Appendix A

Harmonia^{+PL} – procedure for negative impact risk assessment for invasive alien species and potentially invasive alien species in Poland

QUESTIONNAIRE

A0 | Context

Questions from this module identify the assessor and the biological, geographical & social context of the assessment.

a01. Name(s) of the assessor(s):

first name and family name

1. Zbigniew Celka
2. Katarzyna Bzdęga
3. Bogdan Jackowiak

acomm01. Comments:

	degree	affiliation	assessment date
(1)	dr hab.	Department of Plant Taxonomy, Institute of Environmental Biology, Faculty of Biology, Adam Mickiewicz University in Poznań	22-01-2018
(2)	dr	Department of Botany and Nature Protection, Faculty of Biology and Environmental Protection, University of Silesia in Katowice	28-01-2018
(3)	prof. dr hab.	Department of Plant Taxonomy, Institute of Environmental Biology, Faculty of Biology, Adam Mickiewicz University in Poznań	02-02-2018

a02. Name(s) of ***the species*** under assessment:

Polish name: Partenium ambrozjowate

Latin name: ***Parthenium hysterophorus*** L.

English name: Santa Maria feverfew

Współfinansowano w ramach projektu nr POIS.02.04.00-00-0100/16 pn. *Opracowanie zasad kontroli i zwalczania inwazyjnych gatunków obcych wraz z przeprowadzeniem pilotażowych działań i edukacją społeczną* ze środków Unii Europejskiej w ramach Programu Infrastruktura i Środowisko 2014-2020

acomm02. Comments:

The Latin name of the species was given according to The Plant List (2013 – B). Synonyms of the Latin name are quite numerous: *Parthenium lobatum* Buckley, *Parthenium pinnatifidum* Stokes, *Parthenium glomeratum* Rollins, *Argyrochaeta bipinnatifida* Cav., *Argyrochaeta parviflora* Cav., *Echetrosis pentasperma* Phil., *Villanova bipinnatifida* Ortega (The Plant List 2013, Tropicos 2018 – B). The Polish name is: Partenium ambrozjowate. Its synonym is: Roślimianek ambrozjowaty. Both Polish names were given according to Flowering plants and pteridophytes of Poland checklist (Mirek et al. 2002 – P). There are a lot of English names: Santa Maria feverfew, ragweed parthenium, bastard feverfew, Santa-Maria, whitetop weed, famine weed, bhajpa weed, Barley flower (BSBI List 2007 – B, McConnachie et al. 2011 – P, ITIS 2018, USDA 2018 – B).

Polish name (synonym I)	Polish name (synonym II)
Roślimianek ambrozjowaty	–
Latin name (synonym I)	**Latin name (synonym II)**
Parthenium pinnatifidum	*Argyrochaeta bipinnatifida*
English name (synonym I)	**English name (synonym II)**
ragweed parthenium	Bastard feverfew

a03. **Area** under assessment:

Poland

acomm03. Comments:

–

a04. **Status** of *the species* in Poland. *The species* is:

	native to Poland
X	alien, absent from Poland
	alien, present in Poland only in cultivation or captivity
	alien, present in Poland in the environment, not established
	alien, present in Poland in the environment, established

aconf01. Answer provided with a

low	medium	high
		X

level of confidence

acomm04. Comments:

Parthenium hysterophorus has ephemerophyte status in Poland – a status of a foreign species, temporarily brought, not permanently established, and eliminated mainly by climatic factors (Rostański and Sowa 1987, Mirek et al. 2002, Urbisz 2011, Tokarska-Guzik et al. 2012 – P). The species is native to subtropical regions of North, Central and South America (OEPP/EPPO 2015 – B; CABI 2018 – B). In Poland, it was first noted by G. Wangrin in 1938 in Szczecin, at the landfill at Gdańska Street (square ATPOL AB83), where six plants were observed (Scheuermann 1956, Urbisz 2011 – P, EPPO 2014 – B). A year later, the presence of the species was confirmed, with only one plant being recorded. In the same place, another ephemerophyte, , was observed in the company of *P. hysterophorus*. *T. minuta* was probably brought with oil plant seeds (Scheuermann 1956, Urbisz 2011 – P). There are no data on other localities of *P. hysterophorus* in Poland (Urbisz 2011 – P). However, it is not possible to rule out the periodic occurrence of individuals of this species in Poland. *P. hysterophorus* can be confused with the plants of the *Ambrosia* genus (CABI 2018 – B), e.g., with the common ragweed (*Ambrosia artemisiifolia* L.), which is an invasive plant in Poland, especially in the vegetative stage, when only the leaf rosette is developed. The distinction between the plants of both species during flowering does not raise any doubts (CABI 2018 – B).

a05. The impact of *the species* on major domains. *The species* may have an impact on:

X	the environmental domain
X	the cultivated plants domain
X	the domesticated animals domain
X	the human domain
X	the other domains

acomm05. Comments:

