TAS-ISK v2

Taxon and Assessor details	
Category	Mammals
Taxon name	*Ammotragus lervia*
Common name	aoudad
Assessor	Nikica Sprem, Tena Radocaj, Marina Piria
Risk screening context	
Reason and socio-economic benefits	Threat native populations
Risk assessment area	Europe
Taxonomy	Kingdom: Animalia; Phylum:Chordata; Class: Mammalia; Order: Cetartiodactyla; Family: Bovidae
Native range	North Africa
Introduced range	Europe (Croatia, Italy, Spain, Czech Republic) and North America
URL	https://www.iucnredlist.org/resources/dgfiucn2017

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	No	A. lervia has not been the subject of domestication. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1)	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	Yes, it can be.	Medium
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	A. lervia rarely behaves as an invasive species.	Low
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	Medium	The climatic conditions in the RA area and in the native area are similar. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1)	High
5	2.02	What is the quality of the climate matching data?	High	Distribution Map of IUCN, Climatch and (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	Yes	A. lervia is present outside of captivity in the RA area. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1).	High
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	Not applicable	Not applicable (A. lervia is present in the RA area).	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Not applicable	Not applicable (A. lervia is present in the RA area).	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	A. lervia is naturalised outside its native range. In Europe A. lervia has populations in: Croatia, Czech Republic, Italy, and Spain (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1)	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	A. lervia has a adverse impacts on species such as the Iberian Red Deer and the Iberian ibex, as well as on the native flora of the Canary Islands. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	High
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	A. lervia has some adverse impact. In the Canary Islands, A. lervia has a negative economic impact on agricultural land (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium. CAB International)	High
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	Yes	A. lervia has an adverse impact on ecosystem services (Canary Island- adverse impacts the endemic flora). (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-	High
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	Adverse impacts: Wildlife collision; The presence of A. lervia in the southeast of Spain has caused a negative economic impact on agricultural lands. Landowners need to build expensive barriers to prevent this species from entering into their crops. Also, shepherds claim that their presence affects the availability of good pastures for their livestock. (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium. CAB	High
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	No	A. lervia is harmless to human health.	Very high
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	A. lervia may suppress the growth of one or more native taxa - the native flora of Canary Islands. (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium.	High

16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	No	Medium
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	A. lervia is successfully adapted to the climate and other environmental conditions in the RA area. (See fourth question-climate between native area and RA area is similar). (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham.	Medium
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	Yes	It is possible. They can have a negative impact on the endemic flora in Canary Islands. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	Yes	A. lervia has a negative economic impact on agricultural land (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium. CAB International)	Medium
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	No	No evidence (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	No evidence (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	Yes	It can escape from captivity (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
23	4.10	Is the taxon versatile in habitat use?	Yes	A. lervia is unable to survive under significant changes in environmental conditions. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	Yes	They may negatively affect the endemic flora in Canary Islands. The species has been known to feed on the Macaronesian endemic flora, of which a number of species are threatened or vulnerable. (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium. CAB International)	Very high
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	Yes	A. lervia maintains population even when present in low densities. (The populations from Croatia and Italy). (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-	Very high
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Yes	The only evidence on impacts on biodiversity caused by the presence of A. lervia is in La Palma Island, Canary Islands. The species has been known to feed on the Macaronesian endemic flora, of which a number of species are threatened or vulnerable. These include Bencomia exstipulata, Cheirolophus santos-abreui and Lotus pyranthus. (Cassinello J (2015) Ammotragus lervia (aoudad). In: Invasive Species Compendium. CAB International)	High
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Not applicable	Not applicable	Very high
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	Yes	No evidence	High
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	A. lervia can reproduce in the RA area. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-	High
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	No	No confirmed evidence of A. lervia hybridization in the wild. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1)	Medium
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	No	Medium
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	A. lervia does not depend on the presence of another taxon to complete its life cycle.	High
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	No	It is not possible.	High
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	2	18 months	Very high
7. Dispersal mechanisms					

35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable	>1	1. Unintentional: escape from captivity 2. Intentional: illegally released	Medium
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	A. lervia is present in a regional park in Italy.	Medium
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	No	No	High
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	No, it is not possible. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	Medium
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	No evidence. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	High
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	No	Not migrate to another area because of reproduction	Very high
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	It is not possible.	Very high
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	No	No	Very high
43	7.09	Is dispersal of the taxon density dependent?	Yes	Yes, there is evidence. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-	High
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	No	A. lervia is unable to withstand being in water for extended periods at some stage of its life cycle.	Very high
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	Yes	E.g. Barbary sheep from Mt. Mosor showed low levels of toxic elements As, Cd, Hg, and Pb. Also, radio nucleotide values for 137Cs and 40K in muscle tissue were found at low level and significantly below the statutory values of 600 Bq. (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham.	Very high
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	No	Very high
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	A. lervia to tolerate environmental distrubance.	Very high
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual	Yes	A. lervia can able to tolerate soil acidity.	Very high
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	Yes	In Spain: the golden eagle; In Croatia: the grey wolf (Šprem N., Gančević P., Safner T., Jerina K., Cassinello J. (2020) Barbary Sheep Ammotragus lervia (Pallas, 1777). In: Hackländer K., Zachos F.E. (eds) Handbook of the Mammals of Europe. Handbook of the Mammals of Europe. Springer, Cham. https://doi.org/10.1007/978-3-319-65038-8_35-1)	Very high
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	No change	Under predicted future climatic conditions, the risk of A. lervia entering the RA area does not change.	Very high
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Increase	Inadequate hunting policy and monitoring, and increasing climatic resemblance of the study region to the native aoudad areas, due to a strong desertification process, are facilitating a high rate of expansion. Acevedo, P., Cassinello, J., Hortal, J. and Gortázar, C. (2007), Invasive exotic aoudad (Ammotragus lervia) as a major threat to native Iberian ibex (Capra pyrenaica): a habitat suitability model approach. Diversity and Distributions, 13: 587-597. https://doi.org/10.1111/j.1472-4642.2007.00374.x Tena: Under predicted future climatic conditions, the risk of establishment of A. lervia in the RA area does not change.	High
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	Inadequate hunting policy and monitoring, and increasing climatic resemblance of the study region to the native aoudad areas, due to a strong desertification process, are facilitating a high rate of expansion. Acevedo, P., Cassinello, J., Hortal, J. and Gortázar, C. (2007), Invasive exotic aoudad (Ammotragus lervia) as a major threat to native Iberian ibex (Capra pyrenaica): a habitat suitability model approach. Diversity and Distributions, 13: 587-597. https://doi.org/10.1111/j.1472-4642.2007.00374.x Under predicted future climatic conditions, the risk of dispersal of A. lervia within the RA area does not change.	High

53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	No change	Under predicted future climate conditions, the potential impacts on biodiversity do not change. Despite its exotic origin, no evidence of negative impact on habitats have been proved neither in the USA localities where A. lervia ranges freely, nor in the southeastern Iberian Peninsula. Evidence indicates, at most, a certain degree of overlap between its diet and that of some native ungulates (Krysl et al., 1980; Miranda et al., 2012). A. lervia is basically a wild grazer that may well occupy an empty niche in some of the areas where it has been introduced, particularly in Spain, where extant wild ungulates are essentially browsers. To date, only their presence in the Canary Islands can be considered harmful for the environment (Rodríguez Luengo and Cassinello,	Very high
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	No change	Under predicted future climate conditions, the potential impacts on ecosystem do not change.	Very high
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	No change	Under predicted future climate conditions, the potential impacts on ecosystem do not change.	Very high

Statistics	
Scores	
BRA	**29.0**
BRA Outcome	**-**
BRA+CCA	**33.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**12.0**
1. Domestication/Cultivation	*2.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*9.0*
B. Biology/Ecology	**17.0**
4. Undesirable (or persistence) traits	*8.0*
5. Resource exploitation	*5.0*
6. Reproduction	*1.0*
7. Dispersal mechanisms	*-2.0*
8. Tolerance attributes	*5.0*
C. Climate change	**4.0**
9. Climate change	*4.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**9**
Environmental	**11**
Species or population nuisance traits	**16**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.77**
BRA	**0.76**
CCA	**0.92**

Date and Time
23/04/2022 09:50:10

TAS-ISK v2

Taxon and Assessor details	
Category	Birds
Taxon name	*Phasianus colchicus*
Common name	common pheasant
Assessor	Tena Radočaj
Risk screening context	
Reason and socio-economic benefits	Threat to biological diversity in Croatia
Risk assessment area	Croatia
Taxonomy	Domain: Eukaryota; Kingdom: Metazoa; Phylum: Chordata; Subphylum: Vertebrata; Class: Aves;
Native range	Asia (Armenia, Azerbaijan, China, North Korea, South Korea)
Introduced range	Europe (Croatia, Italy, Hungary, Montenegro, Netherlands, Serbia, Slovenia...), North America,
URL	https://www.cabi.org/isc/datasheet/70470

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	Yes	Phasianus colchicus is a game bird widely raised on farms in many countries for shooting, mainly in Europe and the USA. (Redondo, P. G., & Domínguez, P. G. (2012). Typification and characterisation of the pheasant (Phasianus colchicus) game farms in Spain. Spanish journal of agricultural research, (4), 1005-	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	Rice, C. N. (2016). Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands (Doctoral dissertation, University of Kent).	Medium
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	Phasianus colchicus karpowi- 100 of the Japan's Worst Invasive Alien Species (https://www.nies.go.jp/biodiversity/invasive/DB/detail/20030e.html) (Braasch, T. H. I. E. M. O., Pes, T., Michel, S. T. E. F. A. N., & Jacken, H. E. I. N. E. R. (2011). The subspecies of the common pheasant Phasianus colchicus in the wild and captivity. World Pheasant Assoc. 2, 6-13.)	Low
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	Medium	By comparing the similarities of climatic conditions in the area of RA and the native area for P. colchicus is medium. (using Climatch)	Medium
5	2.02	What is the quality of the climate matching data?	Medium	Distribution Map CABI and Climatch	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	Yes	P. colchicus is present outside of captivity in the RA area. (Špirić, Z., Srebočan, E., & Crnić, A. P. (2013). Mercury in pheasant (Phasianus colchicus) organs in Podravina, Croatia. Journal of Environmental Science and Health, Part A, 48(4), 394-399.)	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	Not applicable	P. colchicus is present in the RA area.	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Not applicable	P. colchicus is present in the RA area.	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	Yes, P. colchicus is become naturalised outside its native range. UK (Robertson, P. (1996). Naturalised introduced gamebirds in Britain. The introduction and naturalisation of birds. HMSO, London, 63-69.). In North America, Phasianus colchicus populations have been established on mid-latitude agricultural lands from southern Canada to Utah, California to New England states, and south to Virginia. (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 09, 2021 at	High
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	Common pheasants can carry Newcastle disease and spread it to other wild and domestic birds (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 09, 2021 at https://animaldiversity.org/accounts/Phasianus_colchicus/). Pheasants are often considered threats to native herpetofauna (Rice, C. N. (2016). Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey,	High
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	Common pheasants have long caused concern to farmers through the consumption and damage of crops. In Hawaii, farmers recognise pheasants as the most significant avian pest of vegetable, flower and corn crops. (Rice, C. N. (2016). Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands	High
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	Yes	In the USA, P. colchicus may have an inhibitory effect (as a competitor) on the Northern Bobwhite Colinus virginianus (classified as Near Threatened – IUCN, 2015) and may also affect the Greater Prairie-chicken Tympanuchus cupido (in whose nests they sometimes lay their own eggs, and which is classified as	Medium
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	No	The predominant benefit of Phasianus colchicus to humans is as an upland game bird. (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 10, 2021 at https://animaldiversity.org/accounts/Phasianus_colchicus/).	Low
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	Yes	Toxoplasma gondii is an important ubiquitous protozoan parasite, which can infect almost all warm-blooded vertebrates, including humans. Consumption of feathered game (including Phasianus colchicus) could pose a risk of T. gondii transmission to humans.	Low

15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	No	There is no evidence, but according to the available information, there is a possibility that it may suppress Perdix perdix. P. colchicus can negatively affect Perdix perdix (gray partridge) - (in Croatia it is a native species) through nest parasitism, habitat competition, disease transmission and aggressive behavior (CABI,	Low
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	No threatened or protected taxa that the non-native P. colchicus would be parasitise in the RA area.	High
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	P. colchicus is adaptable to climatic and other environmental conditions in the RA area. The species has in the RA area established self-sustaining populations.	High
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	Yes	It is possible that P. colchicus may have a negative impact on food web function in the ecosystem in the RA area due to its negative impact as a competitor in the other countries where it has been introduced. P. colchicus may negatively affect Perdix perdix (grey partridge)- (in Croatia is native species) through nest parasitism, habitat competition, disease transmission and aggressive behaviour (CABI, 2019)	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	No	No evidence, but I my personal opinion is no	Low
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	Yes	Newcastle disease- Common pheasants can carry Newcastle disease and spread it to other wild and domestic birds (Aldous, E. W., & Alexander, D. J. (2008). Newcastle disease in pheasants (Phasianus colchicus): a review. The Veterinary Journal, 175(2), 181-185.) P. colchicus are susceptible to several nematode	High
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	Yes	Newcastle disease- Common pheasants can carry Newcastle disease and spread it to other wild and domestic birds (Aldous, E. W., & Alexander, D. J. (2008). Newcastle disease in pheasants (Phasianus colchicus): a review. The Veterinary Journal, 175(2), 181-185.) P. colchicus are susceptible to several nematode	High
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	Yes	Range length- 42.5 to 53.6 cm (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 10, 2021 at	High
23	4.10	Is the taxon versatile in habitat use?	Yes	P. colchicus occupy grassland and farmland habitats, preferring relatively open cover, such as grass and stubble fields with nearby trees or bushes for cover (Switzer, 2011). As generalists, they will though occupy a range of habitat types, except for dense tropical or alpine forests or very dry areas (Switzer, 2011). They prefer areas near to water although they can obtain water from dew, insects and succulent vegetation (Switzer, 2011). (CABI, 2019)	High
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	Yes	They could potentially deplete food sources for other animals, affect ground/hedge flora, and attract more predators to the environment (GWCT, 2015).	Medium
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	No	Rice, Charmaine Natasha (2016) Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands. Master of Research (MRes) thesis, University of Kent,.	Low
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Yes	Pheasants are often considered threats to native herpetofauna. Small vertebrates, including herpetofauna, are often listed as items in pheasant diets, and it is known that pheasants will opportunistically consume small vertebrates, including snakes. (Rice, Charmaine Natasha (2016) Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands. Master of Research	High
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Not applicable	Not applicable	Very high
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	Yes	Most parental investment in common pheasants is by females. After building her nest and laying the eggs, the female is responsible for incubating them. They are able to immediately begin following the hen to sources of food and the young chicks will feed themselves. The hen's main role is to lead her chicks to food after hatching. By about 12 days, young are able to fly and typically remain with the hen for 70 to 80 days before becoming	High
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	P. colchicus produce viable gametes in the RA area.	High
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	Yes	Morphological analysis showed evidence for natural hybridisation between introduced Ringnecked and autochthonous pheasants in the northern belt of Iran. (Kayvanfar, N., Aliabadian, M., & Ghasempouri, S. M. (2015). Morphometric and morphological differentiation of the subspecies of Phasianus colchicus (Linnaeus, 1758) on the Iranian Plateau (Aves: Galliformes). Zoology in the	Low
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	No	Low
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	The habitats that pheasants nest in are diverse and include woodland, hedges, crop fields, grass fields, gardens and roadside ditches. (Rice, Charmaine Natasha (2016) Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands. Master of Research (MRes) thesis, University of Kent)	Medium
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	Ring-necked pheasants breed once yearly. Average eggs per season- 10 (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 13, 2021 at https://animaldiversity.org/accounts/Phasianus_colchicus/)	Low

