THE IMPACT OF INVASIVE ALIEN SPECIES ON NATIVE THREATENED SPECIES IN EUROPE

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Cover photo: Japanese knotweed (*Fallopia japonica*) © Riccardo Scalera

Summary

Introduction 1
Methods 2
Results and discussion 3
Conclusions 13
References 15
Annex 1 - Complete list of alien invasive species and groups that affect threatened (IUCN Red List CR, EN, VU) species in Europe 17

Introduction

Invasive alien species (IAS) are considered the second greatest threat to biodiversity globally, second only to habitat loss and fragmentation (MA 2005). Besides being one of the first cause of animal extinctions (Clavero & Garcia-Berthou 2005), IAS also severely affect the ecosystem services we depend upon (Vilà *et al*. 2010). The economic consequences of biological invasions are also impressive. In Europe alone it is estimated that the overall losses due to this threat are above 12 billion euro/year (Kettunen *et al.* 2009). Furthermore, there are evidences showing that the number of IAS in Europe is constantly increasing, with a rate of 76% in the 1970-2007 period (Butchart *et al.* 2010).

The pressure of IAS is expected to be steadily increasing over the next decade if significant actions are not implemented (GBO 4). To adequately address this problem, Europe has been developing a number of tools over the years. For example, in 2003 the Bern Convention adopted the European Strategy on IAS (Genovesi & Shine 2004), on the basis of which the European Union (EU) has been working to develop a dedicated policy and legislation on the issue. This work eventually resulted in the adoption of the EU Regulation No 1143/2014, which entered into force on 1st January 2015 (herewith referred to as the EU Regulation on IAS).

The scope of the present report is to provide an assessment of the impact caused by IAS on European biodiversity. The objective is to define a baseline against which to measure the impact of the response actions implemented in Europe to deal with IAS over the next five years, with a special focus on the measures directly linked to the implementation of the EU Regulation on IAS. The innovative element of this approach lies on the opportunity to base the assessment on the best available information from key regional and global datasets built through the collaboration of the most reliable experts in the field.

Given the focus on a wide range of species native to Europe, this approach can offer a complementary view of the overall situation compared to the two recent reports on “The State of Nature in the European Union” (European Commission, 2015) and “State of nature in the EU” (EEA, 2015). In fact the data analysed within the present report focus on the species “threatened” (i.e. within the IUCN Red List), while those of the mentioned EC and EEA reports focus on species “protected” (i.e. by the Birds and Habitats directives). Also the geographic scope is slightly different, as the present report analyses the situation in the entire European region, while the EC and EEA reports are based on the data available from the monitoring activities carried out within the EU Member States.

Methods

The assessment is based on the analysis of the data available from two key IUCN knowledge tools: the Global Invasive Species Database (GISD) - implemented by the IUCN SSC Invasive Species Specialist Group - and the IUCN Red List of Threatened Species. The analyses were carried out using the on-line version of the two tools, integrated with data from the datasets available off-line.

The dataset for the present work was built by selecting all available data and information on native species assessed as threatened within the IUCN Red List and reported as affected by invasive alien species (Red List threat code 8.1, under the more general "*invasive and other problematic species and genes*" category). To this purpose, all relevant data available in the database of the IUCN Red List under the relevant code were duly screened, including any additional information reported in the narrative (taking note of additional details on IAS involved, level of threat, type of impacts, etc.).

As a result, for each IUCN Red List assessed species, all relevant information has been excerpted and included in a dedicated database. The dataset has been further integrated with the data excerpted from GISD. In particular, for impact mechanisms and relevant effects (outcomes), the classification schemes developed within the GISD have been used. Also information on the level of impact has been included in the database, based on the information provided in the IUCN Red List assessments.

The key records used for the present analysis are the following:

- Name of red listed species (one or more record for each red listed species, depending on the number of alien species reported as a threat)
- Category of threat (for details see criteria in the www.iucnredlist.org[1])
- Name of the alien species posing a threat (one record for each alien species)
- Impact mechanism (of the alien species toward the red listed species)
- Effect of impact on the red listed species (outcome)
- Level of impact

Regarding the level of impact, the following information is reported in the dataset: high, medium, low, no/negligible/unknown/future/past. The level "high" is assigned whenever IAS are the only recognised threat for the target species in the IUCN Red List, or whenever the occurrence of IAS is specifically reported as the main threat. The level "medium" means that IAS are associated with other threats, while a "low" level indicates that at least three or more different threats are known to affect the target species of the IUCN Red List. "Future threat" is assigned to an invasive alien species expected to become a threat in the near future, and "past threat" whenever an alien species was recognised within the IUCN Red List as a threat in the past, but has been currently removed/mitigated.

[1] http://www.iucnredlist.org/documents/RL_Criteria_1994_versus_2001.pdf

Results and discussion

In total the IUCN Red List includes assessments for 9226 species occurring in Europe, encompassing all taxonomic groups (animals, plants, fungi, bacteria, chromista and protozoa) and environments (e.g. marine, terrestrial, freshwater). Out of them, 1872 species (20.3%) are considered as threatened, i.e. classified as "critically endangered" (CR), "endangered" (EN) and "vulnerable" (VU). The analysis shows that in particular, **354 threatened species (229 animals, 124 plants and 1 fungus) are specifically affected by IAS (which accounts for 19% of all threatened species)**. The figures above are the result of the selection of all species coded as threatened by alien species (code 8.1) in the Red List assessments, plus ten additional species for which the impact of IAS was clearly indicated in the narrative of the description of the threats (but were not coded accordingly).