Parthenium hysterophorus is invasive in many regions of the world – in Africa, Asia, Australia and eastern part of North America (Navie et al. 1996, Kohli et al. 2006, McConnachie et al. 2011 – P, CABI 2018 – B). The species poses a major threat to biodiversity and its presence can lead to degradation of natural ecosystems and irreversible changes in various habitats, such as grasslands, forests, river banks and flood plains, where it can effectively compete with and replace native species (McConnachie et al. 2011 – P, CABI 2018 – B). It also colonizes disturbed areas and negatively affects pastures and crops (Kohli et al. 2006 – P). The species is allelopathic to crops, preventing them from successful competing for nutrients and water (Ramachandra Prasad et al. 2010 – P). Losses in yield reach even up to 40% (Khosla and Sobti 1981 – P); for example: wheat yields are reduced by 40% to 90% (Tamado et al. 2002a – P). An indirect influence is associated with the species' pollen deposited on the flowers of many crops, e.g. bean, eggplant, pepper, tomato, and also corn, which inhibits the setting of seeds and the formation of fruit (Stamps 2011 – P). *P. hysterophorus* produces an average of 316 million pollen grains per 0.1 m^2 (Stamps 2011). The species also reduces the chlorophyll content in heavily infested crops (Towers and Subba Rao 1992 – P). It is also a host to many pathogens and insects that are crop pests (Lakshmi and Srinivas 2007, OEPP/EPPO 2014 – P). Because the plant contains sesquiterpenes and phenols, it is toxic to cattle. The meat and milk of such animals is contaminated (Tudor et al. 1982, Towers and Subba Rao 1992 – P). In Australia, the invasion of the species into the pasture areas of 170,000 km^2 prevented cattle grazing and caused millions of losses (Chippendale and Panetta 1994 – P). In humans and animals, contact with *P. hysterophorus* may cause both allergic respiratory problems and contact dermatitis (Patel 2011 – P). In humans, it causes serious allergic diseases (fatal cases were also recorded) and its pollen is sensitizing (OEPP/EPPO 2014, Gaurav et al. 2017 – P). The probability of allergy to *P. hysterophorus* is 50% in case of people regularly exposed to direct contact. In addition, hypersensitivity to other plants belonging to the same Asteraceae family may occur., In such a case, patients develop allergy to plants they were not previously sensitive to (Rodriguez et al. 1977 – P). Also public areas in urban zones, such as gardens, parks, recreational areas, roadsides and railways (CABI 2018 – B) are threatened with *P. hysterophorus* invasion.

A1 | Introduction

Questions from this module assess the risk for *the species* to overcome geographical barriers and – if applicable – subsequent barriers of captivity or cultivation. This leads to *introduction*, defined as the entry of *the organism* to within the limits of *the area* and subsequently into the wild.

a06. The probability for ***the species*** to expand into Poland's natural environments, **as a result of self-propelled expansion** after its earlier introduction outside of the Polish territory is:

X	low
	medium
	high

aconf02. Answer provided with a

low	medium	high	level of confidence
		X	

acomm06. Comments:

Parthenium hysterophorus belongs to highly invasive plants in many countries of its non-native range of distribution (Navie et al. 1996, Kohli et al. 2006, McConnachie et al. 2011 – P, CABI 2018 – B). In Europe, it has been so far reported only from Belgium and Poland. In Belgium, it was found in 1999 in the port of Ghent at the transshipment terminal for cereals and soybeans, and in 2013 – in Roeselar, in the vicinity of a plant producing pet food (Verloove 2006 – P). In Poland, it was recorded in 1938 and 1939 in Szczecin, at a landfill (Scheuermann 1956, Urbisz 2011 – P, EPPO 2014 – B, OEPP/EPPO 2014 – P, see comment a04). It can potentially spread to new regions of the world. In Europe, these include France, Italy, Spain and Portugal (McConnachie et al. 2011 – P). The species can easily spontaneously spread and break down subsequent geographical and environmental barriers due to its wide ecological and habitat tolerance. In addition, the plant is characterized by high adaptability, resistance to light and temperature, drought tolerance, as well as strong competitive and allelopathic properties, as well as high productivity of fertile achenes (dry, non-bursting, single-seed fruits), 15-25 thousand per plant (McConnachie et al. 2011, Dhileepan 2012, Gaurav et al. 2017 – P). It creates a durable soil seed bank. The species disperses mostly by small (1–2 mm in diameter) and light (50 µg) achenes (Navie et al. 1996, Taye 2002 – P). They are carried locally over a distance of a few meters by wind and water and for much longer distances with contaminated hay, seed, manure, compost, as well as transferred from fields along with soil, by birds and other animals, on wheels of vehicles and agricultural machinery. *P. hysterophorus* also spreads through cyclones and floods (OEPP/EPPO 2015 – P, CABI 2018 – B). Due to the currently unconfirmed presence of the species in the neighboring countries, the probability of the species appearing in the natural environment of Poland as a result of independent expansion after being introduced outside the area of Poland earlier is low.

a07. The probability for *the species* to be introduced into Poland's natural environments by **unintentional human actions** is:

	low
	medium
X	high

aconf03. Answer provided with a

low	medium	high	level of confidence
		X	

acomm07. Comments:

Parthenium hysterophorus reproduces through fruits (achenes), spreading spontaneously with the aid of water and wind (see comment a06). The documented history of introductions and further species spread in many countries shows that the plant colonizes vast areas primarily due to unintentional and accidental human activities. Fruits can be introduced by import of contaminated grains used, e.g., as food for fish in ponds, along with import of contaminated cereals (Fessehaie et al. 2005, Sushilkumar and Varshney 2010 – P), seeds or substrate used in greenhouses and nursery-gardens, also on clothes, shoes and traveler and tourist luggage (OEPP/EPPO 2014 – P). Along the roads and around the buildings, the species can be brought by transporting soil, sand and gravel for construction purposes from the areas colonized by the species to new areas (Taye 2002 – P). Continental and intercontinental distribution may occur when seeds contaminate commercial stocks of useful plants or agricultural machinery. Indicated paths of unintentional introduction of *P. hysterophorus* may result in its invasion of naturally valuable areas, including rivers and grasslands (see comment a05). There are known cases of several nature reserves colonized by this species, e.g., in Australia, Ethiopia, India, Pakistan, South Africa and Zimbabwe (Dhileepan 2009 – P). The localities of *P. hygrophorus* that are nearest to Poland are located in Israel (Danin and Fragman-Sapir 2016 – B), and in Africa – in Ethiopia (McConnachie et al. 2011 – P). Having considered the possible vectors for bringing the diaspores of this species, the probability of introducing the species to the natural environment of Poland due to unintended human activities can be assessed as quite high.

a08. The probability for *the species* to be introduced into Poland's natural environments by **intentional human actions** is:

X	low
	medium
	high

aconf04.	Answer provided with a	low	medium	high **X**	level of confidence

acomm08. Comments:

The species has many uses. Plants can be used as a green fertilizer, compost, as well as soil improver, because they are a source of readily available plant micro and macro elements that improve the physical, chemical and biological properties of soils (Kishor et al. 2010 – P). *Parthenum hysterophorus* can also be used as a bioherbicide. It also has healing properties and is used particularly as a medicine for dermatitis, rheumatic pains, diarrhea, urinary tract infections, dysentery, malaria and neuralgia. Other potential applications include the use of plants for the removal of heavy metals, as a substrate for the production of enzymes for commercial purposes and additives for cattle manure for biogas production (Patel 2011 – P, see comment a39). Such plant use can only take place in case of obtaining them from nature and can be a potential option for getting rid of troublesome biomass. Therefore, the introduction of the species into the environment due to deliberate human actions cannot be completely ruled out. Due to the danger posed by *P. hysterophorus*, in many regions of the world, according to applicable law, plants should be removed and immediately destroyed and their trade prohibited (OEPP/EPPO 2014 – P). In 2014, the European Commission developed a draft list of invasive species posing a threat to the Union, comprising 39 species, including *P. hysterophorus*.

A2 | Establishment

Questions from this module assess the likelihood for *the species* to overcome survival and reproduction barriers. This leads to *establishment*, defined as the growth of a population to sufficient levels such that natural extinction within *the area* becomes highly unlikely.

a09. Poland provides **climate** that is:

	non-optimal
X	sub-optimal
	optimal for establishment of *the species*

aconf05.	Answer provided with a	low	medium **X**	high	level of confidence

acomm09. Comments:

The species comes from areas with tropical and subtropical climates, where the optimal range of average annual temperatures ranges from 12°C to 25°C. However, plants have a very wide tolerance range of 2°C to even 40°C and are able to survive temperatures below 0°C, even short periods at -2°C down to -5°C (Williams and Groves 1980 – P, CABI 2018 – B). *Parthenium hysterophorus* prefers moderate warm climate with dry winter and summer or wet throughout the year, but it tolerates the steppe climate and tropical climate of savannah with dry season. The species is an annual plant (or short–lived perennial) with a deep root. Seeds germinate in spring and early summer. Plants of the analyzed species produce flowers and fruits throughout their entire life, dying in late Autumn (Navie et al. 1996 – P). Under favorable conditions, the plants bloom for 6 to 8 months (CABI 2018 – B). They can grow at any time of the year, if there is adequate moisture (Tamado 2001, Taye 2002 – P). The species is unable to reproduce vegetatively from plant fragments and through apomixis, but produces a huge amount of fertile achene (fruits), from 15,000 to 25,000 per individual (Haseler 1976, Navie et al. 1996, Mahadevappa 1997 – P), forming a persistent soil seed bank. Lifespan of

seeds is estimated at 6 years (Navie et al. 1996 – P). They may germinate in a wide range of temperatures (12/2°C – 35/25°C) under light conditions (Tamado et al. 2002b – P) and soil pH from 2.5 to 10 (Parsons and Cuthbertson 1992 – P). Excessive cooling of seeds and exposure to light increase the intensity of germination (Karlsson et al. 2008 – P). The plant life cycle may last up to 335 days under unfavorable (dry) conditions or up to 86 days under optimal conditions (CABI 2018 – B). The similarity between the climate of Poland and the climate of parts of both the native and non-native range of the species is in 45-94% range, meaning that climatic conditions in Poland are moderately favorable for the species (CABI 2018 – B). This thesis may indirectly be confirmed by the fact that in the last century, the species was sporadically observed in Europe (see comment a04). The wide adaptive and competitive abilities of this species may favor its establishment in Poland (see comment a34).