34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	1	Average age at sexual or reproductive maturity (male anf female)- 1 years (Switzer, C. 2011. "Phasianus colchicus" (On-line), Animal Diversity Web. Accessed April 10, 2021 at https://animaldiversity.org/accounts/Phasianus_colchicus/)	High
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable	One	1. Intentional release- In areas where it is managed as a game bird, it is intentionally released from pens into surrounding estates/countryside in large numbers for hunting (CABI, 2019)	High
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	No	Intentional release does not bring P. colchicus close to protected areas.	Low
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	No	No	Low
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	Only with the help of people.	Medium
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	Only with the help of people.	Medium
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	Yes	Yes, older life stages P. colchinus likely to migrate in the RA area for reproduction.	Low
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	No	Medium
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	Yes	Intentional release	Low
43	7.09	Is dispersal of the taxon density dependent?	No	Rice, Charmaine Natasha (2016) Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands. Master of Research (MRes) thesis, University of Kent,.	Medium
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	No	CABI 2019	Medium
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	No	Contributing factors to the ongoing negative trend, such as the effects of pesticides. (Liebing J, Völker I, Curland N, Wohlsein P, Baumgärtner W, Braune S, et al. (2020) Health status of free-ranging ring-necked pheasant chicks (Phasianus colchicus) in North-Western Germany. PLoS ONE 15(6): e0234044).	Medium
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	In the RA area is not regulated	Very high
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	No	Rice, Charmaine Natasha (2016) Abundance, impacts and resident perceptions of non-native common pheasants (Phasianus colchicus) in Jersey, UK Channel Islands. Master of Research (MRes) thesis, University of Kent,.	Low
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual environment?	No	Liebing J, Völker I, Curland N, Wohlsein P, Baumgärtner W, Braune S, et al. (2020) Health status of free-ranging ring-necked pheasant chicks (Phasianus colchicus) in North-Western Germany. PLoS ONE 15(6): e0234044.	Medium
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA	Yes	Vulpes vulpes, Mustela, Meles meles..	Very high
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	Not applicable	P. colchicus is present in the RA area.	Very high
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	No change	Smith, M. L. (2015). Understanding the implications of climate change for birds of the family Phasianidae: incorporating fleshy structures into models of heat dissipation capacity.	Medium
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	No change	Smith, M. L. (2015). Understanding the implications of climate change for birds of the family Phasianidae: incorporating fleshy structures into models of heat dissipation capacity.	Medium
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	No change	Smith, M. L. (2015). Understanding the implications of climate change for birds of the family Phasianidae: incorporating fleshy structures into models of heat dissipation capacity.	Medium
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	No change	Smith, M. L. (2015). Understanding the implications of climate change for birds of the family Phasianidae: incorporating fleshy structures into models of heat dissipation capacity.	Medium
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	No change	Smith, M. L. (2015). Understanding the implications of climate change for birds of the family Phasianidae: incorporating fleshy structures into models of heat dissipation capacity.	Medium

Statistics	
Scores	
BRA	**27.5**
BRA Outcome	**-**
BRA+CCA	**27.5**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**15.5**
1. Domestication/Cultivation	*4.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*10.5*

B. Biology/Ecology	**12.0**
4. Undesirable (or persistence) traits	*8.0*
5. Resource exploitation	*5.0*
6. Reproduction	*5.0*
7. Dispersal mechanisms	*-2.0*
8. Tolerance attributes	*-4.0*
C. Climate change	**0.0**
9. Climate change	*0.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**11**
Environmental	**10**
Species or population nuisance traits	**9**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.57**
BRA	**0.57**
CCA	**0.58**

Date and Time
13/04/2021 14:08:04

TAS-ISK v2

Taxon and Assessor details	
Category	Reptiles
Taxon name	*Hemidactylus frenatus*
Common name	common house gecko
Assessor	Bettina Szajbert, Marina Piria
Risk screening context	
Reason and socio-economic benefits	Pet trade
Risk assessment area	Pannonian region of Hungary
Taxonomy	Gekkonidae, Gekkota, Sauria, Squamata (lizards: geckos)
Native range	Worldwide in tropical and subtropical regions
Introduced range	Europe, USA
URL	https://reptile-database.reptarium.cz/species?genus=Hemidactylus&species=frenatus&search_param=()

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	Yes	It has also been introduced accidentally in the USA via the zoo trade in Texas in the 1970s and 1988 (McAllister et al., 1990; Saenz and Klawinski, 1996) and pet trade in Florida in 1993 (Meshaka et al., 1994; Krysko and Sheehy, 2005; Krysko et al. 2016).	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	It has also been introduced accidentally in the USA via the zoo trade in Texas in the 1970s and 1988 (McAllister et al., 1990; Saenz and Klawinski, 1996) and pet trade in Florida in 1993 (Meshaka et al., 1994; Krysko and Sheehy, 2005; Krysko et al. 2016).	High
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	Hemi-dactylus geckos (Hemidactylus mabouia (Moreau de Jonnès, 1818), H. turcicus Linnaeus, 1758, H. brookii Gray, 1845, H. frenatus Schlegel 1836, H. garnotii Duméril & Bibron, 1836, H. persicus Anderson, 1872, H. flaviviridis Rüpel, 1835 and H bowringii Gray, 1845) have appreciably extended their ranges during the last century (e.g. Carranza & Arnold 2006). They represent the most obvious cases of large range extensions of any reptilian group. Hemidactylus frenatus, which has its native range in tropical Asia and the Indo-Pacific (Case et al. 1994), and Hemidactylus mabouia, which has its native range in Central and East Africa, are especially widespread (Carranza & Arnold 2006). Hemidactylus frenatus has already colonized many pacific islands, Florida, Central America and the Venezuelan coast (e.g. Case et al. 1994, Meshaka et al. 2004). Rodder et al 2008: Predicting the potential distributions of two alien invasive Housegeckos (Gekkonidae: Hemidactylus frenatus, Hemidactylus mabouia); http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-	Very high
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	Low	Climate in Pannon region Dfa, Dfb which is not preferred climate for species; it is tropical species and may tolerrate Mediterranean climate; Climatch; https://www.cabi.org/isc/datasheet/80353#tolatitudeAndAltitudeRanges	High
5	2.02	What is the quality of the climate matching data?	Medium	http://hanschen.org/koppen	High
6	2.03	Is the taxon already present outside of captivity in the RA area?	Yes	There is no any documented evidence that is foound outside of captivity in RA area but colleagues from Hungary said that We found Hemydactilus frenatus in 13. March 2019. in Budapest, Hungary on a brick wall. They were collected by András Weiperth. There are no written literature yet in this area, but we are currently working on it with András. (We have been monitoring them over the last two years, and András will soon process the data.) , http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Low
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	Transported in cargo and in pet trade; Pet trade is could be the most probably vector for pannon region; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	No	Species is established in tropical areas of Australia, SAD, Afrika; In Europe is found as hitchiker in cargo ships in Italy and Portigal but there is no exact note about status of this species and no any information of their establishment; https://academic.oup.com/cz/article/64/5/559/4101659; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	established is in Australia, SAD; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High

10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	The main ecological impacts of H. frenatus are on native animals, particularly insects (Punzo, 2005) and spiders, and displacement of native Indo-Pacific (H. garnotii) (Dame and Petren, 2006) and mourning geckos (Lepidodactylus lugubris) (Case et al., 1994) and the decline and extinction of native and endemic night geckos (Nactusspp.) (Cole et al., 2005). http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	No	No evidence, only impact on biodiversity; https://www.cabi.org/isc/datasheet/80353#tolatitudeAndAltitudeR anges; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	No	Noevidence; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	No	No evidence found; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	Yes	H. frenatus can have high extoparasite and endoparasite loads, and can act as vectors by transmission to native gecko species and provide a zoonotic pathway to affect human health (Obi et al., 2013; Reimche, 2013).; Bettina: ticks, salmonella and: https://bioone.org/journals/comparative-parasitology/volume-74/issue-2/4209.1/Pentastomid-Parasites-of-the-Introduced-Asian-House-Gecko-Hemidactylus-frenatus/10.1654/4209.1.short, https://link.springer.com/article/10.1007/s004420050508, https://search.informit.com.au/documentSummary;dn=266791012 890639;res=IELHSS, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1442-	Low
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	The main ecological impacts of H. frenatus are likely to be consumption of native insects and spiders, as well as the displacement of native Indo-Pacific (H. garnotii) and mourning geckos (Lepidodactylus lugubris), and the decline and extinction of native and endemic night geckos (Nactusspp.). http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	It can trasmite patogens, but it is not parasit; lizards, https://bioone.org/journals/comparative-parasitology/volume-74/issue-2/4209.1/Pentastomid-Parasites-of-the-Introduced-Asian-House-Gecko-Hemidactylus-frenatus/10.1654/4209.1.short, https://link.springer.com/article/10.1007/s004420050508, https://search.informit.com.au/documentSummary;dn=266791012 890639;res=IELHSS, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1442-	Very high
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	No	Species is tollerant but not for negative temperature found in pannon RA http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	Yes	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	No	no evidence; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et .al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	No	https://bioone.org/journals/comparative-parasitology/volume-74/issue-2/4209.1/Pentastomid-Parasites-of-the-Introduced-Asian-House-Gecko-Hemidactylus-frenatus/10.1654/4209.1.short, https://link.springer.com/article/10.1007/s004420050508, H. frenatus can have high extoparasite and endoparasite loads, and can act as vectors by transmission to native gecko species and provide a zoonotic pathway to affect human health (Obi et al., 2013; Reimche, 2013).; https://search.informit.com.au/documentSummary;dn=266791012 890639;res=IELHSS, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1442-	Medium
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	Yes	H. frenatus can have high extoparasite and endoparasite loads, and can act as vectors by transmission to native gecko species and provide a zoonotic pathway to affect human health (Obi et al., 2013; Reimche, 2013).; https://bioone.org/journals/comparative-parasitology/volume-74/issue-2/4209.1/Pentastomid-Parasites-of-the-Introduced-Asian-House-Gecko-Hemidactylus-frenatus/10.1654/4209.1.short, https://link.springer.com/article/10.1007/s004420050508, https://search.informit.com.au/documentSummary;dn=266791012 890639;res=IELHSS, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1442-	High

22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	H. frenatus grows up to 57 mm snout-vent length (Powell et al., 2016). http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Very high
23	4.10	Is the taxon versatile in habitat use?	Yes	H. frenatus is found from sea level up to 1600 m altitude (Spawls et al., 2002) in rainforests, savannas, deserts and urban areas; it occurs on boulders and trees, under rocks or rotting logs, and on buildings (Ota and Whitaker, 2010). In Florida, it is found in mangrove swamps, hardwood hammocks, sheltering under debris in pinelands, rocks and loose bark of Australian pine trees (Casuarina equisetifolia) or on fig trees and buildings (Krysko et al., 2003; Krysko and Sheehy, 2005). H. frenatus is edificarian and typically found in association with human dwellings (Punzo, 2005; Carranza and Arnold, 2006; Zug et al., 2007). http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-	Medium
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	No	no evidence; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	Yes	Has high genetic variability; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-	Medium
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Yes	Its diet consists of insects (Meshaka et al., 2004; Punzo, 2005) and spiders, and an adult was observed feeding on a juvenile tropical house gecko (Hemidactylus mabouia) on Key West, Florida Associations; it may found similar food items that are protected in pannon region http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-	Low
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Yes	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Low
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	Yes	Hatchlings measure 23 mm SVL. Interspecific communal nesting has been reported in the Florida Keys, with up to three gecko species sharing the same nest site (Krysko et al., 2003).; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Low
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	No	Eggs hatch in 48-90 days at 28-29°C (82-84°F) (Church, 1962; Krysko et al., 2003). in RA may not be available such temperatures for so long.	Low
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	No	No evidence for hybridization	High
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	No such evidences. https://www.jstor.org/stable/1564081, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4492922/	Very high
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	Pioneering in disturbed areas https://animaldiversity.org/accounts/Hemidactylus_frenatus/	Very high
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	No	H. frenatus reproduces year-round, and females lay 1-2 eggs (Krysko et al., 2003). Eggs are laid in soil, under leaf litter, rocks, boards, or carpet, or under loose bark and within thickets of dry pine needles in crotches of Australian pines up to 2.5 m high (Krysko et al., 2003). Oviposition frequency is 21-28 days (Krysko et al., 2003), and Meshaka et al. (1994) reported females laying up to 4 clutches annually in southern Florida. https://animaldiversity.org/accounts/Hemidactylus_frenatus/	Medium
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	1	a year, https://animaldiversity.org/accounts/Hemidactylus_frenatus/	Medium
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable habitats nearby)?	>1	possible vector can be release or escape from terrarium, or maybe transport (on indirect way); http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-	Medium
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	https://link.springer.com/article/10.1007/s10530-008-9285-3, https://animaldiversity.org/accounts/Hemidactylus_frenatus/	Low
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	Yes	on smooth surface, https://animaldiversity.org/accounts/Hemidactylus_frenatus/	Very high
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	No, adults are found	Very high
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	we are catched some but probably they were released from terrarium. They can move across considerale distances https://en.wikipedia.org/wiki/Common_house_gecko#Reproductive_biology	Low
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	Yes	we are catched some https://en.wikipedia.org/wiki/Common_house_gecko#Reproductive_biology	Low

41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	Yes	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
43	7.09	Is dispersal of the taxon density dependent?	No	H. frenatus reproduces year-round, and females lay 1-2 eggs (Krysko et al., 2003). Eggs are laid in soil, under leaf litter, rocks, boards, or carpet, or under loose bark and within thickets of dry pine needles in crotches of Australian pines up to 2.5 m high (Krysko et al., 2003). Oviposition http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-	High
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	No	No evidence found	Low
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	No	Benefits from human association (i.e. it is a human commensal); but not evidence on persistance of elevate levels of chemicals http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Low
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	Once established it is unlikely to be eradicated.	High
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	Benefits from human association (i.e. it is a human commensal) but not evidence of enhancement of human generated impacts. for http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Low
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual	No	No evidence found. https://link.springer.com/chapter/10.1007/978-3-319-67177-2_7, https://www.jstor.org/stable/1443243,	High
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA	Yes	mammals, reptiles, pets, birds but not konwledge how effective they can be	Low
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	No change	Enty possibilities will not change. http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Increase	With global warnimg establishment could be possible; http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	Medium
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	Probably increase because will have more warm days for reproduction. http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Higher	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Higher	http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	No change	Probably no change because it is to hard to distinguish between other similar species and humans in RA are not afraid of them, on contrary - like them. http://www.publish.csiro.au/zo/zo12077, http://biozoojournals.ro/nwjz/content/v4.2/28.nwjz.4.2.Roedder.et.al.pdf, https://link.springer.com/article/10.1007/s10530-008-9285-3,	High

Statistics	
Scores	
BRA	**24.0**
BRA Outcome	**-**
BRA+CCA	**32.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**9.0**
1. Domestication/Cultivation	*4.0*
2. Climate, distribution and introduction risk	*2.0*
3. Invasive elsewhere	*3.0*
B. Biology/Ecology	**15.0**
4. Undesirable (or persistence) traits	*5.0*
5. Resource exploitation	*7.0*
6. Reproduction	*1.0*
7. Dispersal mechanisms	*2.0*
8. Tolerance attributes	*0.0*
C. Climate change	**8.0**
9. Climate change	*8.0*

Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**9**
Environmental	**11**
Species or population nuisance traits	**17**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.60**
BRA	**0.59**
CCA	**0.71**

Date and Time
10/01/2022 07:47:58

TAS-ISK v2

Taxon and Assessor details	
Category	Amphibians
Taxon name	*Bombina variegata*
Common name	yellow-bellied toad
Assessor	Onur Candan
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Anatolia (Turkey)
Taxonomy	Species
Native range	Central and southern Europe
Introduced range	Turkish thrace
URL	

