Glossary - Framework and Guidelines for Implementing the Proposed IUCN Environmental Impact Classification for Alien Taxa (EICAT)

Modified from Blackburn et *al.* 2014 and Hawkins et *al.* 2015

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Impact criteria for assigning alien taxa to different categories in the classification scheme

Twelve mechanisms have been identified by Hawkins et al. 2015, by which alien taxa may cause deleterious impacts in areas to which they have been introduced (Table 1). For each mechanism, there are a number of criteria against which taxa should be evaluated, to determine the level of deleterious impact caused under that mechanism. Taxa should be evaluated against every mechanism and criterion.

These categories are for taxa that have been evaluated, have alien populations (i.e., are known to have been introduced outside their native range), and for which there is adequate data to allow classification. Classification follows the general principle outlined in the first row. However, the different mechanisms through which an alien taxon can cause impacts are outlined, in order to help assessors to look at the different aspects and to identify potential research gaps.

Table 1: Impact Criteria

	Massive (MV)	**Major (MR)**	**Moderate (MO)**	**Minor (MN)**	**Minimal Concern (MC)**
Categories should adhere to the following general meaning	Causes at least local extinction of native species , and irreversible changes in community composition; even if the alien taxon is removed the system does not recover its original state	Causes changes in community composition, which are reversible if the alien taxon is removed	Causes population declines in native species, but no changes in community composition	Causes reductions in individual fitness, but no declines in native population sizes	No effect on fitness of individuals of native species
Competition: the alien taxon competes with native taxa for resources (e.g. food, water, space), leading to deleterious impact on native taxa	Competition resulting in replacement or local extinction of one or several native species; changes in community composition are irreversible	Competition resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Competition resulting in a decline of population size of at least one native species, but no changes in community composition	Competition affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	Negligible level of competition with native species; reduction of fitness of native individuals is not detectable

Table 1 – *Continued from previous page*

	Massive (MV)	**Major (MR)**	**Moderate (MO)**	**Minor (MN)**	**Minimal Concern (MC)**
Predation: the alien taxon predates on native taxa, either directly or indirectly (e.g. via mesopredator release), leading to deleterious impact on native taxa	Predators directly or indirectly (e.g., via mesopredator release) resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Predators directly or indirectly (e.g., via mesopredator release) resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Predators directly or indirectly (e.g., via mesopredator release) resulting in a decline of population size of at least one native species but no changes in community composition	Predators directly or indirectly (e.g., via mesopredator release) affecting fitness (e.g., growth, reproduction) of native individuals without decline of their populations	Negligible level of predation on native species
Hybridisation: the alien taxon hybridises with native taxa, leading to deleterious impact on native taxa	Hybridisation between the alien taxon and native species is common in the wild; hybrids are fully vigorous and fertile; pure native species cannot be recovered by removing the alien, resulting in replacement or local extinction of native species by introgressive hybridisation (genomic extinction)	Hybridisation between the alien taxon and native species is common in the wild; F1 hybrids are vigorous and fertile, however offspring of F1 hybrids are weak and sterile (hybrid breakdown), thus limited gene flow between alien and natives; individuals of the alien taxon and hybrids discernible from pure natives, pure native populations can be recovered by removing the alien and hybrids	Hybridisation between the alien taxon and native species is regularly observed in the wild; hybrids are vigorous, but sterile (reduced hybrid fertility),limited gene flow between alien and natives, local decline of populations of pure native species, but pure native species persists	Hybridisation between the alien taxon and native species is observed in the wild, but rare; hybrids are weak and never reach maturity (reduced hybrid viability), no decline of pure native populations	No hybridisation between the alien taxon and native species observed in the wild (prezygotic barriers), hybridisation with a native species might be possible in captivity
Transmission of diseases to native species: the alien taxon transmits diseases to native taxa, leading to deleterious impact on native taxa	Transmission of diseases to native species resulting in replacement or local extinction of native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Transmission of diseases to native species resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Transmission of diseases to native species resulting in a decline of population size of at least one native species, but no changes in community composition	Transmission of diseases to native species affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	The alien taxon is not a host of diseases transmissible to native species or very low level of transmission of diseases to native species; reduction of fitness of native individuals is not detectable
Parasitism: the alien taxon parasitizes native taxa, leading directly or indirectly (e.g. through apparent competition) to deleterious impact on native taxa	Parasites or pathogens directly or indirectly (e.g., apparent competition) resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Parasites or pathogens directly or indirectly (e.g., apparent competition) resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Parasites or pathogens directly or indirectly (e.g., apparent competition) resulting in a decline of population size of at least one native species but no changes in community composition	Parasites or pathogens directly or indirectly (e.g., apparent competition) affecting fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	Negligible level of parasitism or disease incidence (pathogens) on native species, reduction of fitness of native individuals is not detectable