According to the IUCN threats classification scheme, **IAS represent the third cause of threat to European wildlife**. The first cause, affecting over 450 threatened species, is "Dams & water management/use" (coded 7.2, under "*Natural system modifications*" category) and the second one, with over 400 species affected, is "Agricultural & forestry effluents" (coded 9.3, under "*Pollution*" category). This is clearly in line with the evidence that the greatest threat to biodiversity is directly related to the loss of habitat. The list of the greatest threats to European threatened species is shown in Fig. 1.

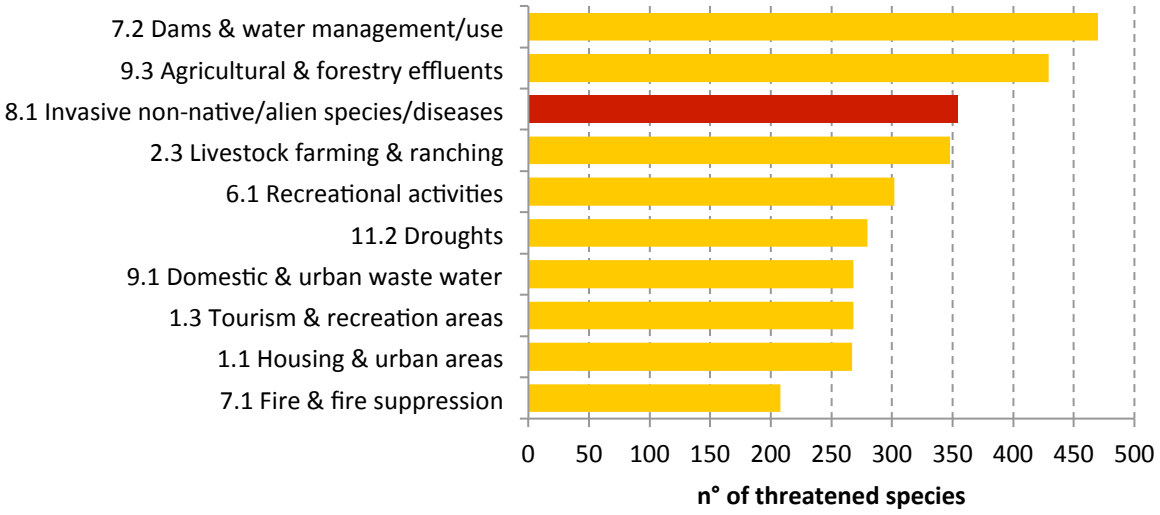

Figure 1 – Ranked list of threats to the IUCN Red List assessed species in Europe

The main groups of IAS responsible for the high level of impact on threatened species in Europe are Vertebrates (42%; n=150) and Vascular plants (Tracheophyta: 34%; n=120).

Considering the different categories of threat, 114 European species threatened by IAS are "critically endangered" (CR, 32%), 112 are "endangered" (EN, 31%) and 128 are "vulnerable" (VU, 36%). In figure 2 the number of species of the main groups are reported by category of threat.

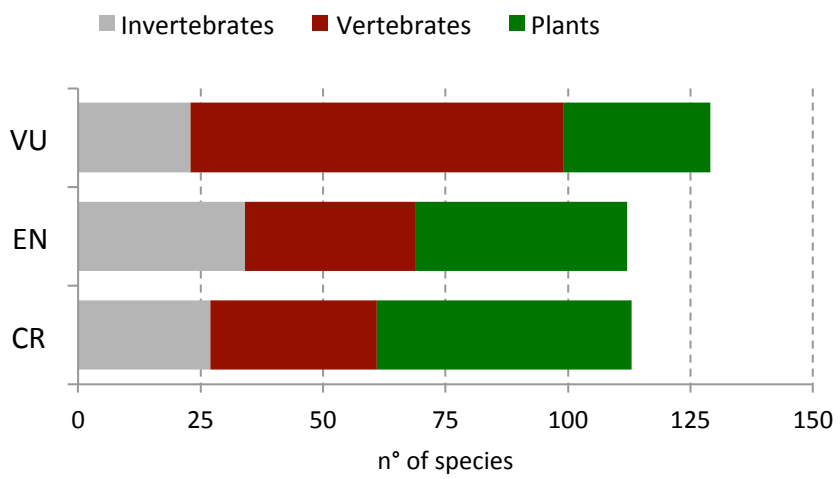

Figure 2 - Number of species under each category of threat sorted by higher taxonomic group

Animal species account for 65% of all threatened taxa affected by IAS. In particular, 1 out of 3 threatened species of Freshwater fish appears affected by this threat (29%), followed by Molluscs (19%) and Arthropods (5%). Plants account only for 35% of the total (Figure 3), most are Dicotyledons (31%).

