

## Global patterns in threats to vertebrates by biological invasions

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### SUPPLEMENTARY TABLES AND FIGURES:

**Table S1:** Mean numbers of threats per IAS-threatened species that are categorized as Critically Endangered (CR), Endangered (EN), and Vulnerable (VU) for mammals, birds, reptiles, and amphibians.

	Mean number of threats		
	CR	EN	VU
<b>Mammals</b>	10.1	11.2	10.5
<b>Birds</b>	9.2	9.7	8.9
<b>Reptiles</b>	7.9	8.4	7.8
<b>Amphibians</b>	12.1	12.5	12.3

**Table S2:** Top-20 ranked countries for absolute number of IAS-threatened (CR, EN, and VU) mammals, birds, reptiles, and amphibians as given in the middle column; information on other threats is given in the right column.

<b>Country</b>	<b>IAS-threatened species</b>	<b>Species threatened by other factors</b>
Mexico	129	1178
Australia	108	452
Ecuador	107	924
Colombia	97	1083
United States	89	765
New Caledonia	63	168
New Zealand	62	75
Madagascar	52	1247
Peru	51	889
Argentina	48	668
Indonesia	42	1556
Costa Rica	40	361
Guatemala	40	445
Brazil	38	1230
Honduras	37	505
Panama	35	405
South Africa	34	348
India	34	1228
Chile	33	284
Venezuela	33	610

**Table S3:** Frequency of IAS identified at species-, family-, or kingdom-level as threatening vertebrates.

<b>Species</b>	<b>Frequency</b>
Chytrid <i>Batrachochytrium dendrobatidis</i>	383
<i>Rattus</i> spp. ( <i>Rattus rattus</i> : 148; unspecified <i>Rattus</i> spp.: 127; <i>R. norvegicus</i> : 46; <i>R. exulans</i> : 40; <i>R. praetor</i> : 1)	362
<i>Felis catus</i>	322
<i>Canis familiaris</i>	124
<i>Sus scrofa</i>	110
Unspecified Plantae	104
Unspecified Animalia	88
<i>Capra hircus</i>	64
Family Rodentia	50
<i>Bos taurus</i>	47
<i>Eucalyptus</i> spp.	42
Unspecified fish	39
<i>Wasmannia auropunctata</i>	39
Superorder Ungulata	37
Family Salmonidae	36
<i>Herpestes javanicus</i>	36
Unspecified Pathogens	36
<i>Plasmodium relictum</i>	32
<i>Mustela erminea</i>	31
<i>Ovis aries</i>	31
<i>Vulpes vulpes</i>	30
<i>Poxvirus avium</i>	27
<i>Oryctolagus cuniculus</i>	24
<i>Acridotheres tristis</i>	21
Family Herpestidae	20
<i>Mus musculus</i>	20
<i>Trichosurus vulpecula</i>	17
<i>Lithobates catesbeianus</i>	16
<i>Mustela putorius furo</i>	15
<i>Pinus</i> spp.	14
<i>Boiga irregularis</i>	12
<i>Psidium cattleianum</i>	12
Family Cervidae	11
<i>Molothrus bonariensis</i>	11
<i>Tyto alba</i>	11
Unspecified mammalia	11
<i>Mustela nivalis</i>	10
<i>Anoplolepis gracilipes</i>	9
<i>Gambusia affinis</i>	8
Unspecified Aves	8

Unspecified Insecta	8
<i>Apis mellifera</i>	7
<i>Equus caballus</i>	7
<i>Erinaceus europaeus</i>	7
<i>Ligustrum robustum</i>	7
<i>Neovison vison</i>	7
<i>Philornis downsi</i>	7
<i>Sturnus vulgaris</i>	7
<i>Zosterops japonicus</i>	7
<i>Eichhornia crassipes</i>	6
<i>Gallus domesticus</i>	6
<i>Rhinella marina</i>	6
Unspecified Anura	6
<i>Axis axis</i>	5
<i>Cervus elaphus</i>	5
<i>Equus asinus</i>	5
Family Cyprinidae	5
Family Formicidae	5
<i>Flavivirus</i>	5
<i>Gambusia</i> spp.	5
<i>Lantana camara</i>	5
<i>Macaca fascicularis</i>	5
<i>Mustela</i> spp.	5
<i>Odocoileus virginianus</i>	5
<i>Oncorhynchus mykiss</i>	5
<i>Rusa timorensis</i>	5
<i>Cercopithecus mona</i>	4
<i>Civettictis civetta</i>	4
<i>Corvus splendens</i>	4
<i>Eleutherodactylus johnstonei</i>	4
<i>Gallirallus australis</i>	4
<i>Hedychium gardnerianum</i>	4
<i>Mus</i> spp.	4
<i>Pycnonotus cafer</i>	4
<i>Syzygium jambos</i>	4
<i>Vespula</i> spp.	4
<i>Ammophila arenaria</i>	3
<i>Cinnamomum verum</i>	3
<i>Dichrostachys cinerea</i>	3
<i>Erysipelas</i> spp.	3
<i>Erysipelothrix rhusiopathidae</i>	3
<i>Foudia madagascariensis</i>	3
<i>Iguana iguana</i>	3
<i>Nasua nasua</i>	3
<i>Pasturella multocida</i>	3
<i>Phormium tenax</i>	3

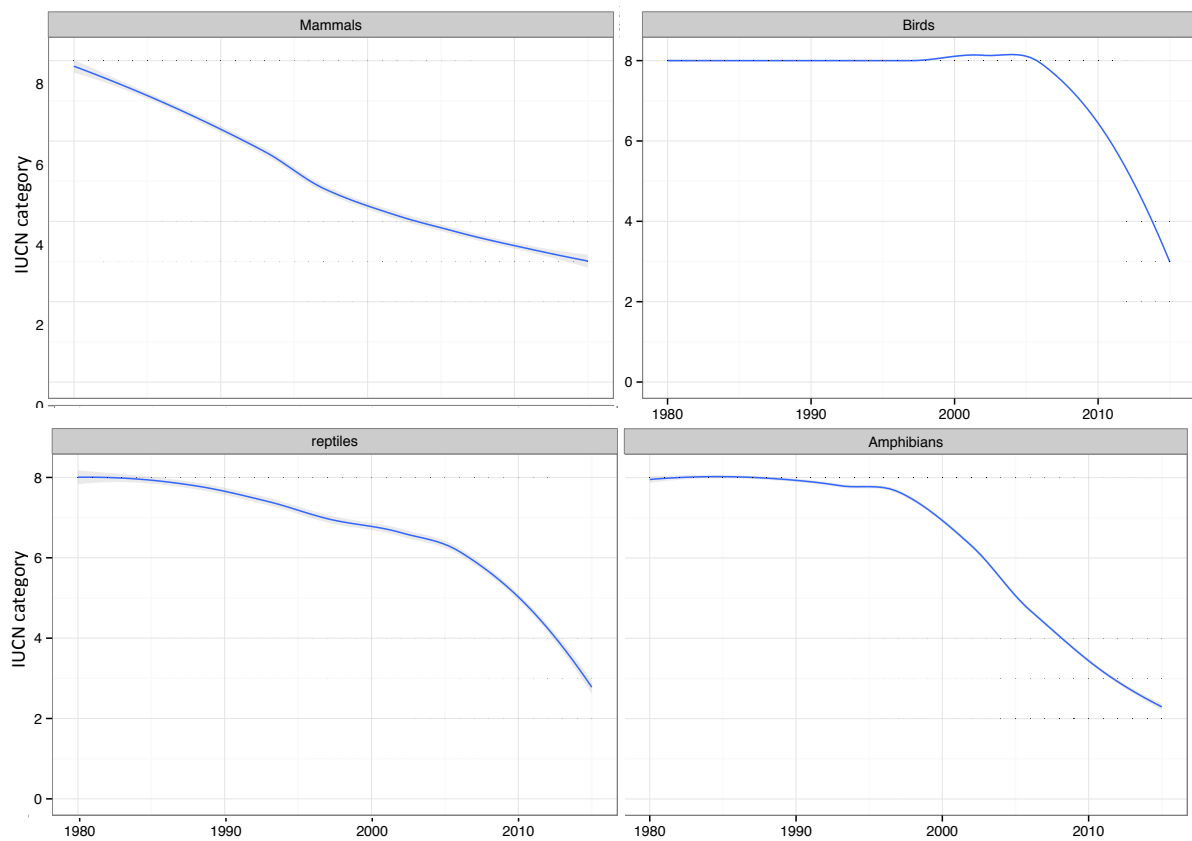
<i>Phytophthora cinnamomi</i>	3
<i>Psittacine circovirus</i>	3
<i>Salix fragilis</i>	3
<i>Salmo trutta</i>	3
<i>Solenopsis</i> spp.	3
<i>Sophonia rufofascia</i>	3
<i>Spartina alterniflora</i>	3
<i>Tenrec ecaudatus</i>	3
<i>Tilapia</i> spp.	3
Unspecified Crustacea	3
<i>Vespula germanica</i>	3
<i>Anas platyrhynchos</i>	2
<i>Boa constrictor</i>	2
<i>Bubo virginianus</i>	2
<i>Callithrix jacchus</i>	2
<i>Callithrix penicillata</i>	2
<i>Cenchrus ciliaris</i>	2
<i>Cenchrus echinatus</i>	2
<i>Cettia diphone</i>	2
<i>Channa</i> spp.	2
<i>Chromolaena odorata</i>	2
<i>Clostridium botulinum</i>	2
<i>Copsychus malabaricus</i>	2
<i>Cryptomeria japonica</i>	2
<i>Ctenosaura similis</i>	2
<i>Cytisus scoparius</i>	2
<i>Dicrurus macrocercus</i>	2
<i>Erythrocebus patas</i>	2
<i>Garrulax canorus</i>	2
<i>Hemidactylus frenatus</i>	2
<i>Melinis minutiflora</i>	2
<i>Miconia calvescens</i>	2
<i>Micropterus salmoides</i>	2
<i>Mustela sibirica</i>	2
<i>Myocastor coypus</i>	2
<i>Ondatra zibethicus</i>	2
<i>Passer domesticus</i>	2
<i>Platycercus elegans</i>	2
<i>Procyon lotor</i>	2
<i>Psidium guajava</i>	2
<i>Salix</i> spp.	2
<i>Salvelinus fontinalis</i>	2
<i>Scinax x-signatus</i>	2
<i>Solenopsis geminata</i>	2
<i>Solenopsis invicta</i>	2
<i>Tyto novaehollandiae</i>	2

<i>Urochloa decumbens</i>	2
<i>Vachellia nilotica</i>	2
<i>Yersinia pestis</i>	2
<i>Acacia catechu</i>	1
<i>Acacia drepanolobium</i>	1
<i>Acacia mangium</i>	1
<i>Achatina Fulica</i>	1
<i>Adelges cooleyi</i>	1
<i>Ageratina adenophora</i>	1
<i>Ageratina riparia</i>	1
<i>Agropyron repens</i>	1
<i>Alphaherpes virus</i>	1
<i>Ambystoma tigrinum</i>	1
<i>Amietophrynus gutturalis</i>	1
<i>Aristotelia chilensis</i>	1
<i>Aulacaspis yasumatsui</i>	1
<i>Batis maritima</i>	1
<i>Beak and feather disease virus (BFDV)</i>	1
<i>Bison bison</i>	1
<i>Boa constrictor imperata</i>	1
<i>Brachiaria spp.</i>	1
<i>Bromus diandrus</i>	1
<i>Bromus inermis</i>	1
<i>Bromus tectorum</i>	1
<i>Broussonetia papyfera</i>	1
<i>Bubulcus ibis</i>	1
<i>Callithrix geoffroyi</i>	1
<i>Camelus dromedarius</i>	1
<i>Carduelis carduelis</i>	1
<i>Carduelis chloris</i>	1
<i>Cervus unicolor</i>	1
<i>Channa striata</i>	1
<i>Cinchona pubescens</i>	1
<i>Circoviridae</i>	1
<i>Clethra arborea</i>	1
<i>Clidemia hirta</i>	1
<i>Corvus macrorhynchus</i>	1
<i>Crocidura suaveolens</i>	1
<i>Crotophaga ani</i>	1
<i>Cyathostoma bronchialis</i>	1
<i>Dactylis glomerata</i>	1
<i>Dalbergia sissoo</i>	1
<i>Delairea odorata</i>	1
<i>Dracophyllum longifolium</i>	1
<i>Dracophyllum scoparium</i>	1
<i>Echinuria uncinata</i>	1

<i>Elaphe guttata</i>	1
<i>Eleutherodactylus planirostris</i>	1
<i>Equus zebra hartmannae</i>	1
<i>Euphorbia paralias</i>	1
Family Corvidae	1
Family Vitaceae	1
Gallid herpesvirus 2	1
<i>Genetta genetta</i>	1
<i>Gymnophthalmus underwoodi</i>	1
<i>Gymnorhina tibicen</i>	1
<i>Hedychium</i> spp.	1
<i>Hemitragus jemlahicus</i>	1
<i>Herpestes edwardsi</i>	1
<i>Herpestes javanicus auropunctatus</i>	1
<i>Hyparrhenia rufa</i>	1
<i>Icerya purchasi</i>	1
<i>Iguana</i> spp.	1
<i>Ipomoea</i> spp.	1
<i>Juncus tenuis</i>	1
<i>Lavatera arborea</i>	1
<i>Lepidium latifolium</i>	1
<i>Lepus europaeus</i>	1
<i>Leucaena leucocephala</i>	1
<i>Leucaena</i> spp.	1
<i>Linepithema humile</i>	1
<i>Litoria genimaculata</i>	1
<i>Lucilia sericata</i>	1
<i>Mikania cordata</i>	1
<i>Mikania scandens</i>	1
<i>Mikania</i> spp.	1
<i>Mimosa diplotricha</i>	1
<i>Mimulus moschatus</i>	1
<i>Mnemiopsis leidyi</i>	1
<i>Mycobacterium avium</i>	1
<i>Natrix maura</i>	1
<i>Odontesthes bonariensis</i>	1
<i>Orconectes virilis</i>	1
<i>Oxychilus alliarius</i>	1
<i>Oxyura jamaicensis</i>	1
<i>Parabuteo unicinctus</i>	1
<i>Paspalum notatum</i>	1
<i>Paspalum vaginatum</i>	1
<i>Pavo</i> spp.	1
<i>Pennisetum setaceum</i>	1
<i>Peromyscus fraterculus</i>	1
<i>Peromyscus maniculatus</i>	1

<i>Petrogale inornata</i>	1
<i>Phalanger</i> spp.	1
<i>Phasianus colchicus</i>	1
<i>Pheidole megacephala</i>	1
<i>Phragmites australis</i>	1
<i>Pisonia umbellifera</i>	1
<i>Pistia stratiotes</i>	1
<i>Pittosporum undulatum</i>	1
<i>Platycercus eximius</i>	1
<i>Poa pratensis</i>	1
<i>Podarcis siculus</i>	1
<i>Polistes versicolor</i>	1
<i>Procambarus clarkii</i>	1
<i>Prosopis glandulosa</i>	1
<i>Psittacula krameri</i>	1
<i>Pueraria phaseoloides</i>	1
<i>Pycnonotus jocosus</i>	1
<i>Rhizophora mangle</i>	1
<i>Rubus fruticosus</i>	1
<i>Rubus niveus</i>	1
<i>Rubus rosifolius</i>	1
<i>Rubus ulmifolius</i>	1
<i>Rupicapra rupicapra rupicapra</i>	1
<i>Salvinia molesta</i>	1
<i>Sciurus carolinensis</i>	1
<i>Sesbania</i> spp.	1
<i>Spartina densiflora</i>	1
<i>Spathodea campanulata</i>	1
<i>Sphenodon punctatus</i>	1
<i>Tachybaptus novaehollandiae</i>	1
<i>Taeniatherum asperum</i>	1
<i>Testudo kleinmanni (libyan origin)</i>	1
<i>Thinopyrum junceiforme</i>	1
<i>Tilapia melanopleura</i>	1
<i>Tilapia zillii</i>	1
<i>Toxoplasma gondii</i>	1
<i>Ugni molinae</i>	1
<i>Ulex europaeus</i>	1
Unspecified Blatodea	1
<i>Vespula pensylvanica</i>	1
<i>Vespula vulgaris</i>	1
<i>Xiphophorus hellerii</i>	1
<i>Zosterops lateralis</i>	1





**Figure S1:** Temporal trends in IUCN Category from 1980 to 2014, considering all Categories (1: EX-EW, 2: CR, 3: EN, 4: VU, 5: NT, 6: LC, 7: DD, 8: NA, NE & IN), for species threatened by IAS (i.e, which were known in 2014 to be threatened by IAS). IUCN Categories were extracted for each species using letsR package version 2.1. The fit was performed using the ‘lm’ method of the geom\_smooth() function in ggplot2 package version 1.0.0.

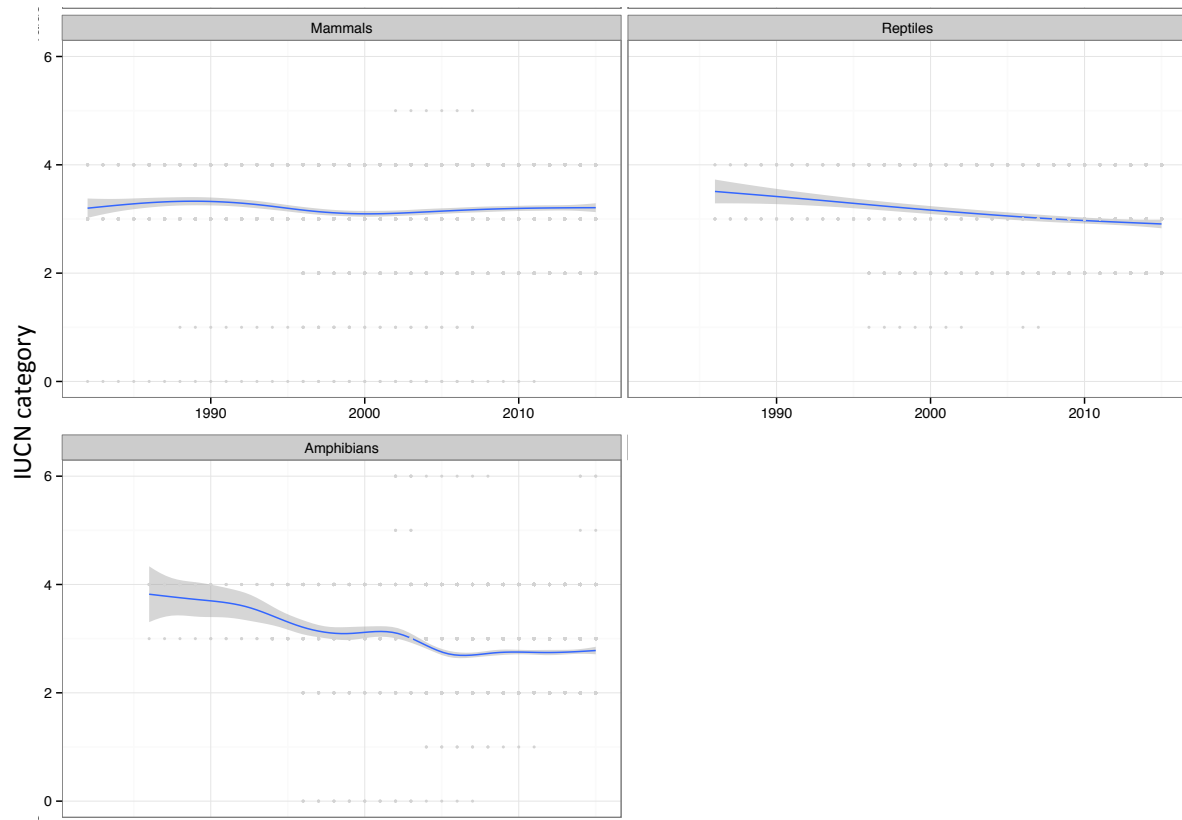
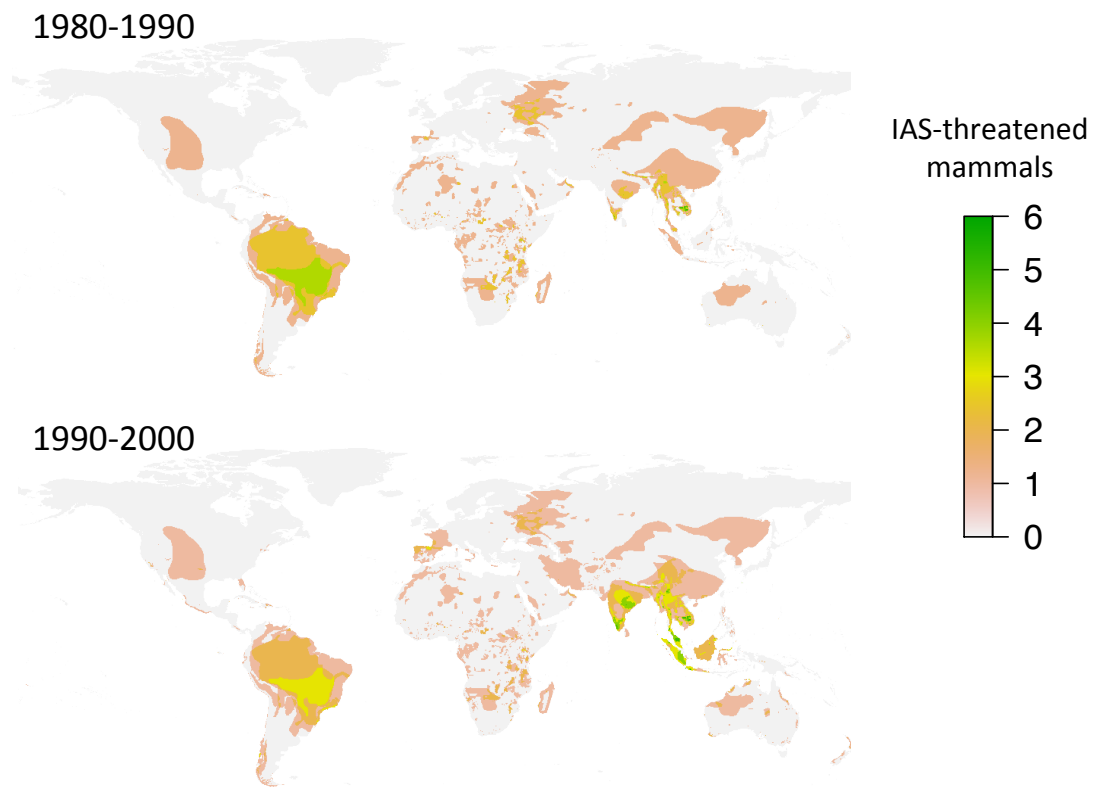
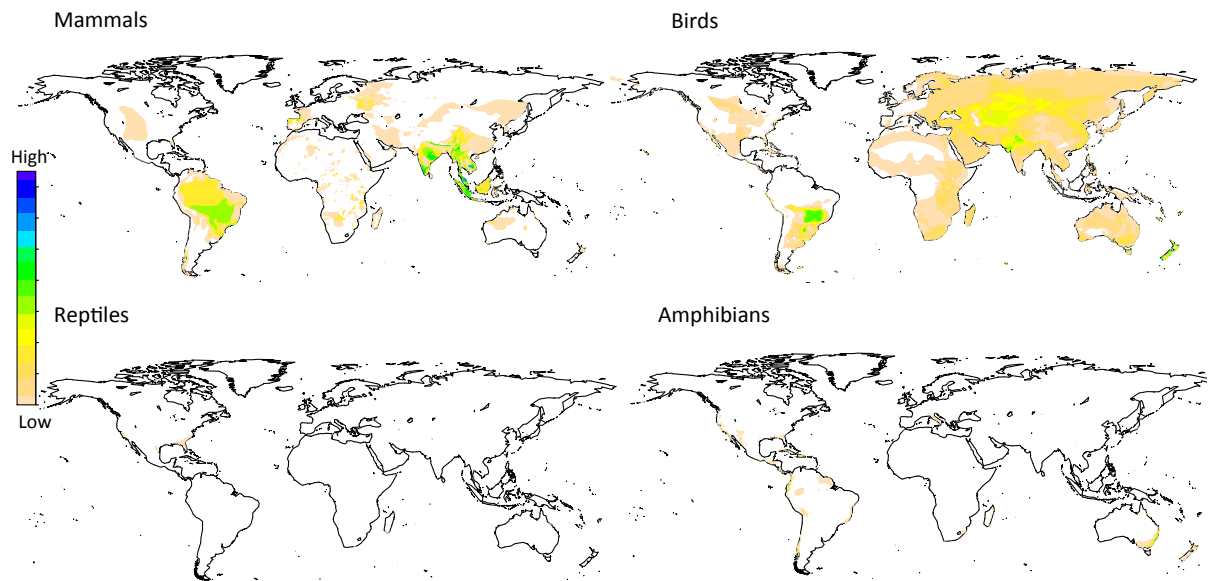


Figure S2: Temporal trends in IUCN Category from 1980 to 2014, restricted to Categories 1-6 (1: EX-EW, 2: CR, 3: EN, 4: VU, 5: NT, 6: LC), for species threatened by IAS (i.e. which were known in 2014 to be threatened by IAS). IUCN Categories were extracted for each species using letsR package version 2.1. The fit was performed using the 'lm' method of the geom\_smooth() function in ggplot2 package version 1.0.0. Because the number of records for birds was too low, we were not able to fit the data for this group.

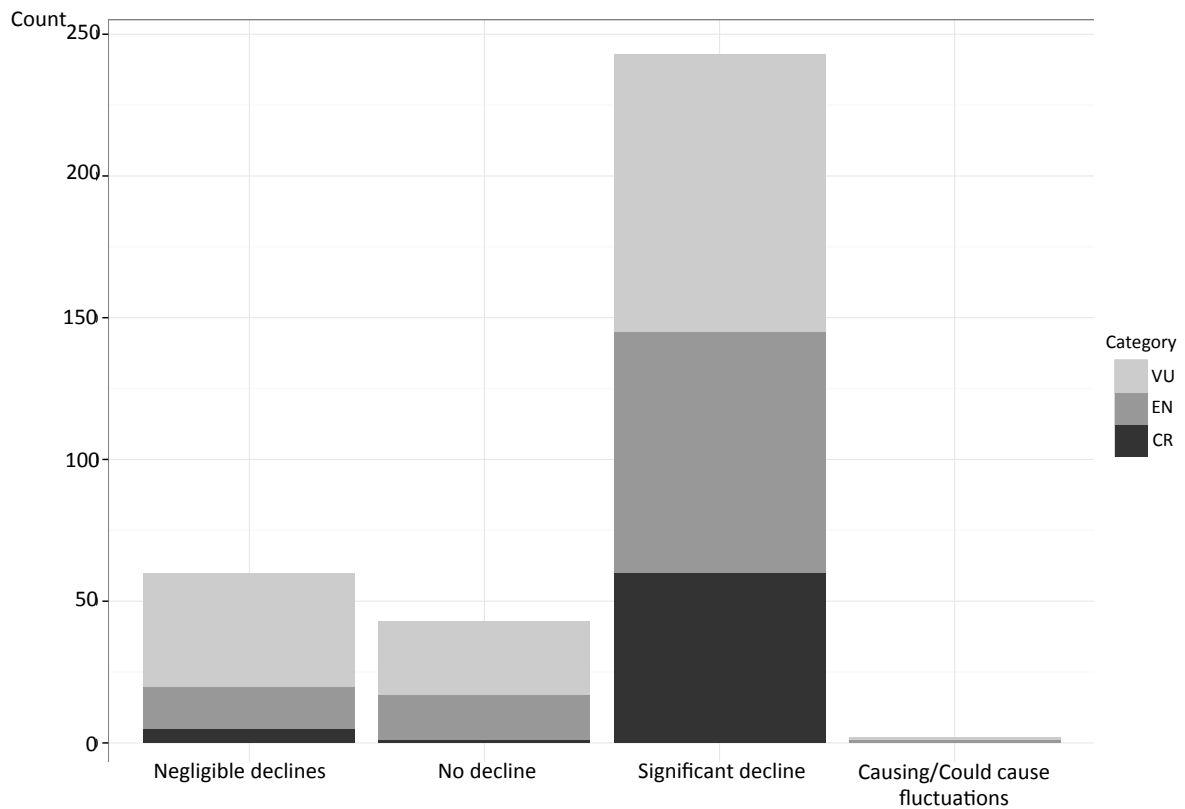
Figures S1-2 combined show that many mammals moved from DD, NA, NE & IN categories to threatened categories (Fig. S1), while there was no change when restricting the analysis to the categories with known status (Fig. S2). In contrast, there was a clear degradation of reptile and amphibian IAS-threatened species also for the restricted analysis (Fig. S2). Thus, there are different explanations for the steep declines in threat category shown in Fig. S1 for the different taxonomic groups. For amphibians and reptiles, the declines seem to be, at least partly, due to the worsening of the status of many IAS-threatened species over time. For mammals, on the other hand, the decline seems to be mainly due to species directly moving from an "unknown" status to "threatened".



**Figure S3:** Spatial distribution of IAS-threatened mammals in 1980-1990 vs. 1990-2000. Early IAS-threatened mammals mainly occupied South America, Africa, and some areas in Asia and Australia. Lately, IAS-threatened mammals increased in India, Indonesian islands, Australia, and Europe.



**Figure S4:** Spatial distribution of all other (not due to IAS) threatened (CR, EN, and VU) mammals (Pearson correlation with distribution of IAS-threatened mammals shown in Fig. 1A = 0.801), birds (Pearson correlation = 0.685), amphibians (Pearson correlation = 0.629), and reptiles (Pearson correlation = 0.199). Low numbers of threatened species from 1 species per pixel are in light-brown to medium numbers in green and high numbers in blue.



**Figure S5:** Severity information of IAS threat for IAS-threatened birds and amphibians accumulated. We extracted the information about the severity of IAS threat (i.e., IAS (i) cause no decline, (ii) could cause fluctuations, (iii) cause negligible declines, or (iv) cause significant decline for the species population) for bird and amphibian IAS-threatened species for which severity data were available (N=438).