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	Massive (MV)	**Major (MR)**	**Moderate (MO)**	**Minor (MN)**	**Minimal Concern (MC)**
Poisoning/ toxicity: the alien taxon is toxic, or allergenic by ingestion, inhalation or contact to wildlife, or allelopathic to plants, leading to deleterious impact on native taxa	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in replacement or local extinction of native species; changes in community composition are irreversible	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in local or population extinction of at least one native species (i.e., species vanish from communities at sites where they occurred before the alien arrived), leading to changes in community composition, but changes are reversible when the alien taxon is removed	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, resulting in a decline of population size of at least one native species, but no changes in community composition (native species richness)	The alien taxon is toxic/allergenic by ingestion, inhalation, or contact to wildlife or allelopathic to plants, affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	The alien taxon is not toxic/allergenic/ allelopathic, or if it is, the level is very low, reduction of fitness of native individuals is not detectable
Bio-fouling: the accumulation of individuals of the alien taxon on wetted surfaces leads to deleterious impact on native taxa	Bio-fouling resulting in replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Bio-fouling resulting in local or population extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Bio-fouling resulting in a decline of population size of at least one native species, but no changes in community composition	Bio-fouling affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	Negligible level of bio-fouling on native species; reduction of fitness of native individuals is not detectable
Grazing/ herbivory/ browsing: grazing, herbivory or browsing by the alien taxon leads to deleterious impact on native plant species	Herbivory resulting in replacement or local extinction of one or several native plant species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes in community composition are irreversible	Herbivory resulting in local or population extinction of at least one native plant species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Herbivory resulting in a decline of population size of at least one native species, but no changes in community composition	Herbivory affects fitness (e.g., growth, reproduction, defence, immunocompetence) of individual native plants without decline of their populations	Negligible level of herbivory on native plant species, reduction of fitness on native plants is not detectable
Chemical, physical, or structural impact on ecosystems: the alien taxon causes changes to either: the chemical, physical, and/or structural biotope characteristics of the native environment; nutrient and/or water cycling; disturbance regimes; or natural succession, leading to deleterious impact on native taxa	Many changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient and water cycling; or disturbance regimes; or changes in natural succession, resulting in replacement or local extinction of native species (i.e., species vanish from communities at sites where they occurred before the alien arrived); changes (abiotic and biotic) are irreversible	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient cycling; or disturbance regimes; or changes in natural succession, resulting in local extinction of at least one native species, leading to changes in community composition, but changes are reversible when the alien taxon is removed	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient cycling; or disturbance regimes; or changes in natural succession, resulting in a decline of population size of at least one native species, but no changes in community composition	Changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient cycling; or disturbance regimes; or changes in natural succession detectable, affecting fitness (e.g., growth, reproduction, defence, immunocompetence) of native individuals without decline of their populations	No changes in chemical, physical, and/or structural biotope characteristics; or changes in nutrient cycling; or disturbance regimes; or changes in natural succession detectable, or changes are small with no reduction of fitness of native individuals detectable