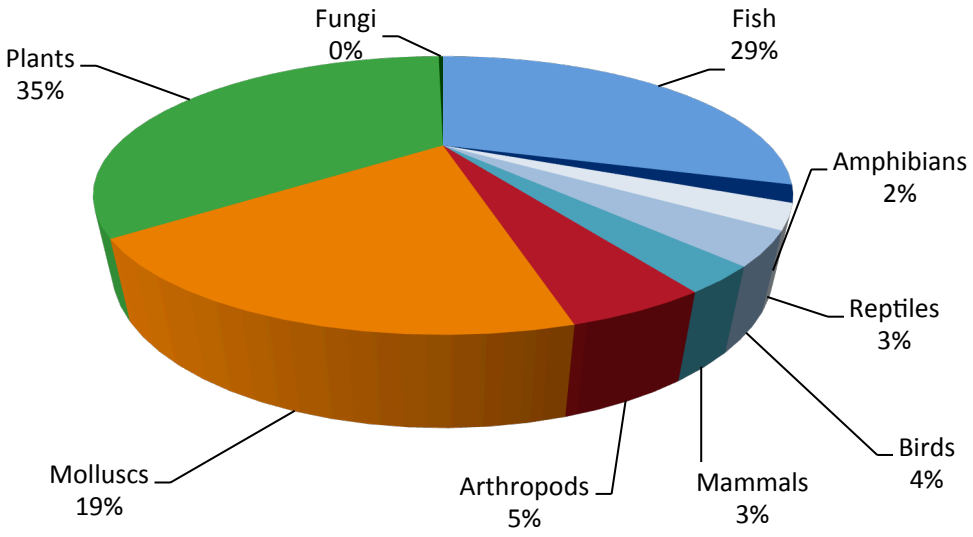

Figure 3 – Percentage of species affected by IAS for the main taxonomic groups

Among fish, those with the highest number of "critically endangered" species are Cyprinids (14 species), Salmonids (10) and Acipenserids (4). The particular vulnerability of fish to IAS is not surprising, given the frequent episodes of introduction and translocation of species from other river basins for angling, fishery and aquaculture. A typical example is the brook trout

(*Salvelinus fontinalis*) a native from North America now established in several European countries, which may compete for food and cover with and predate on native fish such as other salmonids. Introductions and stockings of brook trout have strongly affected the distribution and structure of native fish communities, as it might even replaces native salmonids. In addition, the brook trout can hybridise with native brown trout (*Salmo trutta*), and some hybrids are known to be fertile, which can lead native populations to a loss of local adaptations and failure to reproduce (Scalera *et al*. 2012).

Very few discrepancies were highlighted in relation to the category of threat at the global level. In particular, only the following three species were assessed as more threatened in Europe than at the global level:

- The False Ringlet (*Coenonympha oedippus)*, a species of butterfly in the Satyridae family considered "endangered" in Europe, and "near threatened" at global level.
- The European mink (*Mustela lutreola)* which is considered as "critically endangered" in Europe, and "endangered" at the global level.
- The Sandarac Gum Tree (*Tetraclinis articulata*) which is considered as "endangered" in Europe, and of "low concern" at the global level.

This is clearly a consequence of the different conservation status in different parts of their range, which is typical also in other species. For example, due to its wide distribution in North Africa, the Sandarac Gum Tree (*Tetraclinis articulata)* is assessed as "Least Concern" globally, although some small subpopulations (Malta and Spain) are highly threatened and there are some evidences of decline in the main parts of its range (Sánchez Gómez *et al*. 2015). Otherwise the situation is quite the opposite for the Thick shelled river mussel (*Unio crassus)*, which is more threatened at the global level, where is considered as "endangered", than in Europe, where is considered as "vulnerable".

The analyses also show that most species threatened by IAS (namely 91%) are affected by one or two alien species. Only 8 species are affected by more than 5 alien species (namely *Austropotamobius pallipes, Arvicola sapidus, Pyrrhula murina, Salvelinus fimbriatus, Salvelinus grayi, Asparagus arborescens, Juniperus brevifolia, Puffinus mauretanicus*). For example, the native European white-clawed crayfish (*Austropotamobius pallipes*), is severely impacted by many introduced crayfish among which the red swamp crayfish (*Procambarus clarkii),* and others (e.g. *Astacus leptodactylus, Pacifastacus leniusculus, Orconectes virilis,* etc). This is the result of a typical chain effect due to several concurring causes. In particular, it is thought that the North American red swamp crayfish (which is a proven chronic carrier of *Aphanomyces astaci*, a fungus-like organism responsible for the so-called crayfish plague in Europe) has led to the accidental introduction of the crayfish plague. European crayfish species are killed by this very aggressive pathogen, so the spread of this disease in Europe has led to the further introduction of other replacement species of North American origin – known to be resistant to the disease - for farming and restocking. The red swamp crayfish is contributing to the decline of the native European crayfish also by replacing it through other mechanisms, e.g. competitive exclusion, differential susceptibility to predation and reproductive interference (Scalera *et al*. 2012).

The analyses of the mechanisms of impact, identified for a sample of 169 animals and 202 plants, show that **competition is the most common impact mechanism associated to IAS threatening native species (40% of the total).** This is a very subtle type of biodiversity impact, as it can even affect the functioning of entire ecosystems. For example, the successful competition of the alien zebra mussel (*Dreissena polymorpha*) against native clams in the freshwater ecosystem has lead to local extirpations of the native molluscs. In addition, its introduction to lakes in Europe and North

America has resulted in significant changes in the water quality of the lakes. This invasive mussel may thus have the 'power' to alter the structure and function of entire ecosystems (Scalera *et al*. 2012). Other significant mechanisms of impact are grazing/herbivory/browsing (24%) followed by predation (21%) and trampling (7%). Other reported impact mechanisms are hybridisation (3%), disease transmission (3%) and "Others", which include poisoning/toxicity (n=4) and parasitism (n=2). The results are summarised in Figure 4.