a10. Poland provides **habitat** that is

	non-optimal
X	sub-optimal
	optimal for establishment of *the species*

aconf06.	Answer provided with a	low	medium **X**	high	level of confidence

acomm10. Comments:

Parthenium hysterophorus exhibits wide habitat spectrum. In its non-native range, it grows in degraded, and disturbed habitats, as well as in riverside habitats with natural features. It is a species with pioneer traits that can enter pastures, arable fields, orchards, forests, railway areas, roadsides, river banks and floodplains (Navie et al. 1996, McConnachie et al. 2011, OEPP/EPPO 2014 – P). The species can be found in the plantations of perennial plants such as alfalfa or clover, as well as in annual plant crops, such as: sorghum, tomato, onion, cucumber, watermelon, tobacco, garlic, eggplant, beans, peppers, maize, wheat and other cereals (EPPO 2014 – B). According to the Corine Land Cover nomenclature, habitat types of the species include: arable lands, permanent cultivations (for example, vineyards, fruit orchards, berry plantations and olives), pastures, river banks, dry river beds, roads and railway networks and related grounds, as well as other wastelands (OEPP/EPPO 2014 – P). The species prefers alkaline, loamy and fertile soil, but grows on various types, including acidic and neutral. High clay content in the soil extends the rosette phase, increasing its growth rate, hinders root growth, but at the same time promots biomass allocation in shoots (Annapurna and Singh 2003 – P). The plant has several mechanisms facilitating the stress survival in various ecological conditions (Mahadevappa 1997 – P, see comment a34). Although in Poland there are groups of habitats analogous to those occupied by the species in the areas of its invasion, other abiotic and biotic factors that may limit its survival and reproduction should be taken into account.

A3 | Spread

Questions from this module assess the risk of *the species* to overcoming dispersal barriers and (new) environmental barriers within Poland. This would lead to spread, in which vacant patches of suitable habitat become increasingly occupied from (an) already-established population(s) within Poland.

Note that spread is considered to be different from range expansions that stem from new introductions (covered by the Introduction module).

a11. The capacity of *the species* to disperse within Poland by natural means, **with no human assistance**, is:

	very low
	low
	medium
X	high
	very high

aconf07.	Answer provided with a	low	medium **X**	high	level of confidence

acomm11. Comments:

Parthenium hysterophorus has a very high reproductive potential, reproducing only through achenes (dry, non–bursting, single–seed fruits). A single plant can produce up to 156,000 achenes over the course of a year and thus creates a huge, long-term soil seed bank (Dhileepan 2012 – P). Achenes can be spread by water (the so–called hydrochory) and wind (the so–called anemochory) locally over a distance of several meters or more or during floods and strong winds over much greater distances (OEPP/EPPO 2015, Gaurav et al. 2017 – P, CABI 2018 – B). The average speed of winds in Poland is about 11 km/h, but gusts can reach up to 100 km/h (in recent years, such a weather phenomenon has been appearing more and more often). The plant diaspores may also cover large distances with the aid of birds and other animals (OEPP/EPPO 2015 – P, CABI 2018 – B, see comment a06 and a09). Data on dispersion from a single source (Type A data): one can assume that the possible distance that the species will cover over a year will exceed several dozen kilometers – high or very high dispersion. Data on population expansion (Type B data) and biological estimation of species mobility (Type C data): based on the biology and ecology characteristics of the species, high or very high dispersion should be assumed for both types of data, respectively. It should be noted that in the absence of localities of this species in Poland, we only assess its potential ability to spread spontaneously. This means that all quantitative data from the areas of its invasive occurrence should be treated with caution. Biological features described do not need to appear in Poland. This applies to all subsequent stages of individual development and life history.

a12. The frequency of the dispersal of *the species* within Poland by **human actions** is:

	low
	medium
X	high

aconf08.	Answer provided with a	low	medium **X**	high	level of confidence

acomm12. Comments:

The introduction of *Parthenium hysterophorus* into a new environment and its further spread is possible primarily due to unintended human actions, e.g., with distribution of seed containing plant diaspores through the trade and transport of goods, grazing animals on pastures occupied by this species, transport of sand, soil, manure and compost from infected to uninfected areas, as well as on the wheels of vehicles and agricultural machinery (OEPP/EPPO 2015 – P, CABI 2018 – B, see comment a06 and a09). A potential cause of the spread may also be the intentional introduction of the species, e.g., aimed at using its biomass for biogas (Patel 2011 – P) or bioethanol production, which may be a potential solution for the effective use of harmful waste biomass (Bharadwaja et al. 2015 – P). At the same time, however, this is another source of potential threat to the environment, which is why the presence of *P. hysterophorus* is absolutely undesirable in country. In Poland, *P. hysterophorus* is not established, but if it had been established, the probability of its diaspores moving over a distance greater than 50 km with human participation is high. Man, unintentionally, may contribute to the spread of this species along with the transport of various materials. As the assessment concerns a potential situation, the degree of certainty is lowered.