Table 1 – *Continued from previous page*

	Massive (MV)	**Major (MR)**	**Moderate (MO)**	**Minor (MN)**	**Minimal Concern (MC)**
Interaction with other alien species: The alien taxon interacts with other alien taxa, (e.g., through pollination, seed dispersal, habitat modification), facilitating deleterious impact on native species. These interactions may be included under other impact mechanisms (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien species	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates replacement or local extinction of one or several native species (i.e., species vanish from communities at sites where they occurred before the alien arrived), and produces irreversible changes in community composition that would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates local or population extinction of at least one native species, and produces changes in community composition that are reversible but would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal, habitat modification) facilitates a decline of population size of at least one native species, but no changes in community composition; changes would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal) affects fitness (e.g., growth, reproduction, defence, immunocompetence) of native species' individuals without decline of their populations; changes would not have occurred in the absence of the species. These interactions may be included under other impact categories (e.g., predation, apparent competition) but would not have resulted in the particular level of impact without an interaction with other alien taxa	Interaction of an alien taxon with other aliens (e.g., pollination, seed dispersal) but with minimal effects on native species; reduction of fitness of native individuals is not detectable

Assessing a confidence score

For each alien taxon that is assessed and for which adequate data exist to allow for classification, the assessor should place it in the most likely of the five impact categories (MC, MN, MO, MR, MV) and assign a level of confidence to this placement according to the availability and reliability of evidence, the type of data used to make the assessment, the spatial scale over which data were recorded, and whether or not the evidence is contradictory.

Confidence is categorized into five levels:

- **Very confident** (80-100%) should be assigned when there is relevant direct observational evidence to support the assessment; the data are reliable and of good quality; impacts are recorded at the typical spatial scale at which original native communities can be characterized; and all evidence points in the same direction.

- **Somewhat confident** (60-80%) should be assigned when there is relevant direct observational evidence to support the assessment and all evidence points in the same direction, but some of the data are inferred (e.g. impact estimated from mathematical models); impacts are recorded at a spatial scale which may not be relevant to the scale over which original native communities can be characterized but extrapolation or downscaling of the data to relevant scales is considered reliable, or to embrace little uncertainty.

- **Medium confidence** (40-60%) should be assigned when there is some direct observational evidence to support the assessment, but some of the data are inferred (e.g. impact estimated from mathematical models); impacts are recorded at a spatial scale which may not be relevant to the scale over which original native communities can be characterized but extrapolation or downscaling of the data to relevant scales is considered reliable, or to embrace little

uncertainty; and/or there is some degree of ambiguity in the direction or magnitude of the impact.

- **Somewhat not confident** (20-40%) is defined as no direct observational evidence to support the assessment, for example only data from other species have been used as supporting evidence; or data are of low quality or strongly ambiguous; or impacts are recorded at a spatial scale which is unlikely to be relevant to the scale at which original native communities can be characterized and extrapolation or downscaling of the data to relevant scales is considered unreliable or to embrace significant uncertainties.

Assessing the reliability of the data

Blackburn et *al.* 2014 and Hawkins et *al.* 2015 suggested including information about the reliability of the data source used for scoring:

- **Low**: mentioned in paper, no reference, speculation, expert judgment
- **Medium**: evidence in literature, observational
- **High**: demonstrated evidence in peer-reviewed literature, experimental.

These certainty levels and data reliability are to be communicated to the decision maker and can potentially influence the final decision making. Furthermore, they can identify research needs (e.g., species with large effects with low certainty).

References

[1] Blackburn, Tim M and Essl, Franz and Evans, Thomas and Hulme, Philip E and Jeschke, Jonathan M and Kühn, Ingolf and Kumschick, Sabrina and Marková, Zuzana and Mrugała, Agata and Nentwig, Wolfgang (2014). A unified classification of alien species based on the magnitude of their environmental impacts, *PLoS Biol*, 12:5:e1001850.

[2] Hawkins, Charlotte L and Bacher, Sven and Essl, Franz and Hulme, Philip E and Jeschke, Jonathan M and Kühn, Ingolf and Kumschick, Sabrina and Nentwig, Wolfgang and Pergl, Jan and Pyšek, Petr (2015). Framework and guidelines for implementing the proposed IUCN Environmental Impact Classification for Alien Taxa (EICAT), *Diversity and Distributions*, 21(11):1360–1363.