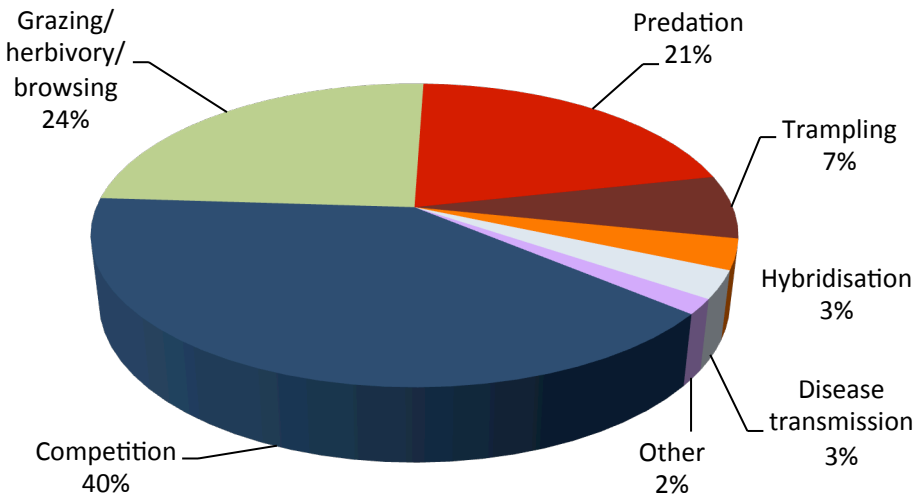

Figure 4 - Impact mechanisms of invasive species on threatened species. The category "Others" includes parasitism and poisoning/toxicity.

Some important differences have been highlighted by comparing mechanisms of impact affecting animals and plants (see Figure 5). For example, competition is identified as the main mechanism of impact for plants (i.e. in 49% of cases in this group) followed by grazing/herbivory/browsing in 37% of cases. A key difference is that for animals species competition is only the second cause of impact, accounting for 29% of cases. For this group the main cause of impact is in fact predation. This is not surprising, as predation is always likely to pose a major direct threat to native species, and can be characterised by devastating effects. For example, generalist predators such as feral cats (*Felis catus*), once introduced to the wild (or simply allowed to roam outdoor), can prey on a variety of native species, which may suffer severe population declines and even face extinction. In Britain, for example, estimates derived from scaling up local studies to the national level show that cats kill 25–29 million birds per year (Sims *et al*., 2008). It is easy to imagine how detrimental this species can be, considering that cats have been introduced practically everywhere.

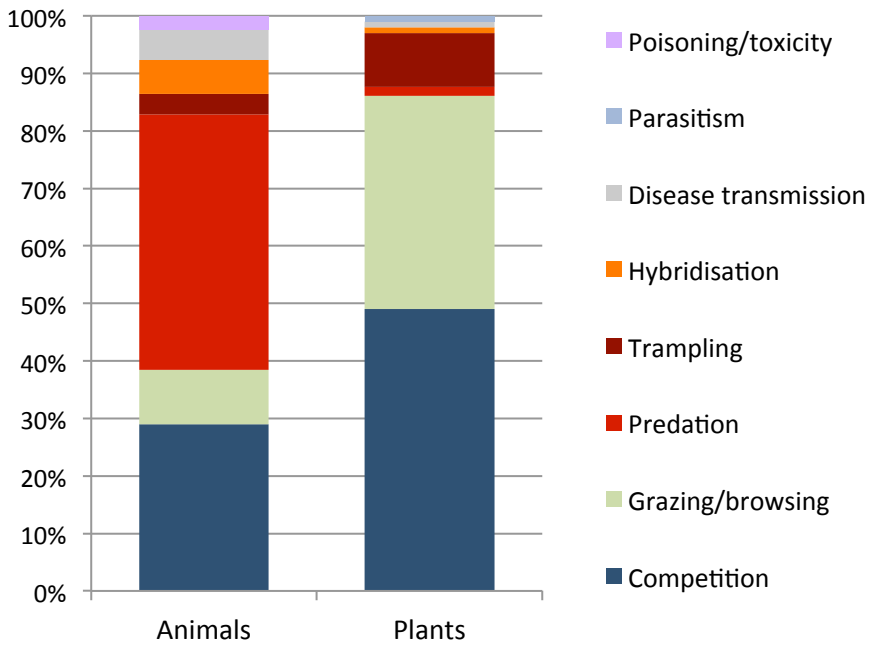

Figure 5 – Impact mechanisms recorded for animals and plants.

The use of the GISD classification of impacts, allowed the assessment of the trends on effects and outcomes of impacts on the basis of a sample of 365 records. The change on species distribution range (e.g. in terms of shift, reduction, etc.) is the most common effect (shown in 44% of cases, mostly referred to plants). Invasive alien species like the Japanese knotweed (*Fallopia japonica*) are a typical example of species which can have this kind of effect, e.g. by transforming species diversity and physico-chemical properties and the structure of invaded sites. For example, the Japanese knotweed is known to build up large and dense monodominant stands it reduces light availability to the understorey, inhibiting growth of woody seedlings and shading out other plants, which results in a delayed succession. In Europe, dense stands that cover more than 1000 m^2 are known. Exclusion of accompanying species is also supported by allelochemicals that negatively affect other plant species (Scalera *et al*. 2012)

Another major effect of IAS on native species is the decline in population size (23% of cases). The case of the Yelkouan shearwater (*Puffinus yelkouan*) is particularly interesting in this context, as it shows how the removal of the threatening IAS can lead to a prompt recovery of the population size of the affected species (and an associated increase of the species range). In fact, this "threatened" seabird has been recently object of a LIFE project aimed at the removal of black rats (*Rattus rattus*) from the island of Montecristo, where the shearwater nests with an estimated population of 400-750 pairs (3-10% of the known world population at the time). In this case the successful eradication of black rats allowed 93-95% of pairs to successfully fledge juveniles over two years. As a result, the number of breeding pairs is expected to increase over the next ten years, with an expansion of the breeding colonies in the Tuscan Archipelago[2].

All the other identified categories of effects (outcomes) are characterised by having a direct impact on the population of the affected species, with the only exception of habitat degradation or complete replacement/loss - with the local

[2] http://www.montecristo2010.it/stealthV3_pubblica/0840425A0S1345033092.pdf

extinction of impacted species as in the case of the red squirrel (*Sciurus vulgaris*) in areas of expansion of the American grey squirrel (*Sciurus carolinensis*) (Bertolino *et al.* 2014) - that reached 19% of cases. The overall data are shown in the Figure 6.

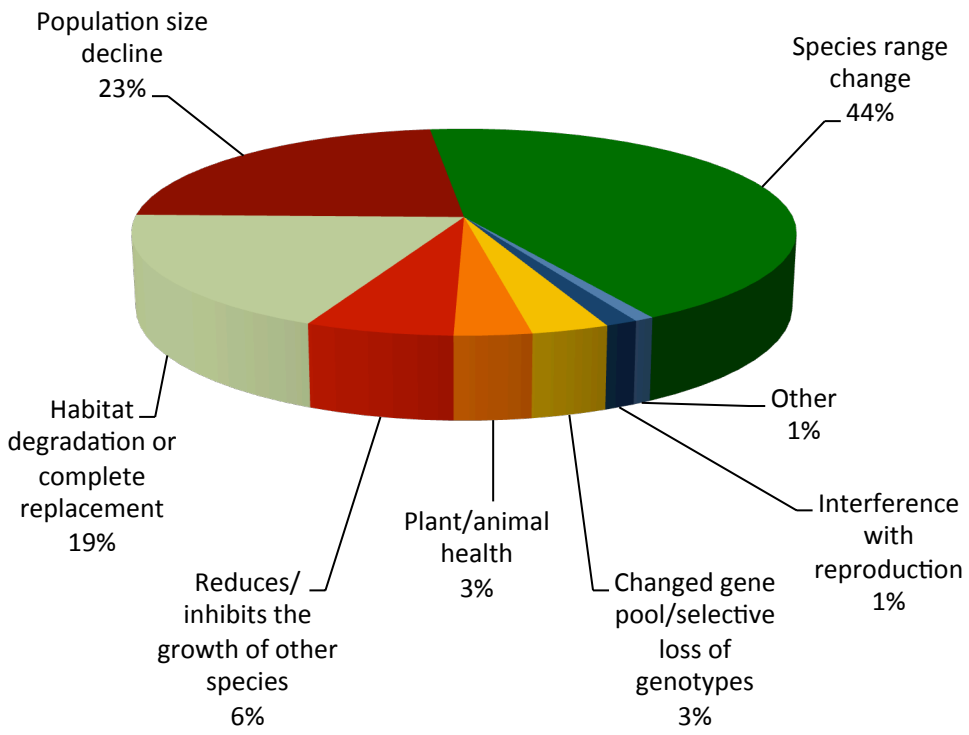

Figure 6 - Impact outcomes of invasive alien species on threatened species. The "Others" category includes soil erosion, indirect mortality, ecosystem change.

The figure 7 shows the impact level of IAS on threatened species sorted by higher taxonomic groups. Reptiles are the taxonomic group characterised by the highest number of species suffering from a "high" level of impact due to IAS (*e.g.* in over 40% of the cases), followed by molluscs (over 30%) and amphibians.

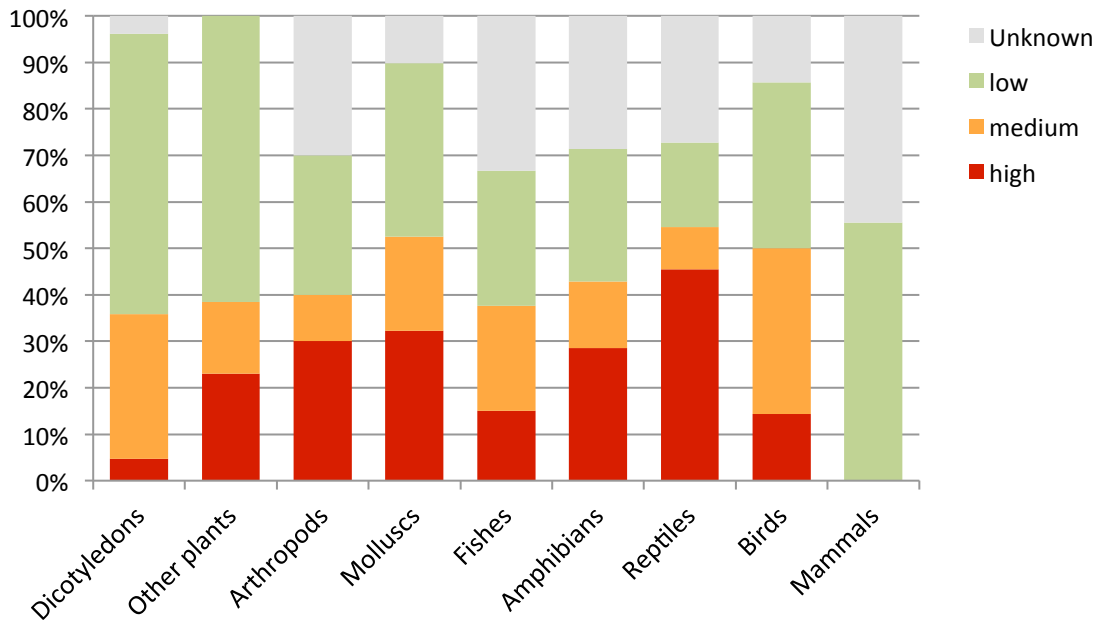

Figure 7 - Impact level on threatened species on a selection of higher taxonomic groups.

But which are the main alien species posing a threat to European biodiversity? A complete list of invasive alien species is reported in Annex 1. Since in a number of situations it was not possible to identify the responsible species precisely, the data reported are related to the best available information (e.g. genus or higher taxonomic group). Information on number of (native) European threatened species affected by each invasive alien species is also reported. For example, rodents (indicated in the dataset as *Rattus rattus*, *Rattus norvegicus, Rattus* spp. and family Rodentia) are considered as a threat to a total of 27 native species (among which birds, mammals, reptiles, molluscs and plants).

In figure 8 the invasive species that have an impact on threatened species, separated on the basis of by the main taxonomic groups, are shown: regarding animals, fish are the largest group with 26 species and 3 different genus identified as a threat (24%), followed by mammals (23%).

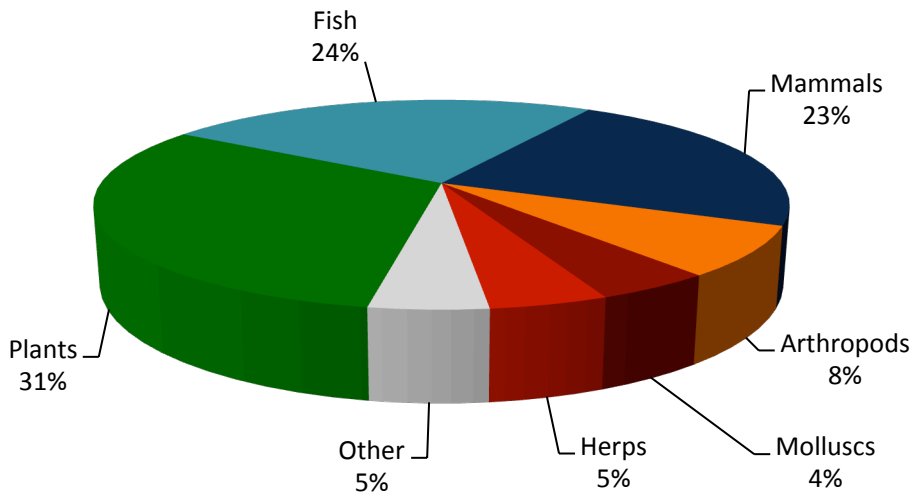

Figure 8 – Alien species that affect threatened species sorted by group. "Others" category includes birds, viruses, fungi and jellyfish.

Invasive alien mammals - despite the relatively small number of species identified as a threat (n=23) - are the group associated with the highest number of threatened species in Europe (141, corresponding to 40% of total), one third of which are "critically endangered". In table 1 the details on the total number of threatened species affected by each alien group are shown (data sorted by category of threat are also provided).

Table 1 – Number of threatened species impacted by each group of IAS

Alien species	VU	EN	CR	Total no. of impacted native species
Mammals	46	46	49	141
Fish	48	27	35	110
Plants	35	39	34	108
Arthropods	4	8	3	15
Molluscs	3	5	5	13
Reptiles and amphibians	3	2	1	6
Others	3	5	1	10

In total, 96 different IAS have been identified, 56 of which are aliens to Europe while 40 are aliens only in part of Europe. Invasive alien species are in some cases indicated in the source dataset at either the genus level or the family level. In fact, besides the 96 species, there are additional data relative to 4 families and 15 genus of IAS representing a threat.

In total, four feral domestic species (the goat *Capra hircus,* wild pig *Sus scrofa,* domestic cat *Felis catus* and domestic dog *Canis familiaris*) have been included in the list, but only when the code assigned in the IUCN Red List did clearly refer to the IAS threat (e.g. sometime the goat is classified under code 2.3 "grazing" like sheep, livestock etc. in which case was not considered). Actually, also the rabbit should be considered

feral, as most of the introductions were carried out since ancient times with animals from domestic origin[3].

Considering only the alien species identified, 17 and 16 are present in the IUCN list of "One Hundred of the World's Worst Invasive Alien Species" and in the DAISIE "One Hundred of the Europe's Worst Invasive Alien Species" respectively (to be noticed that in the European list, feral species are not considered).

In Table 2 invasive alien species that affect more than 4 threatened species are reported (species not precisely identified, or generic categories such as animals and/or plants or groups identified only at family and genus level were not considered in this analysis). The most impacting species is the feral goat (*Capra hircus*), followed by the rabbit (*Oryctolagus cuniculus*) and the feral cat (*Felis catus*). These are all domesticated species, particularly damaging in insular contexts. All those very impacting species are alien to Europe, with the only notable exception of the rabbit. In fact the rabbit is native to southern Europe (Iberian Peninsula) and possibly Northwest Africa. For this reason this species is also considered a 'conservation paradox', for although it is a highly successful (usually devastating) coloniser around the world, it is threatened within its native range (Lees and Bell, 2008).