A4a | Impact on the environmental domain

Questions from this module qualify the consequences of *the species* on wild animals and plants, habitats and ecosystems.

Impacts are linked to the conservation concern of targets. Native species that are of conservation concern refer to keystone species, protected and/or threatened species. See, for example, Red Lists, protected species lists, or Annex II of the 92/43/EWG Directive. Ecosystems that are of conservation concern refer to natural systems that are the habitat of many threatened species. These include natural forests, dry grasslands, natural rock outcrops, sand dunes, heathlands, peat bogs, marshes, rivers & ponds that have natural banks, and estuaries (Annex I of the 92/43/EWG Directive).

Native species population declines are considered at a local scale: limited decline is considered as a (mere) drop in numbers; severe decline is considered as (near) extinction. Similarly, limited ecosystem change is considered as transient and easily reversible; severe change is considered as persistent and hardly reversible.

a13. The effect of *the species* on native species, through **predation, parasitism or herbivory is**:

X	inapplicable
	low
	medium
	high

aconf09.	Answer provided with a	low	medium	high	level of confidence

acomm13. Comments:

Parthenium hysterophorus is a non–parasitic plant, it does not affect native species through predation, parasitism or herbivory.

a14. The effect of *the species* on native species, through **competition** is:

	low
	medium
X	high

aconf10.	Answer provided with a	low	medium **X**	high	level of confidence

acomm14. Comments:

Due to its high adaptability to diverse habitat conditions, the species has a wide range of tolerance towards, among others, temperature, light, drought, salinity and pH of the substrate, and can effectively compete with native plant species in grasslands, forests, on the banks of rivers, in flood plains and anthropogenic areas (Adkins and Shabbir 2014 – P, CABI 2018 – B). As an allelopathic plant with high potential, it replaces native vegetation in a wide spectrum of habitats leading to the impoverishment of species diversity (Kohli 1992, Evans 1997, Batish et al. 2005, Shabbir and Bajwa 2006 – P). The occurrence of the species results in the presence of a long-lasting toxic effect in the soil environment, and the allelopathic compounds contained therein inhibit the binding of nitrogen and nitrifying bacteria (Kanchan and Jayachandra 1981 – P). The undesirable effects include the harmful penetration of the species into naturally valuable areas, including willow carrs (Shabbir 2015 – P) and protected areas (Dhileepan 2009 – P). On the basis of the quoted data, it should be concluded that the appearance of the species in Poland may result in the decline of biodiversity in places affected by the invasion; the lack of data on Europe results in lowering the degree of certainty of the assessment.

a15. The effect of *the species* on native species, through **interbreeding** is:

X	no / very low
	low
	medium
	high
	very high

aconf11.	Answer provided with a	low	medium	high **X**	level of confidence

acomm15. Comments:

There are no other *Parthenium* species in Poland (Mirek et al. 2002, Rutkowski 2011, Tokarska-Guzik et al. 2012 – P). In the Polish literature on the subject, there is no information about intergeneric hybridization involving *Parthenium*.

a16. The effect of *the species* on native species by **hosting pathogens or parasites** that are harmful to them is:

	very low
	low
X	medium
	high
	very high

aconf12.	Answer provided with a	low	medium **X**	high	level of confidence

acomm16. Comments:

Parthenium hysterophorus is a host for pathogens of plants and insects that are crop pests (Basappa 2005, Govindappa et al. 2005, Prasada Rao et al. 2005, Lakshmi and Srinivas 2007 – P). The most dangerous pathogens from the list of the European and Mediterranean Plant Protection Organization (EPPO) have been found to include the tomato yellow leaf curl virus (TYLCV) and the *Bemisia tabaci* insect (Najberek 2018 – I). In case of *P. hysterophorus* in India, the observations included, e.g., leaf curl and deformation, reduction of leaf size, yellowing and chlorosis of leaves, inhibition of plant growth. Pathogens were identified as tobacco leaf curl virus (TLCV), mung bean yellow mosaic (MYMV) and okra yellow vein mosaic viruses (OYVMV). All of them were transmitted by the silverleaf whitefly (*Bemisia tabaci*), a foreign species of the true bugs (*Hemiptera*) brought to Poland (Singh and Singh 1999,– P, Roques 2006, Bemisia 2009 – B, Najberek 2018 – I). For *P. hysterophorus*, there is no detailed data on the impact on native species through the transmission of pathogens or parasites harmful to them. So far, the species has appeared sporadically in Poland. However, its establishment and the possibility of the species pathogens/parasites introduction cannot be ruled out in the future either. It should be expected then that the plant can be a vector for some of them, found so far in the species in the warmer regions of its non-native range (CABI 2018 – B).

a17. The effect of *the species* on ecosystem integrity, by **affecting its abiotic properties** is:

	low
	medium
X	high

aconf13.	Answer provided with a	low	medium **X**	high	level of confidence

acomm17. Comments:

Parthenium hysterophorus may negatively affect the integrity of ecosystems by interfering with its abiotic factors. There is information from Australia about deep changes in pasture habitats, on the river banks and plains that are caused by *P. hysterophorus* (McFadyen 1992, Chippendale and Panetta 1994 – P). Although plants are a source of readily available micro- and macroelements improving the physical, chemical and biological properties of soils (Kishor et al. 2010 – P), their presence, in connection with the production of allelopathic compounds, causes long-lasting toxic effect in soil and inhibition of nitrogen binding by plants (Kanchan and Jayachandra 1981 – P). The problem currently does not concern the European part of the non-native range of the species. Based on the provided data, it should be concluded that the emergence of a species in Poland may lead to disturbed factors of abiotic ecosystems in the areas affected by invasion, however, the lack of data on Europe affects the level of confidence in the assessment.

a18. The effect of *the species* on ecosystem integrity, by **affecting its biotic properties** is:

	low
	medium
X	high

aconf14.	Answer provided with a	low	medium **X**	high	level of confidence

acomm18. Comments:

The species is perceived to be very invasive due to its adaptive and competitive abilities, whereas its allelopathic potential is recognized as one of the factors ensuring the plant's invasive success (Bajwa et al. 2016 – P). The secreted allelocompounds, particularly from the sesquiterpene phenol and lactone group, including parthenin (Belz et al. 2007 – P), inhibit the germination and growth of many plants, including crops (Navie et al. 1996, Evans 1997 – P). In this way, *P. hysterophorus* replaces native plant species and transforms meadows, open forests, river banks and floodplains into extensive monoculture areas (McFadyen 1992, Chippendale and Panetta 1994, Evans 1997 – P). Undesirable effects also include the penetration of the species into the naturally valuable areas, for example, into willow carrs (Shabbir 2015 – P) and protected areas (Dhileepan 2009 – P). The problem currently does not concern the European part of the non-native range of the species. Based on the provided data, it should be concluded that the appearance of the species in Poland may disturb the factors of biotic ecosystems in the areas affected by invasion, however, the lack of data on Europe affects the level of confidence in the assessment.

A4b | Impact on the cultivated plants domain

Questions from this module qualify the consequences of *the species* for cultivated plants (e.g. crops, pastures, horticultural stock).

For the questions from this module, consequence is considered 'low' when presence of *the species* in (or on) a population of target plants is sporadic and/or causes little damage. Harm is considered 'medium' when *the organism's* development causes local yield (or plant) losses below 20%, and 'high' when losses range >20%.

a19. The effect of *the species* on cultivated plant targets through **herbivory or parasitism** is:

	inapplicable
X	very low
	low
	medium
	high
	very high

aconf15.	Answer provided with a	low	medium	high **X**	level of confidence

acomm19. Comments:

The species is a plant, it also has no parasitic properties.

a20. The effect of *the species* on cultivated plant targets through **competition** is:

	inapplicable
	very low
	low
	medium
X	high
	very high

aconf16.	Answer provided with a	low	medium **X**	high	level of confidence

acomm20. Comments:

In the world literature, there is a lot of information about the negative impact of *Parthenium hysterophorus* on plant cultivation. The species adversely affects crops, e.g. through the overgrowing of farmlands that become unsuitable for cultivation. Strong allelopathic chemicals produced by the species inhibit the germination and growth of many species growing in crops and on pastures such as: cereals, vegetables or fodder grasses (Navie et al. 1996, Evans 1997 – P, EPPO Report 2018 – B). The inhibitory effect of allelic compounds on the growth and development of roots containing symbiotic bacteria has been demonstrated, which prevents the binding of nitrogen and the inhibition of nitrifying bacteria, e.g. in legumes (Kanchan and Jayachandra 1981, Dayama 1986 – P). Losses in yield may reach from 40% to even 90% (EPPO Report 2018 – B, see comment a05). The phenomenon of the allelopathic interaction of the species is considered to be one of the mechanisms ensuring the invasive success of the plant (Bajwa et al. 2016 – P). The species also inhibits seed setting and fruit formation in many crop plants, including, e.g., beans, peppers, tomatoes or maize (Stamps 2011 – P), and reduces the chlorophyll content in heavily infested crops (Towers and Subba Rao 1992 – P, see comment a05). Losses in horticulture and fruit farming resulting from pollen allelopathy are also recorded. *P. hysterophorus* produces a huge amount of pollen (an average of 624 million per plant). Pollen is transferred in clusters of 600-800 grains and deposited on generative parts of flowers of other plants (Control 2018 – B, Ramachandra Prasad et al. 2010 – P). The problem currently does not concern the European part of the non-native range of the species. Provided that the species is spreading in Poland and due to the crop structure, it should be assumed that the impact is high.

a21. The effect of *the species* on cultivated plant targets through **interbreeding** with related species, including the plants themselves is:

	inapplicable
X	no / very low
	low
	medium
	high
	very high

aconf17.	Answer provided with a	low	medium	high **X**	level of confidence

acomm21. Comments:

In Poland, there are no other species of the *Parthenium* genus, including cultivated species (Mirek et al. 2002, Rutkowski 2011, Tokarska-Guzik et al. 2012 – P). In the Polish literature on the subject, there is no information about intergeneric hybridization involving *Parthenium*.

a22. The effect of *the species* on cultivated plant targets by **affecting the cultivation system's integrity** is:

	very low
	low
	medium
X	high
	very high

aconf18.	Answer provided with a	low	medium **X**	high	level of confidence

acomm22. Comments:

The presence of *Parthenium hysterophorus* disturbs the integrity of crops by preventing and severely limiting the agricultural use of land as a result of intensive overgrowing and

displacement of crops (Chippendale and Panetta 1994, Navie et al. 1996, Evans 1997 – P; see comments a05 and a020). The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it can be expected that due to less favorable climatic conditions, the impact is large, but limited in space.

a23. The effect of *the species* on cultivated plant targets by hosting **pathogens or parasites** that are harmful to them is:

	very low
	low
	medium
X	high
	very high

aconf19.	Answer provided with a	low	medium	high **X**	level of confidence

acomm23. Comments:

Parthenium hysterophorus is a host for plant pathogens and crop insect pests (Basappa 2005, Govindappa et al. 2005, Prasada Rao et al. 2005, Lakshmi and Srinivas 2007 – P). Insects, including those considered to be crop pests, associated with the species both in its native and non-native range, have been extensively described (McClay et al. 1995, Evans 1997, Singh 1997 – P). The most dangerous ones from the list of the European and Mediterranean Plant Protection Organization (EPPO) have been found to include the tomato yellow leaf curl virus (TYLCV) and the *Bemisia tabaci* insect (Najberek 2018 – I). The species is the host of, e.g., the beetle *Pseudoheteronyx* sp., which is a sunflower crop pest in Australia, a parasitoid nematode in the USA (Navie et al. 1996 – P), or a large pest that is a polyphag from the *Lepidoptera* group (*Diacrisia obliqua*) in India (Evans 1997 – P). In addition, the *P. hysterophorus* is a host to the bacterial pathogen *Xanthomonas campestris* pv. *phaseoli* and thus the cause of bean disease, and also *Pseudomonas solancearum* and tomato leaf yellow curl virus in Cuba and India (Evans 1997 – P). In case of *P. hysterophorus* in India, the observations included, e.g., leaf curl and deformation, reduction of leaf size, yellowing and chlorosis of leaves and inhibition of plant growth. Pathogens were identified as tobacco leaf curl virus (TLCV), mung bean yellow mosaic (MYMV) and okra yellow vein mosaic viruses (OYVMV). All of them were transmitted by the silverleaf whitefly (*Bemisia tabaci*), a foreign species of the true bugs (*Hemiptera*) brought to Poland (Singh and Singh 1999 – P, Roques 2006, Bemisia 2009 – B, Najberek 2018 – I). It can also be a host to parasitic weeds from the *Orobanche* spp. and *Cuscuta* spp. genera in Ethiopia (CABI 2018 – B). The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it can be expected that due to the crop structure, the impact may be high.

A4c | Impact on the domesticated animals domain

Questions from this module qualify the consequences of *the organism* on domesticated animals (e.g. production animals, companion animals). It deals with both the well-being of individual animals and the productivity of animal populations.

a24. The effect of *the species* on individual animal health or animal production, through **predation or parasitism** is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf20.	Answer provided with a	low	medium	high	level of confidence

acomm24. Comments:

Parthenium hysterophorus is a plant.

a25. The effect of *the species* on individual animal health or animal production, by having properties that are hazardous upon **contact**, is:

	very low
	low
	medium
	high
X	very high

aconf21.	Answer provided with a	low	medium **X**	high	level of confidence

acomm25. Comments:

Parthenium hysterophorus has a negative impact on animal production, through its impact on animal health, as well as the quality of milk and meat (Tudor et al. 1982, Towers and Subba Rao 1992 – P). As a result of animal contact with the species through the consumption of plant fragments, there is an excessive loss of water from the body (Oudhia and Tripathy 1998 – P), acute toxicity in cattle and bitter taste of milk produced by them due to the presence of parthenin, which also demonstrates hepatotoxic nature (Gaurav et al. 2017 – P). Animal contact with the plant also results in mastitis, fever and flush in cows, and allergic bovine stomatitis. In addition, contact with the pollen of the species can cause allergic reactions, such as: dermatitis, hay fever and asthma (McFadyen 1995 – P, The Hindu 2003, Pubchem 2018 – B). If the plant is present in the animal diet, it causes dermatitis with visible skin lesions, and a significant amount of the species in the diet (10–50%) can kill cattle, buffalo and sheep within 30 days (Narasimhan et al. 1977a, 1977b, Ahmed et al. 1988, Kushwaha and Maurya 2012 – P, CABI 2018 – B). The presence of the species can also indirectly decrease animal production and generate huge losses, through overgrowing pastures and the formation of *P. hysterophorus* monocultures, which results in a reduction in the percent coverage of plant food for grazing animals or even reduction of grazing areas (CABI 2018 – B, see comment a05). The species also threatens the largest migrations of wild animals, e.g. in the protected area of the Masai Mara National Reserve in Africa (Biogeography 2018 – B). The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it should be assessed that the effect is high, however with the average degree of certainty related to the assessment of the current introduction and establishment possibilities for the analyzed species in Poland.

a26. The effect of *the species* on individual animal health or animal production, by hosting **pathogens or parasites** that are harmful to them, is:

X	inapplicable
	very low
	low
	medium
	high
	very high

aconf22.	Answer provided with a	low	medium	high	level of confidence

acomm26. Comments:

Parthenium hysterophorus is a plant, and is not a host or vector of animal parasites and pathogens.