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	No	No evidence for its domestication (or cultivation). (1- https://www.cabi.org/isc/search/index?q=bombina%20variegata, 2- Sergius Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290.en)	High
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	it is reported that it is collected as bait by fishermen in certain regions and that it is occasionally collected in large numbers for both the pet trade and scientific use. (1- Kuzmin, S.L. (1995): Die Amphibien Russlands und angrenzender Gebiete. Die Neue Brehm-Bücherei Bd. 627, Westarp Wissenschaften, Magdeburg, 274 pp. https://doi.org/10.1163/156853897X00233, 2- Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290.en)	Very high
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	There is no evidence for Bombina variegata as being invasive. But Bombina orientalis, another species within the same genus, is invasive. (1- West, A. M., Jarnevich, C. S., Young, N. E., & Fuller, P. L. (2018). Evaluating Potential Distribution of High-Risk Aquatic Invasive Species in the Water Garden and Aquarium Trade at a Global Scale Based on Current Established Populations. Risk Analysis. doi:10.1111/risa.13230)	High
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	Most of the Anatolia has similar climatic conditions of the taxon's native range according to the Köppen-Geiger climate classification system. The taxon's native range is mostly Cfa and Cfb, and especially lower parts are Csa and Csb according to the Köppen-Geiger system. The climatic conditions of the RA area is mostly Csa and Csb (whole aegean and mediterranean region of Anatolia) and Cfa and Cfb (whole west and middle Blacksea region, and coastal part of eastern Blacksea region). The climatic conditions are so similar not only today, but also for 2100 projection. (Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-	High
5	2.02	What is the quality of the climate matching data?	High	According to the Köppen-Geiger climate classification, the main results comprise an estimation of the shifts of climate zones within the 21st century by considering different IPCC scenarios. (Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI:	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	No	The taxon already found within the borders of Turkey, but not in Anatolian part. (1- Bülbül, U., Kurnaz, M., Eroğlu, A. İ., Koç, H., & Kutrup, B. (2018). Restricted distribution area, threat conditions and additional two new localities of Bombina variegata (L., 1758)(Anura: Bombinatoridae) in Turkey. Russian Journal of Herpetology, 25(3), 236-238., 2- BÜLBÜL, U., Kurnaz, M., EROĞLU, A. İ., Szymura, J. M., Koc, H., & Kutrup, B. (2016). First record of Bombina variegata (L., 1758)(Anura: Bombinatoridae) from Turkey. Turkish Journal of Zoology, 40(4), 630-636.)	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	The Marmara Sea, The İstanbul and the Çanakkale Straits constitute a natural border for the species to pass from the Turkish Thrace to the Anatolia part of Turkey. However, considering its use as pet or fish bait, it can invade Anatolia by transportation. (1- Kuzmin, S.L. (1995): Die Amphibien Russlands und angrenzender Gebiete. Die Neue Brehm-Bücherei Bd. 627, Westarp Wissenschaften, Magdeburg, 274 pp. https://doi.org/10.1163/156853897X00233, 2- Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290.	Low
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Yes	The species is found and recorded a few locations in the Turkish Thrace. (1- Bülbül, U., Kurnaz, M., Eroğlu, A. İ., Koç, H., & Kutrup, B. (2018). Restricted distribution area, threat conditions and additional two new localities of Bombina variegata (L., 1758)(Anura: Bombinatoridae) in Turkey. Russian Journal of Herpetology, 25(3), 236-238., 2- BÜLBÜL, U., Kurnaz, M., EROĞLU, A. İ., Szymura, J. M., Koc, H., & Kutrup, B. (2016). First record of Bombina variegata (L., 1758)(Anura: Bombinatoridae) from Turkey. Turkish Journal of Zoology, 40(4), 630-636.)	Very high
3. Invasive elsewhere					

9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	No	It has been reported that the species has been seriously reduced even in the locality where it was first found. (Bülbül, U., Kurnaz, M., Eroğlu, A. İ., Koç, H., & Kutrup, B. (2018). Restricted distribution area, threat conditions and additional two new localities of Bombina variegata (L., 1758)(Anura: Bombinatoridae) in Turkey. Russian Journal of Herpetology, 25(3), 236-238.)	Medium
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	Hybridization of B. variegata with B. bombina might also be considered a threat, at least in some areas. Mosaic hybridization in Transylvania has resulted in the loss of pure populations. B. bombina has recently been introduced in Moselle, north-eastern France, in an area where the yellow-B. variegata occurs naturally. Both species hybridize in a wide area throughout Europe where their distribution overlaps. So hybridization could be occur in Turkish Thrace population of B. bombina. (1- Vacher, J. P., Aumaître, D., & Ursenbacher, S. (2020). Genetic characteristics of an introduced population of Bombina bombina (Linnaeus, 1761)(Amphibia: Bombinatoridae) in Moselle, France. Acta Herpetologica, 15(1), 47-54., 2- Vörös, J., Alcobendas, M., Martínez-Solano, I., & García-París, M. (2006). Evolution of Bombina bombina and Bombina variegata (Anura: Discoglossidae) in the Carpathian Basin: a history of repeated mt-DNA introgression across species. Molecular Phylogenetics and Evolution, 38(3), 705-718., 3- Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290	Medium
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	No	No evidence for the taxon's adverse impacts to agriculture and forestry.	Medium
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem	No	No evidence for its adverse impacts to ecosystem services.	Low
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	No	There is an unsustainable frog harvesting in Turkey, for economic income. Frogs have been harvested from the wild for the last 40 years in Turkey. Bombina variegata and the other frogs could have helminths that can effect health. So that could be an adverse socio-economic impact. (1-Çiçek, K., Ayaz, D., Afsar, M., Bayrakcı, Y., Pekşen, Ç.A., Cumhuriyet, O., İsmail, İ.B., Yenmiş, M., Üstündağ, E., Tok, C.V. and Bilgin, C.C., 2021. Unsustainable harvest of water frogs in southern Turkey for the European market. Oryx, 55(3), pp.364-372., 2- Hristovski, N.D. and Riggio, S., 1973. Comparative data of the parasitic helminthofaunas in Discoglossus pictus Otth, D. sardus Tschudi and Bombina variegata L.(Amphibia: Discoglossidae) from southern Europe. Folia Balcanica, Institut de Pisciculture de la RS de Macedoine, 3(3), pp.1-19., 3- Sattmann, V.H., 1990. Endohelminths of some amphibians from Northern Greece (Trematoda, Acanthocephala, Nematoda; Amphibia: Triturus, Rana, Bombina). Herpetozoa	Medium
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	Yes	It is concluded that in B. variegata the mechanism controlling the skin "venom" emission is of an adrenergic nature, i.e. is stimulated by alpha- and inhibited by beta-adrenoceptor stimulation. The skin secration of B. variegata possess a strong haemolytic activity. (1- Delfino, G., Amerini, S. and Mugelli, A., 1982. In vitro studies on the "venom" emission from the skin of Bombina variegata pachypus (Bonaparte)(Amphibia Anura Discoglossidae). Cell biology international reports, 6(9), pp.843-850., 2- KAISER, E. and KRAMAR, R., 2016, April. Biochemistry of the cytotoxic action of amphibian poisons. In Animal Toxins: A Collection of Papers Presented at the First International Symposium on Animal Toxins, Atlantic City, New Jersey, USA,	High
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	No	There is no evidence for its suppression on the growth of native taxa. An invasive species experiences a niche overlap with native species in the introduced area. In this case, a pressure is expected on native species.	Low
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	Yes	There are threatened or protected taxa that the non-native taxon would become predator or parasitise in the RA area. [1- Karataş, A., Filiz, H., Erciyas-Yavuz, K., Özeren, S.C. and Tok, C.V., 2021. The Vertebrate Biodiversity of Turkey. Biodiversity, Conservation and Sustainability in Asia: Volume 1: Prospects and Challenges in West Asia and Caucasus, p.175., 2- Hristovski, N.D. and Riggio, S., 1973. Comparative data of the parasitic helminthofaunas in Discoglossus pictus Otth, D. sardus Tschudi and Bombina variegata L.(Amphibia: Discoglossidae) from southern Europe. Folia Balcanica, Institut de Pisciculture de la RS de Macedoine, 3(3), pp.1-19., 3- Sattmann, V.H., 1990. Endohelminths of some amphibians from Northern Greece (Trematoda, Acanthocephala, Nematoda; Amphibia: Triturus, Rana, Bombina). Herpetozoa	High

17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	Water temperature is the major ecological variable affecting selection of spawning sites in Bombina variegata. The altitudinal distribution of the species ranged from 5 m to 1900m a.s.l., with a general preference for hilly and mountain areas at medium-low altitudes. The species was mostly observed in small shallow pools for reproduction; it was sometimes found in wider humid habitats such as ponds, river pools, ditches and marshes. Both sexes can breed several times during the reproductive season. According to the altitude and general preference of the RA area, with the similar climatic conditions, the B. vairegata is adaptable if it invades to the RA area. (1- Reyer, H.U. and Barandun, J., 1997. Reproductive ecology of Bombina variegata: characterisation of spawning ponds. Amphibia-Reptilia, 18(2), pp.143-154., 2- Barbieri, F., Bernini, F., Guarino, F.M. and Venchi, A., 2004. Distribution and conservation status of Bombina variegata in Italy (Amphibia, Bombinatoridae). Bollettino di Zoologia, 71(S1), pp.83-90., 3- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI:	High
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	No	There is no evidence on disruption of food-web structure. According to a research on B. bombina and B.variegata, prey diversity changes a lot during the seasons due to low food availability. The high adaptability of their feeding strategies and the consuming of the most abundant prey shows a high ecological plasticity and an opportunist feeding behaviour. Prey of the B. variegata is mostly terrestrial. (1- Sas, I., Covaciu-Marcov, S.D., Pop, M., Ile, R.D., Szeibel, N. and Duma, C., 2005. About a closed hybrid population between Bombina bombina and Bombina variegata from Oradea (Bihor county, Romania). North-Western Journal of Zoology, 1(1), pp.41-60., 2- FERENŢI, S. (2010), STUDIES ON TWO Bombina variegata POPULATIONS FROM TWO VALLEYS IN THE IEZER MOUNTAINS, ROMANIA. South Western Journal of Horticulture, Biology and Environment Vol. 1(2): 167-	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	No	There is no evidence for adverse impacts on ecosystem services in the RA area. But the taxon is mostly feeding on terrestrial invertebrates, that include hymenoptera. So the taxon may effect on beekeeping. (Sas, I., Covaciu-Marcov, S.D., Cupşa, D., Cicort-Lucaciu, A.Ş. and Popa, L., 2005. Food analysis in adults (males/females) and juveniles of Bombina variegata. Analele Stiintifice ale Universităţii „Al. I. Cuza" Iaşi, s. Biologie animală,	Low
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA	No	No evidence for such an endemic agent in the RA.	Medium
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	No evidence for such an introduction vector in the RA. But some studies were reported that disease- and parasite-mediated reduction of longevity may affect B. variegata populations (1-Spitzen-van der Sluijs Annemarieke, Canessa Stefano, Martel An and Pasmans Frank 2017Fragile coexistence of a global chytrid pathogen with amphibian populations is mediated by environment and demographyProc. R. Soc. B.2842017144420171444, 2-Campbell, L.J., Garner, T.W., Tessa, G., Scheele, B.C., Griffiths, A.G., Wilfert, L. and Harrison, X.A., 2018. An emerging viral pathogen truncates population age structure in a European amphibian and may reduce population viability. PeerJ, 6, p.e5949).	Medium
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	There is no documentation for this question. For pet trading of amphibians "the bigger is the better". So, there is not any exact body size to be released from captivity.	Low
23	4.10	Is the taxon versatile in habitat use?	No	The taxon has fast behavioral response to rainfall but geothermal wetlands are marginal habitats for living. But the taxon euryobiont features are poorly investigated. (1- Sergius Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290.en)	Medium
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	No	There is no evidence for this situation.	Medium
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	No	There is no literature on maintaning a viable population with low densities. But it was stated that the taxon inroduced to United Kingdom but there is no actual record now. (1- Sergius Kuzmin et al. 2009. Bombina variegata. The IUCN Red List of Threatened Species 2009: e.T54451A11148290. http://dx.doi.org/10.2305/IUCN.UK.2009.RLTS.T54451A11148290.en)	Medium
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	No	There is no foreseen evidence for consuming a threatened native taxa in the RA area. The diet of the taxon is mostly arthropods, and limitedly (app. 20%) egg laying fragments could be found in the trophic spectrum. But egg laying fragments are thought to be swallowed by chance while eating a prey. (1- Ghiurcă, D. and Zaharia, L., 2005. Data regarding the trophic spectrum of some population of Bombina variegata from Bacău county. North-western journal of zoology, 1, pp.15-24.)	Medium
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	No	No evidence for this.	Medium
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	No	No evidence for this.	High

29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	No	The taxon is not available in the RA area	High
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	Yes	There are numerous article on hybridisation of the taxon with Bombina bombina. (1- Vörös, J., Alcobendas, M., Martínez-Solano, I. and García-París, M., 2006. Evolution of Bombina bombina and Bombina variegata (Anura: Discoglossidae) in the Carpathian Basin: a history of repeated mt-DNA introgression across species. Molecular Phylogenetics and Evolution, 38(3), pp.705-718., 2- Gollmann, G., Roth, P. and Hödl, W., 1988. Hybridization between the fire-bellied toads Bombina bombina and Bombina variegata in the karst regions of Slovakia and Hungary: morphological and allozyme evidence. Journal of Evolutionary Biology, 1(1), pp.3-14., 3- Talarico, L., Ciambotta, M., Tiberi, A. and Mattoccia, M., 2020. Introgressive hybridization between the endangered native Bombina pachypus and the introduced B. variegata in a protected area in central Italy. Amphibia-Reptilia, 42(1), pp.107-114.)	Very high
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	No documented evidence or personal observation.	High
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	No evidence on this issue.	High
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	No	The taxon grew rapidly in early life; thereafter their growth was very limited. Body size was not an accurate age indicator of an individual of this species. The taxon were long-lived in nature, some individuals surviving for much more than ten years, and perhaps even more than 20 years. It was reported that most offsprings reached sexual maturity after two or three winters. Single individuals grew into adult size during the summer following the first winter, but it is unlikely that they took part in reproductive activity in that year. The taxon isn't produce offspring shorter than 1 year. (1- Plytycz, B. and Bigaj, J., 1993. Studies on the growth and longevity of the yellow-bellied toad, Bombina variegata, in natural environments. Amphibia-Reptilia, 14(1), pp.35-44., 2- Anholt, B., Barandun, J. and Reyer, H.U., 1997. Reproductive ecology of Bombina variegata: aspects of life	Medium
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	2	years (It was reported that most offsprings reached sexual maturity after two or three winters. Single individuals grew into adult size during the summer following the first winter, but it is unlikely that they took part in reproductive activity in that year.)	High
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable	>1	The potential vector seems to be utilization of the taxon as pet or live baits.	Medium
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	There are lots of protected areas over Anatolia (Turkey) and the taxon prefer a large variety of ponds such as farmed areas, urban areas, natural and artificial ones even they are permanent or temporary. (1- Hartel, T. and von Wehrden, H., 2013. Farmed areas predict the distribution of amphibian ponds in a traditional rural landscape. PLoS One, 8(5), p.e63649., 2- Hartel, T., 2008. Movement activity in a Bombina variegata population from a deciduous forested landscape. North-Western Journal of Zoology, 4(1)., 3- Oboňa, J. and Hromada, B.B.M., Overlooked importance of watering trough for Yellow-bellied toad in extensively used agricultural areas., 4- Küçük, M. and Ertürk, E., 2013. Biodiversity and protected areas in Turkey. Sains Malaysiana, 42(10), pp.1455-	High
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	No	No evidence for this issue	High
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	No evidence on natural dispersal of the taxon by eggs in the RA area	Medium
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	No evidence on natural dispersal of the taxon by larvae or juvenile in the RA area	Medium
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	No	No evidence on migration of the taxon's older life stages in the RA area for reproduction.	Medium
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	No evidence on dispersal of the taxon's eggs by other animals in the RA area.	Medium
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	No	It is likely that the taxon can disperse in the RA among waterbodies with large variety of ponds, but not rapidly.	Medium
43	7.09	Is dispersal of the taxon density dependent?	No	No evidence for this question.	Medium
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	Yes	The taxon prefer a large variety of ponds such as farmed areas, urban areas, natural and artificial ones even they are permanent or temporary. (1- Hartel, T. and von Wehrden, H., 2013. Farmed areas predict the distribution of amphibian ponds in a traditional rural landscape. PLoS One, 8(5), p.e63649., 2- Hartel, T., 2008. Movement activity in a Bombina variegata population from a deciduous forested landscape. North-Western Journal of Zoology, 4(1)., 3- Oboňa, J. and Hromada, B.B.M., Overlooked importance of watering trough for Yellow-bellied toad in extensively used	High

45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	No	Bombinin H2 that isolated from the taxon displayed bactericidal activity toward multidrug-resistant clinical isolates of belonging to species often involved in nosocomial infections. And also using pesticides can act as a restrictive factor for the taxon's dispersal. (1- Mangoni, M.L., Maisetta, G., Di Luca, M., Gaddi, L.M.H., Esin, S., Florio, W., Brancatisano, F.L., Barra, D., Campa, M. and Batoni, G., 2008. Comparative analysis of the bactericidal activities of amphibian peptide analogues against multidrug-resistant nosocomial bacterial strains. Antimicrobial agents and chemotherapy, 52(1), p.85., 2- Arntzen, J.W., 1978. Some hypotheses on postglacial migrations of the fire-bellied toad, Bombina bombina (Linnaeus) and the yellow-bellied toad, Bombina variegata (Linnaeus). Journal of Biogeography, pp.339-	Medium
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	No evidence for control and eradication attempts in the wild	Medium
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	The taxon spread among agricultural, rural and urban areas with permenant or temporary ponds even they are natural or not. So The taxon benefit from human-genarated impacts. (1- Hartel, T. and von Wehrden, H., 2013. Farmed areas predict the distribution of amphibian ponds in a traditional rural landscape. PLoS One, 8(5), p.e63649., 2- Hartel, T., 2008. Movement activity in a Bombina variegata population from a deciduous forested landscape. North-Western Journal of Zoology, 4(1)., 3- Oboňa, J. and Hromada, B.B.M., Overlooked importance of watering trough for Yellow-bellied toad in extensively used agricultural areas.)	High
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual environment?	No	The amphibians are not tolerated the salinity. The lethal concentration of saltwater required to impose 50% mortality (LC50) for adults is 9.0 ppt (0–19.9 ppt BCI). But this issue is not tested specifically for the taxon. (1- Albecker, M.A. and McCoy, M.W., 2017. Adaptive responses to salinity stress across multiple life stages in anuran amphibians. Frontiers in zoology, 14(1), pp.1-	Medium
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	Yes	There are a few aquatic snakes, predator fishes and terrestrial snakes are the natural enemies of the taxon in the RA area. (1- Karataş, A., Filiz, H., Erciyas-Yavuz, K., Özeren, S.C. and Tok, C.V., 2021. The Vertebrate Biodiversity of Turkey. Biodiversity, Conservation and Sustainability in Asia: Volume 1: Prospects and Challenges in West Asia and Caucasus, p.175)	Medium
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	Increase	According to the Köppen Geiger climate maps, the areas with suitable climatic condition will increase in the RA area. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-	Medium
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Increase	According to the Köppen Geiger climate maps, the areas with suitable climatic condition will increase in the RA area. That will promote the ability of the self-sustaining populations. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-	Medium
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	According to the Köppen Geiger climate maps, the areas with suitable climatic condition will increase in the RA area. So the risk of its dispersal will be increase. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-2948/2010/0430)	Medium
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Lower	According to the Köppen Geiger climate maps, the areas with suitable climatic condition will increase in the RA area especially on Aegean and Mediteranean regions and also most of the Blacksea region. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-2948/2010/0430)	Medium
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Lower	According to the Köppen Geiger climate maps, the areas with suitable climatic condition will increase in the RA area especially on Aegean and Mediteranean regions and also most of the Blacksea region. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-2948/2010/0430)	Medium
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	No change	According to the Köppen Geiger climate maps, there is no clear evidence for the taxon's impacts on ecosystem services. (1- Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901-2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135-141. DOI: 10.1127/0941-2948/2010/0430)	Medium

Statistics	
Scores	
BRA	**8.0**
BRA Outcome	**-**
BRA+CCA	**10.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**5.0**
1. Domestication/Cultivation	*2.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*2.0*
B. Biology/Ecology	**3.0**
4. Undesirable (or persistence) traits	*3.0*

5. Resource exploitation	*0.0*
6. Reproduction	*1.0*
7. Dispersal mechanisms	*-3.0*
8. Tolerance attributes	*2.0*
C. Climate change	**2.0**
9. Climate change	*2.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**7**
Environmental	**-3**
Species or population nuisance traits	**9**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.58**
BRA	**0.59**
CCA	**0.50**

Date and Time	
	01/06/2021 12:13:51

TAS-ISK v2

Taxon and Assessor details	
Category	Annelida
Taxon name	*Lumbricus rubellus*
Common name	red earthworm
Assessor	Nurçin Killi
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Aegean region of Turkey
Taxonomy	
Native range	
Introduced range	
URL	

			Response	**Justification (references and/or other information)**	**Confidence**
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	Yes	Elvira et al. 1997; Furlong et al. 2002	Medium
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Yes	This species is used as vermicomposting for removal of sewage sludge in aquaculture, agriculture, mushroom culture and also used in ecotoxicology and bioacumulation researches (Bakar et al. 2011; Azizi et al. 2013; Baylay et al. 2012; Baker et al. 2006; Brown et al. 2004; Hobbelen et al. 2006; Edwards and Arancon 2004). Also, it is used as fish bait (Addison 2009; Keller et al.	Very high
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	L. rubellus is one of the most widespread earthworm invaders in the world and has invaded parts of Canada, United States, South America, Russian Federation and several sub-Antarctic islands (Global Invasive Species Database). It is a peregrine species (Mısırlıoğlu et al. 2017; Omodeo and Rota 1989, 1991; Szederjesi and Mısırlıoğlu 2017; Valchovski and Mısırlıoğlu, 2017; Mısırlıoğlu and Valchovski 2019).	Very high
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	According to Koppen-geiger climate classification system	High
5	2.02	What is the quality of the climate matching data?	High	Koppen-Geiger	High
6	2.03	Is the taxon already present outside of captivity in the RA area?	Yes	Omodeo and Rota 1991; Mısırlıoğlu 2008	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	Balast waters and shipping and also the major factor to transport of these species is other vehicles (Hendrix and Bohlen 2002; Cameron et al. 2008).	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Yes	Mısırlıoğlu 2008; Omodeo and Rota 1989, 1991; Szederjesi and Mısırıoğlu 2017; Mısırlıoğlu and Szederjesi 2015; Mısırlıoğlu and Valchovski 2019	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	Mısırlıoğlu 2008; Omodeo and Rota 1989, 1991; Szederjesi and Mısırıoğlu 2017; Mısırlıoğlu and Szederjesi 2015; Mısırlıoğlu and Valchovski 2019	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	This species can change soil properties, pH, water flows, biodiversity and plant diversity (GLOBAL INVASIVE SPECIES DATABASE, Baker et al. 2006).	Medium
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	This species can change soil properties, pH, water flows, biodiversity and plant diversity (GLOBAL INVASIVE SPECIES DATABASE, Baker et al. 2006). Also, it can destroy organic layer of the soil because it feeds on surface of the soil (Addison, 2009).	Medium
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	Yes	This species can change the soil properties due to the impacts on ecosystem operations and biodiversity (Frelich et al. 2006; Eisenhauer et al. 2007; Addison, 2009). Also, it can destroy organic layer of the soil because it feeds on surface of the soil (Addison, 2009).	High
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	This species can change soil properties, pH, water flows, biodiversity and plant diversity (GLOBAL INVASIVE SPECIES DATABASE, Baker et al. 2006). Also, it can destroy organic layer of the soil because it feeds on surface of the soil (Addison, 2009). So, this species can effect agricultural activities.	High
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	No	No information.	Medium
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	No	No information.	Low
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	No information.	Medium
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	This species tolerates colder area and low pH (3,0-7,7) values (Tiunov et al. 2006; Wironen and Moore 2006). It was found in caves in Alabama, Georgia, South Carolina and Tennessee (Reeves at al. 1999).	Very high
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	Yes	This species can change soil properties, pH, water flows, biodiversity and plant diversity (GLOBAL INVASIVE SPECIES DATABASE, Baker et al. 2006). Also, it can destroy organic layer of the soil because it feeds on surface of the soil (Addison, 2009).	Medium

19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	Yes	L. rubellus feeds leaf litters, plant roots and detritus (organic layer of the soil). And it changes soil properties and plant diversity and also threats plant species (GLOBAL INVASIVE SPECIES DATABASE; Hale et al. 2008).	Medium
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA	Yes	L.rubellus is symbiont with Verminephrobacter (Lund et al 2010).	Medium
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	No information.	Low
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	No information.	Low
23	4.10	Is the taxon versatile in habitat use?	Yes	Epi-endogeic (addison 2009).	Medium
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	Yes	L. rubellus feeds leaf litters, plant roots and detritus (organic layer of the soil). And it changes soil properties and plant diversity and also threats plant species (GLOBAL INVASIVE SPECIES DATABASE; Hale et al. 2008).	Medium
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	No	the cocoons can live for four years even the earthworm dead (Hendrix and Bohlen 2002).	Low
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Yes	This species can threaten such rare plant species (GLOBAL INVASIVE SPECIES DATABASE).	Low
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Not applicable	No evidence.	Low
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	Yes	the cocoons can live for four years even the earthworm dead (Hendrix and Bohlen 2002).	Low
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	the cocoons can live for four years even the earthworm dead (Hendrix and Bohlen 2002).	Medium
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	Yes	According to Giska et al. 2015 the isolation of breeding mechanisms between species is not strict.	High
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	Yes	Lumbricus rubellus reproduces sexually via simultaneous hermaphroditism and has a slow growth rate and long life cycles ranging from 120 to 170 days (Edwards et al., 2011). On average, it takes 91 ± 22 (mean ± SD) days to reach sexual maturity (Cluzeau and Fayolle, 1989).	Very high
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	no evidence.	Low
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	Lumbricus rubellus reproduces sexually via simultaneous hermaphroditism and has a slow growth rate and long life cycles ranging from 120 to 170 days (Edwards et al., 2011). On average, it takes 91 ± 22 (mean ± SD) days to reach sexual maturity (Cluzeau and Fayolle, 1989). 106 cocoons per individual can be produced in the laboratory (Dymock et al. 1997).	Very high
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	3	Lumbricus rubellus reproduces sexually via simultaneous hermaphroditism and has a slow growth rate and long life cycles ranging from 120 to 170 days (Edwards et al., 2011). On average, it takes 91 ± 22 (mean ± SD) days to reach sexual maturity (Cluzeau and Fayolle, 1989).	Medium
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable	>1	Balast waters, transport by vehivles and aquaculture (Hendrix and Bohlen 2002; Cameron et al. 2008).	High
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	Hendrix and Bohlen 2002; Cameron et al. 2008	High
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	No	No evidence	Low
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	Yes	Hendrix and Bohlen 2002; Cameron et al. 2008	High
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	Yes	Hendrix and Bohlen 2002; Cameron et al. 2008	High
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	Yes	Hendrix and Bohlen 2002; Cameron et al. 2008	High
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	No evidence.	Low
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	Yes	by ballast waters (Hendrix and Bohlen 2002; Cameron et al. 2008)	Medium
43	7.09	Is dispersal of the taxon density dependent?	No	No evidence	Low
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	Yes	Cocoons (Hendrix and Bohlen 2002; Cameron et al. 2008)	High
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	Yes	This species tolerates lower temperatures and pH values (Tiunov et al. 2006; Wironen and Moore 2006). In general, the optimal temperature for cultivating European earthworms (i.e. Lumbricidae) is 10–15 °C (Lee, 1985); the optimum temperature of growth and reproduction for L. rubellus is 18 °C (Edwards et al.,	Very high

46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	No evidence.	Low
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	No	According to Steinwandter et al. 2019 food quality of the habitat affects on growth and reproduction range of this species.	Medium
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual	Yes	L. rubellus tolerates low pH values (3,0-7,7) (Wironen and Moore 2006).	High
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA	Yes	Birds (Bengston et al. 1976), fare, yılan (Macdonlad 1983).	Very high
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	No change	expert opinion	Medium
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	No change	expert opinion	Medium
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	No change	expert opinion	Medium
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Higher	expert opinion (because of high tolerances of this species, and high reproduction potential).	Medium
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Higher	expert opinion (because of high tolerances of this species, and high reproduction potential).	Medium
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	Higher	using this species as vermicompost.	High

Statistics	
Scores	
BRA	**48.0**
BRA Outcome	**-**
BRA+CCA	**54.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**24.0**
1. Domestication/Cultivation	*4.0*
2. Climate, distribution and introduction risk	*2.0*
3. Invasive elsewhere	*18.0*
B. Biology/Ecology	**24.0**
4. Undesirable (or persistence) traits	*6.0*
5. Resource exploitation	*5.0*
6. Reproduction	*6.0*
7. Dispersal mechanisms	*4.0*
8. Tolerance attributes	*3.0*
C. Climate change	**6.0**
9. Climate change	*6.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**21**
Environmental	**17**
Species or population nuisance traits	**21**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.60**
BRA	**0.61**
CCA	**0.54**

Date and Time
20/04/2021 22:19:32

TAS-ISK v2

Taxon and Assessor details	
Category	Insecta
Taxon name	*Diabrotica virgifera virgifera*
Common name	western corn rootworm
Assessor	Darija Lemić
Risk screening context	
Reason and socio-economic benefits	Destructive pest of maize.
Risk assessment area	Croatia
Taxonomy	Domain: Eukaryota Kingdom: Metazoa Phylum: Arthropoda Subphylum: Uniramia Class: Insecta
Native range	Mexico, USA
Introduced range	Central-eastern Europe
URL	https://www.cabi.org/isc/datasheet/18637

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	Yes	https://www.cabi.org/isc/datasheet/18637 Insect is present in Croatia from 1995, and has one generation per year. So it developed 26 generations in Croatia.	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	Not applicable	It is invasive species present in corn growing area.	High
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	https://www.mdpi.com/2075-4450/9/4/160	Very high
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	https://www.mdpi.com/2075-4450/12/3/195	High
5	2.02	What is the quality of the climate matching data?	Medium	https://www.mdpi.com/2075-4450/12/3/195	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	Not applicable	Diabrotica is wild species present on open agricultural areas.	High
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	https://www.mdpi.com/2075-4450/12/3/195	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Yes	https://www.mdpi.com/2075-4450/12/3/195	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its	Yes	https://www.mdpi.com/2075-4450/12/3/195 Diabrotica has 1 generation per year, but it has established population in Europe.	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	1. Dematheis, F.; Kurtz, B.; Vidal, S.; Smalla, K. Microbial Communities Associated with the Larval Gut and Eggs of the Western Corn Rootworm. PLoS ONE 2012, 7, e44685. 2. Sever, Z.; Kos, T.; Miličević, T.; Bažok, R. Western Corn Rootworm (Diabrotica vigrifera vigrifera LeConte) as potential vector of phytopathogenic fungi on maize. In Proceedings of the 49th Croatian & 9th International Symposium on Agriculture, Dubrovnik, Croatia, 16–21 February 2014; pp. 416–419. 3. Krawczyk, K.; Foryś, J.; Nakonieczny, M.; Tarnawska, M.; Bereś, P.K. Transmission of Pantoea ananatis, the causal agent of leaf spot disease of maize (Zea mays), by western corn rootworm	High
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	Igrc Barčić, J.; Bažok, R.; Maceljski, M. Research on the western corn rootworm (Diabrotica virgifera virgifera LeConte, Coleoptera: Chrysomelidae) in Croatia (1994–2003). Entomol. Croat. 2003, 7, 63–83.	Very high
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	Yes	This insect was under eradication programmes which always means influence in ecosystems. Carrasco, L.R.; Harwood, T.D.; Toepfer, S.; MacLeod, A.; Levay, N.; Kiss, J.; Baker, R.H.A.; Mumford, J.D.; Knight, J.D. Dispersal kernels of the invasive alien western corn rootworm and the effectiveness of buffer zones in eradication programmes in Europe. Ann. Appl. Biol. 2010, 156,	Medium
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	Farmers education increase. Filipović, J.; Stanković, S.; Ceranić, S. Gross margin as an indicator of the significance of farmer education on the WCR risk assessment in repeated sowing. Econ. Agric. 2015, 62, 137–153. Kropf, B.; Schmid, E.; Schönhart, M.; Mitter, H. Exploring farmers' behavior toward individual and collective measures of western corn rootworm control—A case study in south-east Austria. J. Environ. Manag. 2020, 264, 110431.	Very high
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	No	It is herbivorus pest feeding only on plants.	Very high