The introductions of mammals, such as goats, rabbits, and cats, are typical case studies used to highlight the consequences of the impact of alien mammals, particularly in island ecosystems. Such introductions are known to have caused the severe regression of native and endemic species, of both fauna and flora. In some cases goats and rabbits also led to heavy erosion, e.g. along the coastlines, which in turn caused problems for nesting sites of several marine birds. It is remarkable that to address this problem, specific projects have been implemented particularly through the LIFE programme, e.g. in Deserta Grande (in the Madeira archipelago, Portugal) both rabbits and goats were successfully eradicated, along with cats[4]. It was the first time in Europe that such an eradication programme targeting invasive alien animals was attempted in an island at this scale.

It is likely that as the information on the impact of IAS will be systematically collected in the future, e.g. also in relation to the implementation of the new EU Regulation on IAS, the analysis will provide a more precise assessment of this threat. For example, it is not clear whether the impact of the Chytrid fungus on amphibians is actually underestimated. In the database used for this study only two species seem affected by this threat, namely the Apennine yellow-bellied toad (*Bombina pachypus*) and the Sardinian brook salamander (*Euproctus platycephalus*). However, this is not consistent with the current estimates that about 92 % of amphibians considered "critically endangered" by the IUCN Red List are undergoing declines that might be linked to *Batrachochytrium dendrobatidis (*Bd). In fact, also

[3] Some confusion may be linked to the nomenclature used for the mouflon, because many names are (sometime wrongly) used as synonyms in the existing literature, e.g. *Ovis ammon, O. aries, O. orientalis*. For the mouflon, semi-domestic sheep introduced in ancient time in Corsica-Sardinia, and then translocated for hunting purposes in many other areas – the most correct scientific name is *Ovis aries*. In fact *Ovis orientalis* is a subspecies of *Ovis aries*. However, *Ovis aries* is also used for indicating the domestic sheep (from which the mouflon actually originated). Some experts may have different interpretations, in fact the mouflon is sometime referred to also as *Ovis ammon*, but this species should refer only to the argali, which has never been introduced outside its natural range (definitely not in Europe). This might create further confusion http://www.vertebrates.si.edu/msw/mswcfapp/msw/taxon_browser.cfm?msw_id=13213

[4] Restoration measures for the terrestrial habitat of Deserta Grande (LIFE95 NAT/P/000125) http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=38&docType=pdf

in Europe we know that over one third of amphibian species have the pathogen present, and at least 10 % of the native ones are involved in chytridiomycosis-driven decline, not only in yellow-bellied toads and Sardinian brook newts (Scalera *et al*. 2012). The Bd, which is included in the list of "One Hundred of the World's Worst Invasive Alien Species", is actually spread by other IAS, such the American bullfrog (*Lithobates catesbeianus*) and other amphibians traded as pets in Europe, showing the importance to monitor and possibly prevent the further introduction of IAS. Additionally, the recent emergence of another chytrid fungus, *B. salamandrivorans*, which also causes chytridiomycosis and death in salamanders (Martel *et al*., 2013), shows how dynamic the overall situation is, and stresses the importance to ensure that a picture on the state of the art of IAS impact on native species in Europe is taken regularly across the years.

Table 2 – Invasive alien species impacting more than 4 threatened species.

100 of the worst GISD	100 of the worst DAISIE	*Alien species*	CR	EN	VU	Tot n° of impacted native species
yes		*Capra hircus*	11	7	9	27
yes		*Oryctolagus cuniculus*	14	7	5	26
yes		*Felis catus*	5	5	3	13
	yes	*Neovison vison*	1	2	4	7
		Ovis aries	1	5	1	7
		Ammotragus lervia	1	3	2	6
	yes	*Opuntia ficus-indica*	1	3	2	5
		Pennisetum setaceum	4	1	0	5
	yes	*Procambarus clarkii*	0	3	2	5

Conclusions

This review provides an updated and comprehensive analysis on the impact of invasive species on European native species. The study is based on an in-depth analysis of two key IUCN knowledge products, namely the IUCN Red list of Threatened Species, and the Global Invasive Species Database (GISD).

According to the best data available at the European level, **invasive alien species (IAS) are the 3rd most severe threat to European threatened species**, after dams and water management, and agricultural forestry effluents. The results of the review show that **1 out of 5 threatened species in Europe is directly affected by invasive alien species**. In particular 145 "critically endangered" species, 112 "endangered" species and 128 "vulnerable" species are affected by IAS. Animals are usually more impacted than plants, with **fish being particularly affected by this threat:** 35 "critically endangered" species belonging to this taxonomic group, along with 27 "endangered" and 48 "vulnerable" species, are impacted by IAS.

The **main mechanism of impact by invasive alien species is competition** (accounting for 40% of all cases), followed by grazing, and predation. **Feral domestic species introduced by humans are a serious threat** in several European contexts; for example, feral goats are a concrete threat to 11 "critically endangered" species, 7 "endangered" species and 9 "vulnerable" species. This is not surprising, as goats are well known to be voracious herbivorous which may destroy the vegetation of entire territories, turning dense vegetated areas into a desolated desert.

Some non-feral invasive species are also particularly harmful, impacting high number of native species. Rats are a major threat to many critically endangered seabirds and reptiles (the genus endemic of the Canary islands, *Gallotia* sp.). Among plants, the ice plant (*Carpobrotus sp*[5]) causes impacts on at least 13 native species, seriously endangering the coastal dune ecosystems in Southern Europe. Indeed ice plants are known to have a major impact on ecosystem services as a consequence of the growth of dense, impenetrable and monodominant mats which may cover large areas, reducing local biodiversity by direct competition with native and often endangered coastal plant species.

