im. | other im. | services | climate

- **Section A5a – Ecosystem services**

Questions from this module qualify the consequences of The Organism on ecosystem services.

Ecosystem services are classified according to the Common International Classification of Ecosystem Services, which also includes many examples (CICES Version 4.3).

Note that the answers to these questions are not used in the calculation of the overall risk score (which deals with ecosystems in a different way), but can be used for the calculation of a score apart.

- → **a31. The Organism has a (...) effect on provisioning services.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* affects provisioning services. These services relate to nutrition (e.g. cultivated crops, reared animals, wild plants, drinking water), materials (e.g. fibres, genetic material, water) and energy (e.g. plant or animal-based resources).

Please consider to be in line with answers provided to questions a19 to a26 from the plant and animal impacts modules

- → **a32. The Organism has a (...) effect on regulation and maintenance services.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* affects regulation and maintenance services. These services relate to the mediation of waste, toxics and other nuisances (e.g. bio-remediation, filtration, accumulation), the mediation of flows (e.g. erosion control, water flow, hydrological cycle, flood or storm protection) and the maintenance of physical, chemical or biological conditions (e.g. pollination, seed dispersal, pest control, disease control, decomposition, chemical water condition).

Please consider to be in line with answers provided to questions a17 and a18 from the environmental impacts module.

- → **a33. The Organism has a (...) effect on cultural services.**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

Indicate whether *The Organism* affects cultural services. These services relate to the physical and intellectual interactions with biota, ecosystems, and land-/seascapes (e.g. use of plants, science, education, heritage, entertainment, aesthetics), and the spiritual, symbolic and other interactions with them (e.g. symbolism, religion, existence, bequest).

Harmonia+

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## Harmonia+

Harmonia+ is a first-line risk assessment scheme for potentially invasive species. It present a series of questions concerning an organism, the answers of which need to be provided by one or more assessors. Harmonia+ is described in full here http://ias.biodiversity.be/harmoniaplus. Additional information is described by D'hondt et al. (manuscript).

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compute

context | introduction | establishment | spread | environmental im. | plant im. | animal im. | human im. | other im. | services | climate

- **Section A5b – Climate change**

Below, each of the Harmonia+ modules is revisited under the premise of the future climate. The proposed time horizon is the mid-21st century.

We suggest to take into account the reports of the Intergovernmental Panel on Climate Change. Specifically, the expected changes of atmospherical variables listed in its 2013 report on the physical science basis may be used for this purpose : see chapter E of the summary for policymakers, or the full report here. For instance, the global temperature is expected to rise by 1 to 2 °C by 2046-2065 (Table SPM.2 in the summary for policymakers).

Note that the answers to these questions are not used in the calculation of the overall risk score, but can be used for the calculation of a score apart. Also note that a more complete option would be to perform the entire assessment again, under the premise of a changed climate.

- → **a34. INTRODUCTION - Due to climate change, the risk for The Organism to overcome geographical barriers and -if applicable- subsequent barriers of captivity or cultivation will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a35. ESTABLISHMENT - Due to climate change, the likelihood for The Organism to overcome survival & reproduction barriers will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a36. SPREAD - Due to climate change, the risk of The Organism to overcome dispersal barriers & (new) environmental barriers within The Area will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a37. IMPACTS: ENVIRONMENTAL TARGETS - Due to climate change, the consequences of The Organism on wild animals and plants, habitats and ecosystems will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a38. IMPACTS: PLANT TARGETS - Due to climate change, the consequences of The Organism on cultivated plants (e.g. crops, pastures, horticultural stock) will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a39. IMPACTS: ANIMAL TARGETS - Due to climate change, the consequences of The Organism on domesticated animals (e.g. production animals, companion animals) will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a40. IMPACTS: HUMAN TARGETS - Due to climate change, the consequences of The Organism on humans will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments:

- → **a41. IMPACTS: OTHER TARGETS - Due to climate change, the consequences of The Organism on targets not considered in previous modules will (...).**

Please select an option

Answer provided with a Please select an option level of confidence.

Comments: