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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