15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	It can feed on more than one host with could jeopardize native plants growth. Floarea, A.; Grozea, I.; Popescu, G.; Jurca, D. Setting attack frequency produced by the larvae of Diabrotica virgifera virgifera LeConte in the Arad area. Res. J. Agric. Sci. 2008, 39, 494. Marton, C.L.; Szoke, C.; Pinter, J. Studies of the Tolerance of Maize Hybrids to Corn Rootworm in Hungary. 59; Tagung der Vereinigung der Pflanzenzüchter und Saatgutkaufleute Österreichs: Raumberg-Gumpenstein, Austria, 2008; pp. 77–80. Kadličko, S.R.; Tollefson, J.J.; Prasifka, J.R.; Bača, F.; Stanković, G.; Delić, N. Evaluation of Serbian commercial maize hybrid tolerance to feeding by larval western corn rootworm (Diabrotica virgifera virgifera LeConte) using the novel 'difference approach'. Maydica 2010, 55, 179–185. Gloyna, K.; Thieme, T.; Zellner, M. Miscanthus, a host for larvae of a European population of Diabrotica v. virgifera. J. Appl. Entomol. 2011, 135, 780–785. Toepfer, S.; Zellner, M.; Kuhlamann, U. Food and oviposition preferences of Diabrotica v. virgifera in multiple-choice crop habitat situations. Entomologia 2013, 1, 60–68. Fora, C.G.; Lauer, K.F. Host plants for the western corn rootworm Diabrotica virgifera virgifera (Coleoptera: Chrysomelidae). Rom. Agric. Res. 2014, 30, 291–295. Foltin, K.; Robier, J. Host plant specificity studies of the western corn rootworm—experiments in isolation cages. Jul. Kühn Arch. 2014, 444, 144–146. Grabenweger, G.; Zellner, M. Winter wheat and volunteer cereals as host plants for the western corn rootworm in Europe. Jul. Kühn Arch. 2014, 444, 133. Gloyna, K.; Thieme, T.; Zellner, M. Sorghum, Miscanthus & Co: Energy crops as potential host plants of western corn rootworm larvae. Jul. Kühn Arch. 2014, 444, 134–143. Grozea, I.; Stef, R.; Virteiu, A.M.; Molnar, L.; Carabet, A.; Puia, C.; Dobrin, I. Feeding Behaviour of Diabrotica virgifera virgifera Adults on Corn Crops. Bull. UASVM Hortic. 2015, 72, 463–464. Guzik, J.; Nakonieczny, M.; Tarnawska, M.; Bereš, P.K.; Drzewiecki, J.; Migula, P. The Glycolytic Enzymes Activity in the Midgut of Diabrotica virgifera virgifera (Coleoptera: Chrysomelidae) adult and their Seasonal Changes. J. Insect Sci. 2015, 15, 56. Toepfer, S.; Zellner, M.; Szalai, M.; Kuhlmann, U. Field survival analyses of adult Diabrotica virgifera virgifera (Coleoptera: Chrysomelidae). J. Pest. Sci. 2015, 88, 25–35. Grozea, I.; Trusca, R.; Virteiu, A.M.; Stef,	Very high
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	Not applicable	Diabrotica is herbivore species.	High
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	rozea, I.; Stef, R.; Carabet, A.; Virteiu, A.M.; Dinnesen, S.; Chris, C.; Molnar, L. Te influence of weather and geographical conditions on flight dynamics of WCR adults. Comm. Appl. Biol. Sci. Ghent Univ. 2009, 75, 1–9. Grozea, I.; Carabet, A.; Stef, R.; Virteiu, A.M.; Chis, C.; Dinnesen, S. Analysis of correlations between WCR adults recorded at different altitudes and climate factors. Res. J. Agric. Sci. 2011, 43, 44–50. Ciobanu, C.; Ciobanu, G.; Domuta, C.; Sandor, M.; Domuta, C.; Albu, R.; Vuscan, A.; Popov, C. The influence of ecological factors from northwestern part of romania on Diabrotica virgifera virgifera LeConte (western corn rootworm) species. Nat. Resour. Sustain. Dev. 2011, 1, 89–96. Agargon, P.; Lobo, J.M. Predicted effect of climate change on the invasibility and distribution of the western corn root-worm. Agric. For. Entomol. 2012, 14, 13–18. Fora, C.G. On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm Diabrotica virgifera virgifera LeConte (Col.: Chrysomelidae). Jul. Kühn Arch. 2014, 444, 105–111. Kos, T.; Bažok, R.; Lemić, D.; Igrc Barčić, J. Forecasting of root damage, plant lodging and yield loss caused by western corn root worm larval feeding based on larval population density. Jul. Kühn Arch. 2014, 444, 40. Lindström, L.; Lehmann, P. Climate Change Effects on Agricultural Insect Pests in Europe. In Climate Change and Insect Pests: CABI Climate Change Series	Very high
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA	Yes	It can cause 80% yield losses. Maceljski, M.; Igrc Barčić, J. Significance of Diabrotica virgifera virgifera LeConte (Coleoptera: Chrysomelidae) for Croatia. Poljopr. Znan. Smotra 1994, 59,	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	Not applicable	This information is not available. If this answer can be related with damages on different hosts (even weeds) than the answer could be YES.	Medium
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	Yes	Diabrotica can transmit viruses. In the cases of new intorduction it could transmit some new virus in invaded area. Krawczyk, K.; Foryś, J.; Nakonieczny, M.; Tarnawska, M.; Bereś, P.K. Transmission of Pantoea ananatis, the causal agent of leaf spot disease of maize (Zea mays), by western corn rootworm (Diabrotica virgifera virgifera LeConte). Crop. Prot. 2020, 105431. ever, Z.; Kos, T.; Miličević, T.; Bažok, R. Western Corn Rootworm (Diabrotica vigrifera vigrifera LeConte) as potential vector of phytopathogenic fungi on maize. In Proceedings of the 49th Croatian & 9th International Symposium on Agriculture,	High

21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	Yes	Diabrotica can transmit viruses. In the cases of new intorduction it could transmit some new virus in invaded area. Krawczyk, K.; Foryś, J.; Nakonieczny, M.; Tarnawska, M.; Bereś, P.K. Transmission of Pantoea ananatis, the causal agent of leaf spot disease of maize (Zea mays), by western corn rootworm (Diabrotica virgifera virgifera LeConte). Crop. Prot. 2020, 105431. ever, Z.; Kos, T.; Miličević, T.; Bažok, R. Western Corn Diabrotica can transmit viruses. In the cases of new intorduction it could transmit some new virus in invaded area. Krawczyk, K.; Foryś, J.; Nakonieczny, M.; Tarnawska, M.; Bereś, P.K. Transmission of Pantoea ananatis, the causal agent of leaf spot disease of maize (Zea mays), by western corn rootworm (Diabrotica virgifera virgifera LeConte). Crop. Prot. 2020, 105431. ever, Z.; Kos, T.; Miličević, T.; Bažok, R. Western Corn Rootworm (Diabrotica vigrifera vigrifera LeConte) as potential vector of phytopathogenic fungi on maize. In Proceedings of the 49th Croatian & 9th International Symposium on Agriculture, Dubrovnik, Croatia	High
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	Yes	Mikac, K.M.; Lemic, D.; Bažok, R.; Benitez, H.A. Wing shape changes: A morphological view of the Diabrotica virgifera virgifera European invasion. Biol. Invasions 2016, 18, 3401–3407. Mikac, K.M.; Lemic, D.; Benitez, H.A.; Bažok, R. Changes in corn rootworm wing morphology are related to resistance development. J. Pest. Sci. 2019, 92, 443–451. Benitez, H.A.; Lemic, D.; Bažok, R.; Bravi, R.; Buketa, M.; Puschel, T. Morphological integration and modularity in Diabrotica virgifera virgifera LeConte (Coleoptera: Chrysomelidae) hind wings. Zool. Anz. 2014, 253,	Very high
23	4.10	Is the taxon versatile in habitat use?	Yes	Grozea, I.; Carabet, A.; Stef, R.; Virteiu, A.M.; Chis, C.; Dinnesen, S. Analysis of correlations between WCR adults recorded at different altitudes and climate factors. Res. J. Agric. Sci. 2011, 43, 44–50. Agargon, P.; Lobo, J.M. Predicted effect of climate change on the invasibility and distribution of the western corn root-worm. Agric. For. Entomol. 2012, 14, 13–18. Lindström, L.; Lehmann, P. Climate Change Effects on Agricultural Insect Pests in Europe. In Climate Change and Insect Pests; CABI Climate Change Series (7); CABI: Delémont, Switzerland, 2015.	Low
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	Yes	Diabrotica can feed on more than one hosts and this means that can cause high damages in this host plants. Moeser, J.; Vidal, S. Do Alternative Host Plants Enhance the Invasion of the Maize Pest Diabrotica virgifera virgifera (Coleoptera: Chrysomelidae, Galerucinae) in Europe? Env. Entomol. 2004, 33, 1169–1177. Gloyna, K.; Thieme, T.; Zellner, M. Miscanthus, a host for larvae of a European population of Diabrotica v. virgifera. J. Appl. Entomol. 2011, 135, 780–785. Grabenweger, G.; Zellner, M. Winter wheat and volunteer cereals as host plants for the western corn rootworm in Europe. Jul. Kühn Arch. 2014, 444, 133.	Medium
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	Yes	Acker, M.; Zintel, A.; Benker, U. Western corn rootworm: Experiments on the improvement of monitoring at low population densities. Jul. Kühn Arch. 2014, 444, 33–38.	Very high
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Not applicable	Not applicable for this species	High
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	No	Diabrotica will not exploit corn in Croatia or in Europe but could cause more than 80% damanges and in yield.	Medium
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	No	Not applicable for insect pest.	Low
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	No	This is not applicable question for insect pest.	High
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	No	There is no interspecific mating in this insect pest.	Medium
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	No evidence for this.	Very high
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	Yes	Highly related to specific host plants. Fora, C.G.; Lauer, K.F. Host plants for the western corn rootworm Diabrotica virgifera virgifera (Coleoptera: Chrysomelidae). Rom. Agric. Res. 2014, 30, 291–295.	Very high
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4693180/	High
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	>10	https://www.cabi.org/isc/datasheet/18637#tobiologyAndEcology	Very high
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable habitats nearby)?	>1	Miller N, Estoup A, Toepfer S, Bourguet D, Lapchin L, Derridj S, Kim KS, Reynaud P, Furlan L, Guillemaud T, 2005. Multiple transatlantic introductions of the western corn rootworm. Science (Washington), 310:992	Very high
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	This insects is highly related with agricultural production.	Very high

37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	No	All introduction were accidental. Szalai, M.; Komáromi, J.P.; Bažok, R.; Igrc-Barčić, J.; Kiss, J.; Toepfer, S. The growth rate of Diabrotica virgifera virgifera populations in Europe. J. Pest. Sci. 2010, 84, 133–142. Miller, N.; Estoup, A.; Toepfer, S.; Bourguet, D.; Lapchin, L.; Derridj, S. Multiple transatlantic introductions of the western corn rootworm. Science 2005, 310, 992. Ciosi, M.; Miller, N.J.; Kim, K.S.; Giordano, R.; Estoup, A.; Guillemaud, T. Invasion of Europe by the western corn rootworm, Diabrotica virgifera virgifera: Multiple transatlantic introductions with various reductions of genetic diversity. Mol. Ecol. 2008, 17, 3614–3627.	Very high
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	Diabrotica is in egg stage during winter and eggs overwinter in soil, so there is no possibility for disperasal by eggs.	High
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	Larve lives on corn roots, and there is no possibility to disperse.	Very high
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	Yes	Cagáň, L.; Rosca, I. Seasonal dispersal of the western corn rootworm (Diabrotica virgifera virgifera) adults in Bt and non-Bt maize fields. Plant. Protect. Sci. 2012, 48, S36–S42. Carrasco, L.R.; Harwood, T.D.; Toepfer, S.; MacLeod, A.; Levay, N.; Kiss, J.; Baker, R.H.A.; Mumford, J.D.; Knight, J.D. Dispersal kernels of the invasive alien western corn rootworm and the effectiveness of buffer zones in eradication programmes in Europe. Ann. Appl. Biol. 2010, 156, 63–77. Ciosi, M.; Miller, N.J.; Toepfer, S.; Estoup, A.; Guillemaud, T. Stratified dispersal and increasing genetic variation during the invasion of Central Europe by the western corn rootworm, Diabrotica virgifera virgifera. Evol. Appl. 2011, 4, 54–70. Bermond, G.; Blin, A.; Vercken, E.; Ravignem, V.; Rieux, A.; Mallez, S.; Morel-Journel, T.; Guillemaud, T. Estimation of the dispersal of a major pest of maize by cline analysis of a temporary contact zone between two invasive outbreaks. Mol. Ecol. 2013, 22	Very high
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	not possible. eggs are in the soil during winter	Very high
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be rapid?	Yes	Bermond, G.; Blin, A.; Vercken, E.; Ravignem, V.; Rieux, A.; Mallez, S.; Morel-Journel, T.; Guillemaud, T. Estimation of the dispersal of a major pest of maize by cline analysis of a temporary contact zone between two invasive outbreaks. Mol. Ecol. 2013, 22, 5368–5381. Mrganić, M.; Bažok, R.; Mikac, K.M.; Benitez, H.A.; Lemic, D. Two Decades of Invasive Western Corn Rootworm Population Monitoring in Croatia. Insects 2018, 9, 160.	Very high
43	7.09	Is dispersal of the taxon density dependent?	No	Dispersal is caused by mating and oviposition not density. Knapič, M.; Urek, G.; Modic, Š. GIS Analysis of the Spread and Population Density of Diabrotica virgifera virgifera LeConte and its Impact on Agricultural Practice in Slovenia during the Period from 2003 to 2007. Cereal Res. Commun. 2009, 37, 227–236.	Very high
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	No	Species can not survive water.	Very high
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	Yes	Fora, C.G. On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm Diabrotica virgifera virgifera LeConte (Col.: Chrysomelidae). Jul. Kühn Arch. 2014, 444, 105–111. Rancov, I.; Carciu, G. Impact of soil works on the dynamics of the population of Diabrotica virgifera virgifera Le Conte. J. Hortic. For. 2011, 15, 55–59. Rancov, I.P.; Cârciu, G.; Lăzureanu, A.; Cristea, T.; Alda, S.; Molnar, L. Influence of Soil Works on the Damage by the Western Corn Rootworm (Diabrotica virgifera virgifera LeConte) in Grain Maize in the Banat's Plain. ProEnvironment 2015, 8,	High
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	Yes	Carrasco, L.R.; Harwood, T.D.; Toepfer, S.; MacLeod, A.; Levay, N.; Kiss, J.; Baker, R.H.A.; Mumford, J.D.; Knight, J.D. Dispersal kernels of the invasive alien western corn rootworm and the effectiveness of buffer zones in eradication programmes in Europe. Ann. Appl. Biol. 2010, 156, 63–77. Furlan, L.; Di Bernardo, A.; Girolami, V.; Vettorazzo, M.; Piccolo, A.M.; Santamaria, G.; Donantoni, L.; Funes, V. Diabrotica virgifera virgifera eradication containment programme in Veneto: Year 2001: Distribution, population level and what has to be done. In Proceedings of the XXI IWGO Conference, Padova, Italy, 27 October–3 November 2001; pp. 47–51. De Luigi, V.; Furlan, L.; Palmieri, S.; Vettorazzo, M.; Zanini, G.; Edwards, C.R.; Burgio, G. Results of WCR monitoring plans and evaluation of an eradication programme using GIS and Indicator Kriging. J. Appl. Entomol.	High
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	Bažok, R.; Igrc-Barčić, J. Pheromone Applications in Maize Pest. Control., 1st ed.; Novascience Publishers: Haupauge, NY, USA, 2010; pp. 23–35. Cagáň, L.; Rosca, I. Seasonal dispersal of the western corn rootworm (Diabrotica virgifera virgifera) adults in Bt and non-Bt maize fields. Plant. Protect. Sci. 2012, 48, S36–S42. Fora, C.G. On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm Diabrotica virgifera virgifera LeConte (Col.: Chrysomelidae). Jul. Kühn Arch. 2014, 444, 105–111.	High
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual	Yes	https://www.proquest.com/docview/302407482?pq-origsite=gscholar&fromopenview=true	High
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	Yes	Toepfer, S.; Haye, T.; Erlandson, M.; Goettel, M.; Lundgren, J.G.; Kleespies, R.G.; Weber, D.C.; Cabrera Walsh, G.; Peters, A.; Ehlers, R.-U.; et al. A review of the natural enemies of beetles in the subtribe Diabroticina (Coleoptera: Chrysomelidae): Implications for sustainable pest management. Biocontrol Sci.	Very high
C. Climate change					
9. Climate change					

50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	Increase	Grozea, I.; Stef, R.; Carabet, A.; Virteiu, A.M.; Dinnesen, S.; Chris, C.; Molnar, L. Te influence of weather and geographical conditions on flight dynamics of WCR adults. Comm. Appl. Biol. Sci. Ghent Univ. 2009, 75, 1–9. Grozea, I.; Carabet, A.; Stef, R.; Virteiu, A.M.; Chis, C.; Dinnesen, S. Analysis of correlations between WCR adults recorded at different altitudes and climate factors. Res. J. Agric. Sci. 2011, 43, 44–50. Ciobanu, C.; Ciobanu, G.; Domuta, C.; Sandor, M.; Domuta, C.; Albu, R.; Vuscan, A.; Popov, C. The influence of ecological factors from northwestern part of romania on Diabrotica virgifera virgifera LeConte (western corn rootworm) species. Nat. Resour. Sustain. Dev. 2011, 1, 89–96. Agargon, P.; Lobo, J.M. Predicted effect of climate change on the invasibility and distribution of the western corn root-worm. Agric. For. Entomol. 2012, 14, 13–18. Fora, C.G. On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm Diabrotica virgifera virgifera LeConte (Col.: Chrysomelidae). Jul. Kühn Arch. 2014, 444, 105–111. Kos, T.; Bažok, R.; Lemić, D.; Igrc Barčić, J. Forecasting of root damage, plant lodging and yield loss caused by western corn root worm larval feeding based on larval population density. Jul. Kühn Arch. 2014, 444, 40. Lindström, L.; Lehmann, P. Climate Change Effects on Agricultural Insect Pests in Europe. In Climate Change and Insect Pests; CABI Climate Change Series	Very high
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Increase	Grozea, I.; Stef, R.; Carabet, A.; Virteiu, A.M.; Dinnesen, S.; Chris, C.; Molnar, L. Te influence of weather and geographical conditions on flight dynamics of WCR adults. Comm. Appl. Biol. Sci. Ghent Univ. 2009, 75, 1–9. Grozea, I.; Carabet, A.; Stef, R.; Virteiu, A.M.; Chis, C.; Dinnesen, S. Analysis of correlations between WCR adults recorded at different altitudes and climate factors. Res. J. Agric. Sci. 2011, 43, 44–50. Ciobanu, C.; Ciobanu, G.; Domuta, C.; Sandor, M.; Domuta, C.; Albu, R.; Vuscan, A.; Popov, C. The influence of ecological factors from northwestern part of romania on Diabrotica virgifera virgifera LeConte (western corn rootworm) species. Nat. Resour. Sustain. Dev. 2011, 1, 89–96. Agargon, P.; Lobo, J.M. Predicted effect of climate change on the invasibility and distribution of the western corn root-worm. Agric. For. Entomol. 2012, 14, 13–18. Fora, C.G. On the influence of different soil cultivation practices in autumn and spring on the population development of the western corn rootworm Diabrotica virgifera virgifera LeConte (Col.: Chrysomelidae). Jul. Kühn Arch. 2014, 444, 105–111. Kos, T.; Bažok, R.; Lemić, D.; Igrc Barčić, J. Forecasting of root damage, plant lodging and yield loss caused by western corn root worm larval feeding based on larval population density. Jul. Kühn Arch. 2014, 444, 40. Lindström, L.; Lehmann, P. Climate Change Effects on Agricultural Insect Pests in Europe. In Climate Change and Insect Pests; CABI Climate Change Series	Very high
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	Agargon, P.; Lobo, J.M. Predicted effect of climate change on the invasibility and distribution of the western corn root-worm. Agric. For. Entomol. 2012, 14, 13–18.	Very high
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Lower	Not applicable for this insects which is highly related to agricultural crops.	Low
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Lower	FAO. Evaluation of Integrated Pest Management for Western Corn Rootworm (WCR) in Central and Eastern Europe (GTFS/RER/017/ITA). Available online: http://www.fao.org/fileadmin/user_upload/oed/docs/GTFSRER017ITA_2008_ER.pdf	Low
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	Higher	Kehlenbeck, H. Assessment of economic impacts of the western corn rootworm (Diabrotica virgifera virgifera) in Germany. Jul. Kühn Arch. 2014, 444, 198–201. Benjamin, E.O.; Wesseler, J.H.H. A socioeconomic analysis of biocontrol in integrated pest management: A review of the effects of uncertainty, irreversibility and flexibility. NJAS-Wagen. J. Life Sc. 2016, 77, 53–60. Feusthuber, E.; Mitter, H.; Schönhart, M.; Schmid, E. Integrated modelling of efficient crop management strategies in response to economic damage potentials of the western corn rootworm in Austria. Agric. Syst. 2017, 157, 93–106. Dillen, K.; Mitchell, P.D.; Tollens, E. On the competitiveness of Diabrotica virgifera virgifera damage abatement strategies in Hungary: A bio-economic	High

Statistics	
Scores	
BRA	**30.0**
BRA Outcome	**-**
BRA+CCA	**34.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**21.0**
1. Domestication/Cultivation	*2.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*18.0*
B. Biology/Ecology	**9.0**
4. Undesirable (or persistence) traits	*9.0*
5. Resource exploitation	*0.0*
6. Reproduction	*-3.0*
7. Dispersal mechanisms	*0.0*
8. Tolerance attributes	*3.0*
C. Climate change	**4.0**
9. Climate change	*4.0*

Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**18**
Environmental	**3**
Species or population nuisance traits	**17**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.81**
BRA	**0.82**
CCA	**0.71**

Date and Time
22/05/2021 15:59:05

TAS-ISK v2

Taxon and Assessor details	
Category	Mollusca
Taxon name	*Arion vulgaris*
Common name	Spanish slug
Assessor	Ivan Špelić
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Croatia
Taxonomy	
Native range	
Introduced range	
URL	

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	No	Not cultivated nor used as a pet (CABI).	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	No	Not used in such way (CABI).	Very high
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	Araiza-Gómez V, Naranjo-García E, Zúñiga G (2021) Occurrence in Mexico of two European invasive slug species: Arion vulgaris Moquin-Tandon, 1855 and Arion intermedius (Norman, 1852). BioInvasions Records 10	Very high
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	Climatch	High
5	2.02	What is the quality of the climate matching data?	Medium	Low number of trget region points on Climatch	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	Yes	Zemanova, M.A., Knop, E., Heckel, G., 2016. Phylogeographic past and invasive presence ofArionpest slugs in Europe. Molecular Ecology 25, 5747–5764.. doi:10.1111/mec.13860	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	One	Horticultural and gardening trade (CABI, Zemanova, MA, Broennimann, O, Guisan, A, Knop, E, Heckel, G. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Divers Distrib. 2018; 24: 1627– 1640. https://doi.org/10.1111/ddi.12789).	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Not applicable	Already present.	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	Zemanova, MA, Broennimann, O, Guisan, A, Knop, E, Heckel, G. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Divers Distrib. 2018; 24: 1627– 1640. https://doi.org/10.1111/ddi.12789; CABI	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	Decline and disappearance of native slugs (CABI).	High
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	CABI	Very high
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem	No	No information available.	Low
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	Destruction of crops (CABI).	Very high
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	Yes	The use of toxic baits could have health impacts on children in gardens and on predators that may accumulate poisons. The volume of sales of garden slug killers in central Europe has been linked to the prevalence of this species (CABI).	Low
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	Displaces native slug species (CABI)	Very high
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	No parasitic behaviour.	Very high
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	Highly adaptable to different environments (CABI), present throughout Europe (Zając, K.S., Hatteland, B.A., Feldmeyer, B., Pfenninger, M., Filipiak, A., Noble, L.R., Lachowska-Cierlik, D., 2020. A comprehensive phylogeographic study of Arion vulgaris Moquin-Tandon, 1855 (Gastropoda: Pulmonata: Arionidae) in Europe. Organisms Diversity & Evolution 20, 37–50.. doi:10.1007/s13127-019-00417-z)	High
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA	No	No information, probably not.	Medium
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	No	No such information for this species.	Low
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	Yes	Gismervik, K., Aspholm, M., Rørvik, L. M., Bruheim, T., Andersen, A., & Skaar, I. (2015). Invading slugs (Arion vulgaris) can be vectors for Listeria monocytogenes. Journal of applied microbiology, 118(4), 809–816.	Very high

21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	Not recorded so far.	Low
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	Size up to 12 cm (CABI).	Very high
23	4.10	Is the taxon versatile in habitat use?	No	Only in vegetated areas (CABI).	Very high
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	No	No information, very unlikely since is not recorded for any slug species.	High
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	No	No record on such populations.	Low
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	No	Feeding on various fresh and decaying plants but also animal excrements and waste including carcasses from both invertebrates and vertebrates (Gismervik, K., Bruheim, T., Rørvik, L.M., Haukeland, S., Skaar, I., 2014. Invasive slug populations (Arion vulgaris) as potential vectors for Clostridium botulinum. Acta Veterinaria Scandinavica 56.. doi:10.1186/s13028-014-0065-z). No records on unusual predatory behaviour.	High
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Not applicable	No data	Very high
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	No	No such behaviour is documented.	Very high
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	Šerić Jelaska, L. (2014) MOGU LI TRČCI (Coleoptera: Carabidae) KONTROLIRATI INVAZIVNOG LUZITANSKOG PRPOLJA Arion lusitanicus (Gastropoda: Pulmonata: Arionidae)?. U: Jelaska, S. (ur.)1. Hrvatski simpozij o invazivnim vrstama. Zbornik sažetaka.	Very high
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	Yes	CABI	Very high
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	Yes	CABI, Zemanova, M.A., Knop, E., Heckel, G., 2016. Phylogeographic past and invasive presence ofArionpest slugs in Europe. Molecular Ecology 25, 5747–5764..	Very high
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	Higly adaptable, generalist, high reproductive potential (CABI).	Very high
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	Roth, S., Hatteland, B. A., & Solhoy, T. (2012). Some notes on reproductive biology and mating behaviour of Arion vulgaris Moquin-Tandon 1855 in Norway including a mating experiment with a hybrid of Arion rufus (Linnaeus 1758) x ater (Linnaeus 1758). Journal of Conchology, 41, 249–258.	Very high
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	1	In first year (Roth, S., Hatteland, B. A., & Solhoy, T. (2012). Some notes on reproductive biology and mating behaviour of Arion vulgaris Moquin-Tandon 1855 in Norway including a mating experiment with a hybrid of Arion rufus (Linnaeus 1758) x ater (Linnaeus 1758). Journal of Conchology, 41, 249–258.)	Very high
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable habitats nearby)?	One	Horticultural and agricultural trade (Zemanova, M.A., Knop, E., Heckel, G., 2016. Phylogeographic past and invasive presence ofArionpest slugs in Europe. Molecular Ecology 25, 5747–5764.. doi:10.1111/mec.13860).	High
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	Already present there (personal obesrvation).	Very high
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	Yes	Main (and only recorded) path of introduction is via agricultural and horticultural trade, within plant material and soil (CABI).	Very high
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	No such evidence, eggs in batches layed on or under soil (Balog, L. and S. Misner 2017. "Arion lusitanicus" (On-line), Animal Diversity Web. Accessed April 17, 2021 at https://animaldiversity.org/accounts/Arion_lusitanicus/).	Medium
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	Low natural despersion and mobility (Zemanova, M.A., Knop, E., Heckel, G., 2016. Phylogeographic past and invasive presence ofArionpest slugs in Europe. Molecular Ecology 25, 5747–5764.. doi:10.1111/mec.13860).	Very high
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	No	Low natural despersion and mobility (Zemanova, M.A., Knop, E., Heckel, G., 2016. Phylogeographic past and invasive presence ofArionpest slugs in Europe. Molecular Ecology 25, 5747–5764.. doi:10.1111/mec.13860).	Very high
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	Not documented, eggs in batches layed on or under soil (Balog, L. and S. Misner 2017. "Arion lusitanicus" (On-line), Animal Diversity Web. Accessed April 17, 2021 at https://animaldiversity.org/accounts/Arion_lusitanicus/).	Medium
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be	Yes	Unintentional human-mediated dispersion (CABI).	Very high
43	7.09	Is dispersal of the taxon density dependent?	No	Not documented.	Low
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	No	Not documented.	Low

45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being	No	There are effective chemicals against this species (CABI).	High
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	Yes	There are effective chemichal agents to control them (CABI).	Very high
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	Tolerates, or benefits from, cultivation, browsing pressure, mutilation, fire etc; pioneering in disturbed areas, benefits from human association (i.e. it is a human commensal) (stated on CABI but no direct published evidence).	High
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual	No	Not documented.	Low
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	Yes	Ducks, hedghehogs, carabids (CABI, Šerić Jelaska, L. (2014) MOGU LI TRČCI (Coleoptera: Carabidae) KONTROLIRATI INVAZIVNOG LUZITANSKOG PRPOLJA Arion lusitanicus (Gastropoda: Pulmonata: Arionidae)?. U: Jelaska, S. (ur.)1. Hrvatski simpozij o invazivnim vrstama. Zbornik sažetaka.)	High
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	Not applicable	Already present (Šerić Jelaska, L. (2014) MOGU LI TRČCI (Coleoptera: Carabidae) KONTROLIRATI INVAZIVNOG LUZITANSKOG PRPOLJA Arion lusitanicus (Gastropoda: Pulmonata: Arionidae)?. U: Jelaska, S. (ur.)1. Hrvatski simpozij o invazivnim vrstama. Zbornik sažetaka.)	Very high
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Decrease	Overall amount of areas with high suitability for Arion slugs will decrease in Europe, due to temperature increase (Zemanova, M.A., Broennimann, O., Guisan, A., Knop, E., Heckel, G., 2018. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Diversity and Distributions 24, 1627–1640.. doi:10.1111/ddi.12789).	High
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Decrease	Overall amount of areas with high suitability for Arion slugs will decrease in Europe, due to temperature increase (Zemanova, M.A., Broennimann, O., Guisan, A., Knop, E., Heckel, G., 2018. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Diversity and Distributions 24, 1627–1640.. doi:10.1111/ddi.12789).	High
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Lower	Overall amount of areas with high suitability for Arion slugs will decrease in Europe, due to temperature increase, reducing their numbers and possible impact on native biodiversity (Zemanova, M.A., Broennimann, O., Guisan, A., Knop, E., Heckel, G., 2018. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Diversity and Distributions 24, 1627–1640.. doi:10.1111/ddi.12789).	High
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Lower	Overall amount of areas with high suitability for Arion slugs will decrease in Europe, due to temperature increase, reducing their numbers and possible impact on native biodiversity (Zemanova, M.A., Broennimann, O., Guisan, A., Knop, E., Heckel, G., 2018. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Diversity and Distributions 24, 1627–1640.. doi:10.1111/ddi.12789).	High
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	Lower	Overall amount of areas with high suitability for Arion slugs will decrease in Europe, due to temperature increase, reducing their numbers and impact on crops (Zemanova, M.A., Broennimann, O., Guisan, A., Knop, E., Heckel, G., 2018. Slimy invasion: Climatic niche and current and future biogeography of Arion slug invaders. Diversity and Distributions 24, 1627–1640..	High

Statistics	
Scores	
BRA	**22.0**
BRA Outcome	**-**
BRA+CCA	**12.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**15.0**
1. Domestication/Cultivation	*0.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*14.0*
B. Biology/Ecology	**7.0**
4. Undesirable (or persistence) traits	*4.0*
5. Resource exploitation	*0.0*
6. Reproduction	*6.0*
7. Dispersal mechanisms	*-1.0*
8. Tolerance attributes	*-2.0*
C. Climate change	**-10.0**
9. Climate change	*-10.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**

9. Climate change	*6*
Sectors affected	
Commercial	**11**
Environmental	**-3**
Species or population nuisance traits	**7**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.79**
BRA	**0.79**
CCA	**0.79**

Date and Time
17/04/2021 13:32:58

TAS-ISK v2

Taxon and Assessor details	
Category	Nematoda
Taxon name	*Ditylenchus destructor*
Common name	potato tuber nematode
Assessor	Marina Piria
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Croatia
Taxonomy	
Native range	
Introduced range	
URL	

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	No	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	No	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	Yes	Ditylenchus dipsaci is known to attack over 450 different plant species, including many weeds CABI Datasheet https://www.cabi.org/isc/datasheet/19287	Very high
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	D. destructor is a pest of potatoes mainly in temperate regions: localised areas in North America and many parts of Europe, the mediterranean region and Asia https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
5	2.02	What is the quality of the climate matching data?	High	Not clear its origin. Once D. destructor is introduced into a field within the RA area with infested plants for planting, it will most certainly establish because of its association with the host plant and in general suitable environmental conditions throughout the RA area. Suitable conditions for establishment are supported by the fact that D. destructor has already been reported from the 21 EU MSs https://www.cabi.org/isc/datasheet/19286#toidentity; EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
6	2.03	Is the taxon already present outside of captivity in the RA area?	No	Present in 20 EU but absent from: Cyprus (CY), Denmark (DK), Spain (ES), Finland (FI), Croatia (HR), Italy (IT), Portugal (PT), Slovenia (SI) EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602; https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	Containers and packaging - wood, soil, sand and gravel https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	Yes	Hungary https://www.cabi.org/isc/datasheet/19286#toidentity; EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
3. Invasive elsewhere					
9	3.01	Has the taxon become naturalised (established viable populations) outside its	Yes	Found between 1970s and 2013s in Europe https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	Potato, sweet potato and bulbous iris are the main hosts of D. destructor; occasionally tulips, gladioli and dahlias become important hosts. Root crops sometimes affected include sugar beet, mangolds (Beta vulgaris) and carrots. Clovers (Trifolium spp.), cultivated mushrooms, onion and garlic are also good hosts. https://www.cabi.org/isc/datasheet/19286#toidentity	Very high

11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem	Yes	Yes posess impact on food quality https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	the pest could lower crop value (includes increasing crop production costs) , could trigger the loss of markets (includes quarantines), could negatively change normal cultural practices. EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
B. Biology/Ecology					
4. Undesirable (or persistence) traits					
14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	No	No. EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	High
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	could have a significant environmental impact such as lowering biodiversity, disrupting natural communities, or changing ecosystem processes and could impact threatened or endangered species by disrupting critical habitats https://www.cabi.org/isc/datasheet/19286#toidentity	Very high
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	Yes	In absence on main hosts possibly can affect other wild species including threatened species https://www.cabi.org/isc/datasheet/19286#tohostPlants	Very high
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	Yes	This species has a high reproductive potential as it completes its life cycle in 6-7 days at 28°C (De Waele et al., 1990). In South Africa, it was found that the optimum temperature for egg hatch was 28°C (De Waele and Wilken, 1990), but this was considered to be an adaptation of the species to different climatic conditions, and it is assumed that temperature requirements are much lower in Europe. Eggs hatch at 28°C, 2 days after egg laying, with an average interval of 4.4 days between egg laying and hatch, and development from egg to adult takes between 6 and 7 days. https://www.cabi.org/isc/datasheet/19286#tohostPlants	High
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA area?	Yes	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	High
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	Yes	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	High
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	No	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high

22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	Smmal size species up to 2 cm ; PM 7/87 (2) Ditylenchus destructor and Ditylenchus dipsaci. EPPO Bulletin, 47: 401– 419. https://doi.org/10.1111/epp.12433 ; EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high
23	4.10	Is the taxon versatile in habitat use?	Yes	The host range of the nematode is extensive, comprising more than 90 plant species, which include ornamental plants, crop plants and weeds. Found on sand dune isolated from Ammophila arenaria root https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology; Dobosz, R., Rybarczyk-Mydłowska, K., Winiszewska, G. (2020). Occurrence of Ditylenchus destructor Thorne, 1945 on a sand dune of the Baltic Sea. Journal of Plant Protection Research.	High
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	No	No documented evidence yet, https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Low
25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	Yes	Dobosz, R., Rybarczyk-Mydłowska, K., Winiszewska, G. (2020). Occurrence of Ditylenchus destructor Thorne, 1945 on a sand dune of the Baltic Sea. Journal of Plant Protection Research, 60(1), 31-40. https://doi.org/10.24425/jppr.2020.132206	High
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	Yes	The host range of the nematode is extensive, comprising more than 90 plant species, which include ornamental plants, crop plants and weeds. Found on sand dune isolated from Ammophila arenaria root https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology; Dobosz, R., Rybarczyk-Mydłowska, K., Winiszewska, G. (2020). Occurrence of Ditylenchus destructor Thorne, 1945 on a sand dune of the Baltic Sea. Journal of Plant Protection Research.	Low
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Yes	may even multiply by feeding on alternative weed hosts (for example Mentha arvensis, Sonchus arvensis) and on fungal mycelia	Medium
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	No	D. destructor is a migratory endoparasite of roots and underground modified plant parts https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Very high
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	Without a resistant resting stage, the species overwinters in soil as adults or larvae and may even multiply by feeding on alternative weed hosts (for example Mentha arvensis, Sonchus arvensis) and on fungal mycelia. It may also possibly overwinter as eggs. These hatch in the spring and larvae are immediately able to parasitize hosts. Thorne (1961) suggested that D. destructor overwintered in USA field soil as eggs and coiled adults. In Ireland, its survival in soil is helped by the presence of corn mint and unharvested potato tubers (Anon., 1972).	High
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	No	Peng H, Gao Bl, Kong La, Yu Q, Huang Wk, et al. (2013) Exploring the Host Parasitism of the Migratory Plant-Parasitic Nematode Ditylenchus destuctor by Expressed Sequence Tags Analysis. PLOS ONE 8(7): e69579. https://doi.org/10.1371/journal.pone.0069579	High
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	No	Sexual reproduction https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	Yes	Yes. the species overwinters in soil as adults or larvae and may even multiply by feeding on alternative weed hosts (for example Mentha arvensis, Sonchus arvensis) and on fungal mycelia. It may also possibly overwinter as eggs. These hatch in the spring and larvae are immediately able to parasitize hosts. https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Very high
33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	Life cycle 6 days https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Very high
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	6	development from egg to adult takes between 6 and 7 days. https://www.cabi.org/isc/datasheet/19286#tohostPlants	Very high
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable habitats nearby)?	>1	Containers and packaging - wood -Carrying potato, Soil, sand, gravel - adults, juveniles eggs; https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology; 1) potato plants for planting (seed potato tubers); 2) plants of other host species for planting (bulbs, tubers, corms, roots and rhizomes of host plants); 3) host plants and plant parts not intended for planting with soil attached originating from areas where the pest occurs; 4) soil or growing media attached to host or non-host plants for planting with roots from areas where the pest occurs; 5) soil adhering to machinery or packaging material from countries where the pest occurs; 6) soil and growing media from countries where the pests occur; 7) water-related pathways. EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Very high

36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	Flowers/Inflorescences/Cones/Calyx https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	Yes	Containers and packaging - wood https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Very high
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	No	Maybe is possible but literature do not describe such dispersal. The nematodes can move only short distances in the soil and have no natural means of long-range movement. The main means of dispersal is with infested potato tubers or other subterranean organs of host plants, for example bulbs and rhizomes (especially of iris). Transport in infested soil is another important means of spread. Irrigation water can also carry the nematodes. https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Medium
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	The nematodes can move only short distances in the soil and have no natural means of long-range movement. https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	No	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	The main means of dispersal is with infested potato tubers or other subterranean organs of host plants, for example bulbs and rhizomes (especially of iris). Transport in infested soil is another important means of spread. Irrigation water can also carry the nematodes.	Very high
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be rapid?	No	The main means of dispersal is with infested potato tubers or other subterranean organs of host plants, for example bulbs and rhizomes (especially of iris). Transport in infested soil is another important means of spread. Irrigation water can also carry the nematodes.	Low
43	7.09	Is dispersal of the taxon density dependent?	No	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	Yes	Irrigation water can also carry the nematodes. https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	No	agricultural measures will prevent further spread (e.g. weed control). EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	Medium
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	Yes	Yes EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp. doi:10.2903/j.efsa. 2016.4602	High
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	No	Irrigation water can also carry the nematodes. The nematode can persist over years by feeding on a wide range of host plants (including weeds and volunteer root crops) decaying plant material and soil-borne fungi. the presence of host plants is critical for the establishment of this nematode. a wide host range comprising more than 100 cultivated plants and weeds belonging to a wide variety of families EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp.	Low
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual environment?	Yes	life cycle of D. destructor is very wide ranging from 5 to 34°C with optimal temperatures between 20 and 27°C. Moisture conditions in the soil will also be suitable for nematode development wherever host crops, in particular potato, are grown. Moisture requirements of the crop will be satisfied by, e.g. irrigation if natural precipitation is not sufficient. EFSA PLH Panel (EFSA Panel on Plant Health), Jeger M, Bragard C, Caffier D, Candresse T, Chatzivassiliou E, Dehnen-Schmutz K, Gilioli G, Gr egoire J-C, Jaques Miret JA, MacLeod A, Navajas Navarro M, Niere B, Parnell S, Potting R, Rafoss T, Rossi V, Van Bruggen A, Van Der Werf W, West J, Winter S, Mosbach-Schulz O and Urek G, 2016. Scientific opinion on the risk to plant health of Ditylenchus destructor for the EU territory. EFSA Journal 2016;14(12):4602, 124 pp.	Medium
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	No	Maybe, in Germany, the bulb mite Rhizoglyphus echinopus was found to feed on D. destructor. Species is also pest and is found in Hungary, possible can soon enter to Croatia https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Low
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	No change	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Medium

51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	No change	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Medium
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	No change	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	Medium
54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	No change	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	No change	https://www.cabi.org/isc/datasheet/19286#tobiologyAndEcology	High

Statistics	
Scores	
BRA	**31.0**
BRA Outcome	**-**
BRA+CCA	**33.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**19.0**
1. Domestication/Cultivation	*0.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*18.0*
B. Biology/Ecology	**12.0**
4. Undesirable (or persistence) traits	*7.0*
5. Resource exploitation	*7.0*
6. Reproduction	*-2.0*
7. Dispersal mechanisms	*-1.0*
8. Tolerance attributes	*1.0*
C. Climate change	**2.0**
9. Climate change	*2.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**13**
Environmental	**12**
Species or population nuisance traits	**11**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.79**
BRA	**0.81**
CCA	**0.63**

Date and Time
10/04/2021 09:29:50

TAS-ISK v2

Taxon and Assessor details	
Category	Platyhelminthes
Taxon name	*Arthurdendyus triangulatus*
Common name	New Zealand flatworm
Assessor	Marina Piria
Risk screening context	
Reason and socio-economic benefits	
Risk assessment area	Croatia
Taxonomy	
Native range	
Introduced range	
URL	

			Response	Justification (references and/or other information)	Confidence
A. Biogeography/Historical					
1. Domestication/Cultivation					
1	1.01	Has the taxon been the subject of domestication (or cultivation) for at least 20 generations?	No	Archie K. Murchie • Alan W. Gordon (2013) The impact of the 'New Zealand flatworm', Arthurdendyus triangulatus, on earthworm populations in the field. Biological invasions, 15:569–586. https://link.springer.com/content/pdf/10.1007/s10530-012-0309-	Very high
2	1.02	Is the taxon harvested in the wild and likely to be sold or used in its live form?	No	the flatworm is found in Ireland, Great Britain and the Faroe Islands. Although capable of active movement the flatworm has been spread mainly by the trade in containerised plants. Its tendency to shelter under debris on the soil surface and its sticky body, have facilitated inadvertent carriage on plant containers, agricultural equipment and soil. Archie K. Murchie • Alan W. Gordon (2013) The impact of the 'New Zealand flatworm', Arthurdendyus triangulatus, on earthworm populations in the field. Biological invasions, 15:569–586. https://link.springer.com/content/pdf/10.1007/s10530-012-0309-	Very high
3	1.03	Does the taxon have invasive races, varieties, sub-taxa or congeners?	No	CABI Datasheet:https://www.cabi.org/isc/datasheet/109121#togapsInKnowledgeOrResearchNeeds A. triangulatus could be confused with other flatworm species but is considerably larger that the native Microplana flatworms in Ireland and GB. The 'Australian flatworm', Australoplana sanguinea is similar in body shape but is orange. Terrestrial leeches also have a cursory similarity but are segmented. The organism is a single taxonomic entity. There are no known varieties, breeds or hybrids. No other species within same genus are known to be serious pests.	High
2. Climate, distribution and introduction risk					
4	2.01	How similar are the climatic conditions of the Risk Assessment (RA) area and the taxon's native range?	High	Soil temperature and moisture are most likely to restrict the establishment of A. triangulatus, with soil temperatures greater than 20°C limiting A. triangulatus survival (Blackshaw & Stewart, 1992) and consistent low temperatures of -2°C causing 100% mortality after 3 days (Anon., 2000) Beck, H., Zimmermann, N., McVicar, T. et al. Present and future Köppen-Geiger climate classification maps at 1-km resolution. Sci Data 5, 180214 (2018). https://doi.org/10.1038/sdata.2018.214 ; EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093#	Medium
5	2.02	What is the quality of the climate matching data?	Medium	Beck, H., Zimmermann, N., McVicar, T. et al. Present and future Köppen-Geiger climate classification maps at 1-km resolution. Sci Data 5, 180214 (2018). https://doi.org/10.1038/sdata.2018.214	Medium
6	2.03	Is the taxon already present outside of captivity in the RA area?	No	Still is not in RA area. established in the UK, Ireland and the Faroe Islands Archie K. Murchie • Alan W. Gordon (2013) The impact of the 'New Zealand flatworm', Arthurdendyus triangulatus, on earthworm populations in the field. Biological invasions, 15:569–586. https://link.springer.com/content/pdf/10.1007/s10530-012-0309-	Very high
7	2.04	How many potential vectors could the taxon use to enter in the RA area?	>1	Vector Transmission (Biotic): A. triangulatus may occasionally be carried sticking to domestic animals (Moore et al., 1998). Accidental Introduction: A. triangulatus has predominantly been spread by movement of horticultural and garden plants (Cannon et al., 1999). Within infected regions, movement of garden plants, topsoil, manure and baled silage is the most probable means of transfer (Blackshaw and Stewart, 1992; Moore et al., 1998; Boag et al., 1999; Murchie et al., 2003). CABI datasheet https://www.cabi.org/isc/datasheetreport/109121	Very high
8	2.05	Is the taxon currently found in close proximity to, and likely to enter into, the RA area in the near future (e.g. unintentional and intentional introductions)?	No	Horticultural trade is the main route of passive dispersal and dissemination to domestic gardens. The global non-native range of Arthurdendyus triangulatus encompasses the UK, Ireland and the Faroe Islands. There is one report of a flatworm in a glasshouse in Iceland (Bloch, 1992) but there are no records of establishment. Organism very likely can enter Europe undetected. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Medium
3. Invasive elsewhere					

9	3.01	Has the taxon become naturalised (established viable populations) outside its native range?	Yes	The global non-native range of Arthurdendyus triangulatus encompasses the UK, Ireland and the Faroe Islands. There is one report of a flatworm in a glasshouse in Iceland. Introduced and naturalized from 1963. year Archie K. Murchie • Alan W. Gordon (2013) The impact of the 'New Zealand flatworm', Arthurdendyus triangulatus, on earthworm populations in the field. Biological invasions, 15:569–586. https://link.springer.com/content/pdf/10.1007/s10530-012-0309-7.pdf; CABI datasheet: https://www.cabi.org/isc/datasheet/109121#tosummaryOfInvasiveness	Very high
10	3.02	In the taxon's introduced range, are there known adverse impacts to wild stocks or commercial taxa?	Yes	A flatworm-induced reduction in earthworm populations could change soil structure and hydrology; A. triangulatus is an invasive earthworm predator that directly reduces earthworm biodiversity. Depletion of earthworms in relation to the presence of A. triangulatus was first noted by Blackshaw (1989), studying the effects of seaweed fertiliser on earthworms. The capability of A. triangulatus to reduce earthworm numbers was subsequently confirmed by field and laboratory studies (Blackshaw, 1990; Blackshaw, 1991; Blackshaw, 1995; Lillico et al., 1996; Blackshaw, 1997b; Blackshaw, 1997a). CABI datasheet https://www.cabi.org/isc/datasheet/109121#toimpactSummary; Archie K. Murchie • Alan W. Gordon (2013) The impact of the 'New Zealand flatworm', Arthurdendyus triangulatus, on	Very high
11	3.03	In the taxon's introduced range, are there known adverse impacts to agriculture and forestry?	Yes	Depletion of lumbricid populations can lead to negative impacts on wildlife, soil structure and fertility, plant production and horticultural/ agricultural trade; . EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093#	High
12	3.04	In the taxon's introduced range, are there known adverse impacts to ecosystem services?	Yes	Provisioning>Nutrition>Biomass>Cultivated crops. Earthworm activities generally increase crop yield. This is through recycling nutrients, including interactions with the soil microbiota, to provide nutrients in a form available for plant uptake. Provisioning>Nutrition>Biomass> Wild animals and their outputs. Earthworms form the basis of the food chain for many familiar birds and mammals (section 2.21), some of which are of game value (e.g. snipe and woodcock) Regulating> Mediation of waste, toxics and other nuisances> Mediation by biota>Bio-remediation by micro-organisms, algae, plants, and animals. Earthworms are an important part of the decomposer community within the soil. They break down and recycle dead plant material and animal dung. Regulating>Mediation of flows>Liquid flows>Hydrological cycle and water flow maintenance. Earthworm burrows create channels in the soil that increase soil porosity, permit water permeation and aid drainage. Maintenance of physical, chemical, biological conditions>Pest and disease control>Disease control. Earthworms, by removal of fallen leaves, reduce apple scab (Venturia inaequalis) infection rates in apple orchards (de Jager & Heijne, 2004). Maintenance of physical, chemical, biological conditions >Soil formation and composition > Decomposition and fixing processes.Earthworms are important decomposer organisms within European soils. Through feeding on dead plant material and soil micro-organisms they physically break down structures and regulate microbial decomposition. Earthworms are arguably the most important component of the soil fauna for soil formation and fertility (Edwards, 2004). Maintenance of physical, chemical, biological conditions > Lifecycle maintenance, habitat and gene pool protection > Pollination and seed dispersal Lumbricus terrestris has been termed an 'ecosystem engineer', in part because of its ability to influence floral composition through the movement of seeds from the seedbank (Milcu et al., 2006). Cultural. There is anecdotal evidence of a decline in earthworms used for angling where A. triangulatus has established. In general, earthworms are some of the commonest and most-easily encountered soil organisms. An earthworm survey undertaken by Boag et al., 1997 found Lumbricus terrestris in 94% of the farms they surveyed and they are often included in primary school curricula on 'minibeasts' studies EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie	Very high
13	3.05	In the taxon's introduced range, are there known adverse socio-economic impacts?	Yes	the flatworm is often regarded with repulsion by gardeners and infestation can cause personal distress. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093#	Medium
B. Biology/Ecology					
4. Undesirable (or persistence) traits					

14	4.01	Is it likely that the taxon will be poisonous or pose other risks to human health?	Yes	Arthurdendyus triangulatus secretes digestive enzymes (e.g. collagenase) and neuropeptides and these may cause skin irritation if the flatworm is handled (Blackshaw & Stewart, 1992), although in most cases this is felt as a mild dermabrasion; EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Medium
15	4.02	Is it likely that the taxon will suppress the growth of one or more native taxa (that are not threatened or protected)?	Yes	The species most affected is Lumbricus terrestris and to a lesser extent Aporrectodea longa. Murchie & Gordon (2013) found a 75% depletion of these species biomass in the presence of A. triangulatus; with potential for local extinction if flatworm densities exceeded 1 per m2. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High
16	4.03	Are there any threatened or protected taxa that the non-native taxon would parasitise in the RA area?	No	The most affected earthworm species, L. terrestris, is widespread across Europe ; EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093#	High
17	4.04	Is the taxon adaptable in terms of climatic and other environmental conditions, thus enhancing its potential persistence if it has invaded or could invade the RA area?	No	The main factors limiting A. triangulatus dispersal are soil temperature, soil moisture and the availability of prey (Boag et al., 1998a). Soil temperatures greater than 20°C are detrimental to A. triangulatus, with 100% mortality after 3 weeks (Blackshaw and Stewart, 1992). Similarly, consistent low temperatures of -2°C caused 100% mortality after 3 days, whereas at -1°C mortality had only reached c. 50% after 21 days (Scottish Executive Rural Affairs Department, 2000). CABI Datasheet https://www.cabi.org/isc/datasheet/109121#tosymptomsOrSigns	High
18	4.05	Is the taxon likely to disrupt food-web structure/function in terrestrial ecosystems if it has invaded or is likely to invade the RA	Yes	A. triangulatus is an invasive earthworm predator that directly reduces earthworm biodiversity. CABI datasheet https://www.cabi.org/isc/datasheet/109121#tosymptomsOrSigns	High
19	4.06	Is the taxon likely to exert adverse impacts on ecosystem services in the RA area?	Yes	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
20	4.07	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are endemic in the RA area?	No	There are no known harmful organisms associated with this species (as food, host, symbiont or vector), although its microbiota has not been investigated. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093#	High
21	4.08	Is it likely that the taxon will host, and/or act as a vector for, recognised pests and infectious agents that are absent from (novel to) the RA area?	No	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High
22	4.09	Is it likely that the taxon will achieve a body size that will make it more likely to be released from captivity?	No	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
23	4.10	Is the taxon versatile in habitat use?	No	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
24	4.11	Is it likely that the taxon's mode of existence (e.g. excretion of by-products) or behaviours (e.g. feeding) will reduce habitat quality for native taxa?	Yes	Some potential indirect impacts of A. triangulatus are: • Increased water-logging and local flooding • Poor soil drainage leading to increased incidence of liver fluke • Greater leaching of fertilisers and pesticides into local watercourses • Unforeseen changes in flora and floral succession as earthworm biodiversity alters: EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High

25	4.12	Is the taxon likely to maintain a viable population even when present in low densities (or persisting in adverse conditions by way of a dormant form)?	Yes	As with other flatworms, A. triangulatus is a hermaphrodite. Mating has not been observed in this species but both male and female reproductive organs are fully functional (Fyfe, 1937; Baird et al., 2005b) suggesting that cross-fertilisation is the norm. A. triangulatus produce shiny black ovoid egg capsules. These are extruded through the dorsal surface or the gonopore on the underside (Blackshaw and Stewart, 1992). In an experimental study, a maximum of nine egg capsules were produced during a 16 week period, equating to roughly one egg capsule every two weeks (Baird et al., 2005a). The size of egg capsules varies depending on the size and nutritional status of the adult. Baird et al. (2005a) gave the smallest egg capsule in their study as 2.5 mm x 2.4 mm (8 mg) with the largest as 8.0 mm x 5.6 mm (180 mg). Egg capsules are typically found in the same habitat as the adults. In the wild, in Northern Ireland, the main period of egg-laying is normally March to July, with a smaller peak in August to September. The time to hatch for egg capsules is dependent on temperature, taking 49 days at 10°C and 38 days at 14°C (Baird et al., 2000). Egg capsules contain between 1-14 juveniles, with an average of 6 (Blackshaw and Stewart, 1992; Christensen and Mather, 1997) CABI datasheet	Very high
5. Resource exploitation					
26	5.01	Is the taxon likely to consume threatened or protected native taxa in the RA area?	No	A. triangulatus feeds on lumbricid earthworms in the invaded areas. Little is known about its natural prey in New Zealand, although it is assumed to be megascolecid earthworms (Johns et al., 1998). CABI datasheet	High
27	5.02	Is the taxon likely to sequester food resources (including nutrients) to the detriment of native taxa in the RA area?	Yes	The ecological significance of this particular species is due to resulting negative effects on European lumbricid earthworms, A. triangulata having depleted populations of these beneficial soil organisms as well as causing a reduction in earthworm species number at certain sites. Depletion of lumbricid populations can lead to negative impacts on wildlife, soil structure and fertility, plant production and horticultural/ agricultural trade. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	High
6. Reproduction					
28	6.01	Is the taxon likely to exhibit parental care and/or to reduce age-at-maturity in response to environmental conditions?	No	Arthurdendyus triangulatus is hermaphrodite and, although mating has not been observed, the reproductive organs indicate sexual reproduction by copulation (Baird et al., 2005b). Reproduction by fission does not appear to take place in A. triangulatus and they are susceptible to mechanical damage. Arthurdendyus triangulatus produces shiny black ovoid egg capsules extruded through the dorsal surface or the ventral gonopore. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
29	6.02	Is the taxon likely to produce viable gametes or propagules (in the RA area)?	Yes	. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Medium
30	6.03	Is the taxon likely to hybridise naturally with native taxa?	No	. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High
31	6.04	Is the taxon likely to be hermaphroditic or to display asexual reproduction?	Yes	Arthurdendyus triangulatus is hermaphrodite and, although mating has not been observed, the reproductive organs indicate sexual reproduction by copulation. . EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Very high
32	6.05	Is the taxon dependent on the presence of another taxon (or specific habitat features) to complete its life cycle?	No	. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high

33	6.06	Is the taxon known (or likely) to produce a large number of propagules or offspring within a short time span (e.g. < 1 year)?	Yes	Arthurdendyus triangulatus produces shiny black ovoid egg capsules extruded through the dorsal surface or the ventral gonopore (Blackshaw & Stewart, 1992). In the British Isles, egg capsules are most commonly found at the soil surface March to July, with a smaller peak in August to September. Each egg capsule contains 1-14 juveniles, with an average of six (Blackshaw & Stewart, 1992; Christensen & Mather, 1997). Under laboratory conditions, flatworms were capable of producing one egg capsule every two weeks for a period of 16 weeks (Baird et al., 2005a). Combining the number of egg capsules produced and an estimate of the number of young therein, gave the figure of c. 40 juvenile flatworms per reproductive adult per year (Blackshaw, 1997; Baird et al., 2005a). EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
34	6.07	How many time units (days, months, years) does the taxon require to reach the age-at-first-reproduction?	1	within 1 year Ole M. Christensen, Janice G. Mather, Long-term study of growth in the New Zealand flatworm Arthurdendyus triangulatus under laboratory conditions, Pedobiologia, Volume 45, Issue 6, 2001, Pages 535-549, ISSN 0031-4056,	High
7. Dispersal mechanisms					
35	7.01	How many potential internal vectors/pathways could the taxon use to disperse within the RA area (with suitable habitats nearby)?	One	Horticulture by soil and plant roots EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Very high
36	7.02	Will any of these vectors/pathways bring the taxon in close proximity to one or more protected areas (e.g. SSSI)? National parks, Nature parks, Special reserve?	Yes	could be possible EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Low
37	7.03	Does the taxon have a means of hiding itself (in e.g. shipping parcels) such that it enhances the likelihood of dispersal?	Yes	It can shelter within root balls in containerised plants or possibly within plant material itself EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	High
38	7.04	Is natural dispersal of the taxon likely to occur as eggs in the RA area?	Yes	Arthurdendyus triangulatus is transported as free-living flatworms and egg capsules, both of which are likely to be embedded in moist soil or plant materials EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Very high
39	7.05	Is natural dispersal of the taxon likely to occur as larvae/juveniles in the RA area?	No	Arthurdendyus triangulatus is transported as free-living flatworms and egg capsules, both of which are likely to be embedded in moist soil or plant materials EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	High
40	7.06	Are older life stages of the taxon likely to migrate in the RA area for reproduction?	Yes	It is is a cryptic soil dwelling species but The flatworm can then actively migrate from sites into surrounding fields and forests, where satellite colonies may establish. The potential for active migration is apparent from crawling speeds, adults moving at relatively fast rates of up to 17 metres per hour. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	High
41	7.07	Are propagules or eggs of the taxon likely to be dispersed in the RA area by other animals?	No	It was not observed yet. EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Medium
42	7.08	Is dispersal of the taxon along any of the vectors/pathways mentioned in the previous seven questions (35–41; i.e. both unintentional or intentional) likely to be rapid?	No	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High

43	7.09	Is dispersal of the taxon density dependent?	No	Such info was not provided, but probably they dispersing when some density is reached EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Low
8. Tolerance attributes					
44	8.01	Is the taxon able to withstand being in water for extended periods (e.g. minimum of one or more hours) at some stage of its life cycle?	Yes	A. triangulatus could be moved by floodwater EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-en/format-PDF/source-63210093	Medium
45	8.02	Is the taxon tolerant of a wide range of soil/air quality conditions relevant to that taxon? [In the Justification field, indicate the relevant quality variable(s) being considered.]	Yes	ndividual A. triangulatus in Petri dishes were exposed to a selection of 14 then-approved grassland pesticides. At 1000 ppm a.i., flatworms survived over a three week period when earthworms died (Blackshaw, 1996). The only pesticide that killed A. triangulatus but had minimum effects on the test earthworm species, Eisenia fetida, was gamma hexachlorocyclohexane (lindane), since withdrawn in the UK. A similar result was obtained in cage bioassays with flatworms maintained in compost. Gamma-HCH, tebufenpyrad, imidacloprid, abamectin and pirimicarb (all insecticides or acaricides) did result in some mortality of A. triangulatus (KFA Walters, Central Science Laboratory, UK, personal communication, 2009) but this was generally low and these results need to be substantiated with	High
46	8.03	Can the taxon be controlled or eradicated in the wild with chemical, biological, or other agents/means?	No	Chemical control of A. triangulatus is problematic because they are a cryptic, soil-dwelling species and therefore difficult to target. In addition, any pesticides applied to kill A. triangulatus may also affect their earthworm prey. In Europe no pesticides are available for control. For biological control it is recognised that predatory beetles (Carabidae and Staphylinidae) will feed on A. triangulatus (Blackshaw 1996; Gibson et al. 1997) and could have a moderating influence on their populations. However, this has not been tested. Classical biological control using a specialist parasitoid such as P. insignis remains a possibility (Blackshaw 1996; Blackshaw and Stewart 1992; Cannon et al. 1999) but the parasitoid species and its relationship with flatworms remains under-researched. It is not known, for example, whether P. insignis is capable of parasitizing A. triangulatus. CABI Database https://www.cabi.org/isc/datasheet/109121#tohabitat ; EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/	Medium
47	8.04	Is the taxon likely to tolerate or benefit from environmental/human disturbance?	Yes	Its principal habitat is cultivated land and managed grasslands CABI Database	High
48	8.05	Is the taxon able to tolerate soil acidity or other parameter levels that are higher or lower than those found in its usual environment?	No	Soil temperatures greater than 20°C are detrimental to A. triangulatus, with 100% mortality after 3 weeks (Blackshaw and Stewart, 1992). Similarly, consistent low temperatures of -2°C caused 100% mortality after 3 days, whereas at -1°C mortality had only reached c. 50% after 21 days. CABI Database https://www.cabi.org/isc/datasheet/109121#tohabitat	High
49	8.06	Are there effective natural enemies (predators) of the taxon present in the RA area?	No	No EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Very high
C. Climate change					
9. Climate change					
50	9.01	Under the predicted future climatic conditions, are the risks of entry into the RA area posed by the taxon likely to increase, decrease or not change?	Increase	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Medium
51	9.02	Under the predicted future climatic conditions, are the risks of establishment posed by the taxon likely to increase, decrease or not change?	Increase	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	Medium
52	9.03	Under the predicted future climatic conditions, are the risks of dispersal within the RA area posed by the taxon likely to increase, decrease or not change?	Increase	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High
53	9.04	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on biodiversity and/or ecological integrity/status?	Higher	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High

54	9.05	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem structure and/or function?	Higher	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High
55	9.06	Under the predicted future climatic conditions, what is the likely magnitude of future potential impacts on ecosystem services/socio-economic factors?	Higher	EU (2018). Study on invasive alien species. Development of risk assessments to tackle priority species and enhance prevention : final report. Contract No 07.0202/2016/740982/ETU/ENV.D2 Author of Asessment Archie K. Murchie; https://op.europa.eu/en/publication-detail/-/publication/c01568d9-025e-11e8-b8f5-01aa75ed71a1/language-	High

Statistics	
Scores	
BRA	**36.0**
BRA Outcome	**-**
BRA+CCA	**48.0**
BRA+CCA Outcome	**-**
Score partition	
A. Biogeography/Historical	**17.0**
1. Domestication/Cultivation	*-2.0*
2. Climate, distribution and introduction risk	*1.0*
3. Invasive elsewhere	*18.0*
B. Biology/Ecology	**19.0**
4. Undesirable (or persistence) traits	*5.0*
5. Resource exploitation	*2.0*
6. Reproduction	*4.0*
7. Dispersal mechanisms	*2.0*
8. Tolerance attributes	*6.0*
C. Climate change	**12.0**
9. Climate change	*12.0*
Answered Questions	
Total	***55***
A. Biogeography/Historical	**13**
1. Domestication/Cultivation	*3*
2. Climate, distribution and introduction risk	*5*
3. Invasive elsewhere	*5*
B. Biology/Ecology	**36**
4. Undesirable (or persistence) traits	*12*
5. Resource exploitation	*2*
6. Reproduction	*7*
7. Dispersal mechanisms	*9*
8. Tolerance attributes	*6*
C. Climate change	**6**
9. Climate change	*6*
Sectors affected	
Commercial	**14**
Environmental	**12**
Species or population nuisance traits	**24**

Thresholds	
BRA	**-**
BRA+CCA	**-**
Confidence	
BRA+CCA	**0.76**
BRA	**0.78**
CCA	**0.67**

Date and Time
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