Glossary

- **Data Deficient (DD)**: highlights taxa for which evidence suggests that alien populations exist, but for which current information is insufficient to assess their level of impact. When the best available evidence indicates that it has individuals existing in a wild state in a region beyond the boundary of its native geographic range, but either there is inadequate information to classify the taxon with respect to its impact, or insufficient time has elapsed since introduction for impacts to have become apparent. It is expected that all introduced taxa will have an impact at some level, because by definition an alien individual in a new environment has a nonzero impact. However, listing a taxon as Data Deficient recognises that current information is insufficient to assess that level of impact.

- **No Alien Population (NA)**: when there is no evidence to suggest the taxon has or had individuals existing in a wild state beyond the boundary of its native geographic range. When there is no reliable evidence that it has or had individuals existing in a wild state in a region beyond the boundary of its native geographic range. We assume the absence of evidence is evidence of absence in this case, as it is impossible to prove that a taxon has no alien individuals anywhere in the world. Taxa with individuals kept in captivity or cultivation in an area to which it is not native would be classified here. A taxon could currently have no individuals existing in a wild state in a region beyond the boundary of its native geographic range because it has died out in, or has been eradicated from, such an area. In these cases, there should be evidence relating to impact that causes it to be classified in one of the impact categories (MC, MN, MO, MR, MV), or alternatively no evidence of impact, which would cause it to be classified as Data Deficient.

- **Not evaluated (NE)**: to taxa that have not yet been evaluated against the EICAT Categories and criteria, as is also the case in the IUCN Red List.

- **Cryptogenic (CG)**: to taxa for which it is unclear whether individuals present at a location are native or alien. CG is not a category in itself; cryptogenic taxa should be evaluated as if they were aliens, but their impact classification modified by the CG label. This is a particular problem in the marine realm, for cosmopolitan plants and for many stored product arthropod pests, for which the native geographic ranges are unknown. Cryptogenic taxa may have deleterious impacts where they occur.

- **Reduction in fitness of individuals**: reduction in growth, reproduction, defence, immunocompetence, or any other aspect that that may reduce the ability of native individuals to survive and produce successful offspring, which has occurred as a result of the introduction of the alien taxa.

- **Decline in population size**: 'population' refers to a group of individuals (the total number of mature individuals1) of a native species within the alien range of the taxon being assessed. A decline in population size is a reduction in the number of mature individuals of native species that has happened as a result of the introduction of the alien taxon. If it is impacting on the recruitment in native species, but not the number of mature individuals, it will be classified as MN. If and when this decrease in fitness leads to decrease in the resultant number of mature individuals within the native population, the alien taxon will be reclassified as MO.

- **Local or population extinction**: elimination of one or more native taxa since the arrival of the alien taxon, in part or all the area invaded by the alien taxon. A native taxon is presumed locally extinct when there is robust evidence from known and/or expected habitat (in a particular area) within the local area invaded by the alien taxon that no individuals of the native taxon remain. If the local or population extinction is on the only existing population (e.g. island endemic species) it can be considered a species' global extinction.

- **Changes on the community structure**: alterations that arise from the local or population extinction of one or more native species since the arrival of the alien taxon. Structural changes that do not engender compositional changes (e.g. to the species-abundance distribution of the community) are not included in this definition, as these are covered by the criterion relating to changes in population size.

- **Reversible**: in the Major (MR) categoryin the context of changes to structure of communities and abiotic or biotic composition of ecosystems. There is evidence that if the alien taxon were removed, the structure of the native community and abiotic/biotic compositions of ecosystems could return to the same state as before the invasion occurred. The evidence may be based on observation, experimental data, or inference. An example of this would be where a locally extinct native species returns (or is returned) to an area after removal of the alien taxon, due to recolonization from populations outside the range of the alien taxa

- **Irreversible**: Used in the Massive (MV) category, in the context of changes to structure of communities and abiotic or biotic composition of ecosystems. There is evidence that removal of the alien would not result in the native community and abiotic/biotic composition of the ecosystem returning to the pre-invasion state. The clearest example is the global extinction of a taxon, or an impact that means that native species cannot return (or be returned) to the invaded area. It may also be "irreversible in practice", i.e. the effort or cost required to reverse the situation is so great, or beyond current technological capabilities, that it would not happen, even if in theory it might be possible.