The American mink (*Neovison vison)* is another species of great concern as it directly impacts at least 7 endangered native species. In particular this predator is the greatest threat to the rare and "critically endangered" European mink (*Mustela lutreola)*, one of the only two endemic carnivore species of Europe, and other small vertebrates, including birds and amphibians.

The outcomes of the present assessment, focused on "threatened" species *sensu* IUCN Red List, partly differ from the results of the recent "State of nature in the EU" (EC 2015, EEA 2015), focused on species and habitats protected under the Birds and Habitats Directives, describing IAS as a less significant threat compared to other causes of harm. The different outcomes are in part due to the different geographic scope which characterises the two approaches, but mostly to the different set of species (and habitats) which the analysis refer to. In fact, only 43.5% of species protected under the Habitats and Birds Directives are assessed as threatened under the

[5] There is some controversy about the taxonomic identity of invasive alien ice plants. Although most records are attributed to *Carpobrotus edulis*, another introduced ice plant species (namely *C. acinaciformis*) occurring in Europe, is actually more widespread than *C. edulis*. Additionally both 'species' hybridise and form a hybrid complex with intermediate characters (see Scalera *et al*. 2012). Therefore the analyses were carried out at the genus level.

IUCN Red List (in particular 465 threatened species on a total of 1069 species included in the Nature Directives). This shows that IAS are of greater concern for “threatened” species, rather than “protected” species such as those covered by the EU Nature Directives.

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Annex 1 - Complete list of alien invasive species and groups that affect threatened (IUCN Red List CR, EN, VU) species in Europe

Alien species or group	No. of impacted native species
Unspecified species	83
Unspecified Fish	51
Unspecified Plants	36
Unspecified Animals	28
Capra hircus	27
Oryctolagus cuniculus	26
Carpobrotus spp.	13
Felis catus	13
Rattus spp.	12
Family Rodentia	10
Neovison vison	7
Ovis aries	7
Ammotragus lervia	6
Family Salmonidae	6
Pennisetum setaceum	6
Coregonus spp.	5
Opuntia ficus-indica	5
Opuntia spp.	5
Procambarus clarkii	5
Agave spp.	4
Esox lucius	4
Potamopyrgus antipodarum	4
Rutilus rutilus	4
Abramis brama	3
Agave americana	3
Family Leporidae	3
Gambusia spp.	3
Hedychium gardnerianum	3
Ondatra zibethicus	3
Pittosporum undulatum	3
Rattus rattus	3
Sander lucioperca	3
Sus scrofa	3
Theba pisana	3
Ailanthus altissima	2
Canis familiaris	2
Capra aegagrus cretica	2
Centranthus ruber	2
Chondrostoma nasus	2
Chytrid Batrachochytrium dendrobatidis	2
Clethra arborea	2
Corbicula fluminea	2
Cotesia Glomerata	2
Cryptomeria japonica	2
Gymnocephalus cernuus	2
Micropterus salmoides	2
Myocastor coypus	2
Ovis aries (domestic sheep)	2
Pacifastacus leniusculus	2
Perca fluviatilis	2
Rattus norvegicus	2
Salvelinus alpinus	2
Scardinius erythrophthalmus	2
Silurus glanis	2
Squalius cephalus	2
Tinca tinca	2
Unspecified molluscs	2
Vulpes vulpes	2
Acacia dealbata	1
Acacia saligna	1
Acipenser stellatus	1
Ageratina adenophora	1
Anguillicoloides crassus	1
Aphanomyces astaci	1
Arundo donax	1
Astacus leptodactylus	1
Azolla filiculoides	1
Bison bison	1
Cannabis sativa	1
Chaetorellia spp.	1
Chondrostoma genei	1
Chrysemys picta	1
Cobitis arachthosensis	1
Cottus gobio	1
Cuscuta spp.	1
Eucalyptus globulus	1
Eucalyptus spp.	1
Family Mustelidae	1
Fundulus heteroclitus	1
Genetta genetta	1
Gymnocephalus acerina	1
Herpestes javanicus	1
Huso huso	1
Icerya purchasi	1
Impatiens spp.	1
Lantana camara	1
Larus cachinnans	1
Leuciscus cephalus	1
Lithobates catesbeianus	1
Martes spp.	1
Melanoides tuberculata	1
Mesembryathemum crystallinum	1
Micropterus spp.	1
Mnemiopsis spp.	1
Mus musculus	1
Mus spp.	1
Natrix maura	1
Orconectes limosus	1
Orconectes virilis	1
Oxyura jamaicensis	1
Pararge aegeria	1
Pelargonium spp.	1
Pennisetum spp.	1

Phalaris aquatica	1
Pinus halepensis	1
Pinus radiata	1
Podarcis siculus	1
Poxvirus avium	1
Procyon lotor	1
Pseudochondrostoma polylepis	1
Ranunculus spp.	1
Rhododendron spp.	1
Rubus spp.	1
Rutilus rubilio	1

Sagittaria subulata	1
Salmo letnica	1
Senecio angulatus	1
Smilax aspera	1
Thelohania contejeani	1
Theodoxus fluviatilis	1
Trachemys scripta	1
Unspecified Anura	1
Unspecified Crustaceans	1
Unspecified Mammals	1