A4d | Impact on the human domain

Questions from this module qualify the consequences of *the organism* on humans. It deals with human health, being defined as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (definition adopted from the World Health Organization).

a27. The effect of *the species* on human health through **parasitism** is:

X	inapplicable
	very low
	low
	medium
	high
	vert high

aconf23.	Answer provided with a	low	medium	high	level of confidence

acomm27. Comments:

The species is not a parasitic plant.

a28. The effect of *the species* on human health, by having properties that are hazardous upon **contact**, is:

	very low
	low
	medium
	high
X	very high

aconf24.	Answer provided with a	low	medium **X**	high	level of confidence

acomm28. Comments:

Parthenium hysterophorus has a very negative effect on human health. It causes many health problems in people, such as asthma, bronchitis, dermatitis, hay fever, allergic skin itching (irritation), cough and hemorrhage (Towers and Subba Rao 1992, McFadyen 1995, Evans 1997 – P, Control 2018 – B, see comments a05 and a33). When contacting the body, pollen causes mouth and nose swelling and itching (Gaurav et al. 2017 – P). The presence of *P. hysterophorus* patches around the villages in Africa exposes people to continuous and direct contact with the plant, which exacerbates allergic reactions, especially in people with reduced resistance to diseases such as HIV and tuberculosis, which are widespread in African populations. The biggest impact on human health was recorded in India and Australia (Sharma and Sethuraman 2007 – P), where up to 50% of the population in some regions experiences health problems caused by contact with the species. Cross–allergy (in both directions) was demonstrated between *P. hysterophorus* and ragweeds (*Ambrosia* spp.) (Towers and Subba Rao 1992, Sriramarao and Rao 1993 – P). *Ambrosia artemisiifolia* causes a serious allergy problem in Europe already, which is why cross–sensitivity with *P. hysterophorus* could exacerbate allergies. Due to the fast development rate, plants reach large sizes (up to 2 m), which can be particularly troublesome in areas generally accessible to people, e.g., on the river and stream banks, where they can hinder access to water. The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it should be assessed that its effect is extremely high, yet with the average degree of certainty related to the assessment of the current introduction and establishment possibilities for the analyzed species in Poland.

a29. The effect of *the species* on human health, by hosting **pathogens or parasites** that are harmful to humans, is:

X	inapplicable
	very low
	low

	medium
	high
	very high

aconf25.	Answer provided with a	low	medium	high	level of confidence

acomm29. Comments:

The species is a plant, it is not a vector of human parasites or pathogens.

A4e | Impact on other domains

Questions from this module qualify the consequences of *the species* on targets not considered in modules A4a-d.

a30. The effect of *the species* on causing damage to **infrastructure** is:

	very low
	low
X	medium
	high
	very high

aconf26.	Answer provided with a	low	medium **X**	high	level of confidence

acomm30. Comments:

Parthenium hysterophorus may pose a serious threat in river valleys. Residual dead plant biomass can limit or inhibit water flow, which makes the river navigability difficult, and also negatively affects the condition of hydrotechnical equipment. The species, due to the large adaptation possibilities and the habitat spectrum, can colonize land by quickly overgrowing not only cultivated areas and pastures, but also habitats near transshipment ports, along roads, roadsides and railway tracks. In these places, *P. hysterophorus* overgrows port infrastructure and passageways, and destroys their surface. Overgrowing is threatening the disturbed and transformed areas to which the species can penetrate easily and spread quickly (CABI 2018 – B, see comments a05, a06). The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it should be assessed that the effect is average, with the average degree of certainty related to the assessment of the current introduction and establishment possibilities for the analyzed species in Poland.

A5a | Impact on ecosystem services

Questions from this module qualify the consequences of *the organism* on ecosystem services. Ecosystem services are classified according to the Common International Classification of Ecosystem Services, which also includes many examples (CICES Version 4.3). Note that the answers to these questions are not used in the calculation of the overall risk score (which deals with ecosystems in a different way), but can be considered when decisions are made about management of *the species*.

a31. The effect of *the species* on **provisioning services** is:

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf27.	Answer provided with a	low	medium **X**	high	level of confidence

acomm31. Comments:

The species adversely affects ecosystem services causing large losses in yields of crops by disturbing the integrity of crops, preventing and limiting the agricultural use of land due to intensive overgrowing (e.g. due to allelopathic properties), resulting in a reduction in crop size and quality (Study 2013, EPPO Report 2018 – B, see comments a020 and a022), as well as through detrimental effects on crops through being a host to pathogens and pests of these crops (see: comment a023). At the same time, *Parthenium hysterophorus* demonstrates a negative effect on animal production, through harmful effects on animal health, as well as the quality of produced milk and obtained meat (Tudor et al. 1982, Towers and Subba Rao 1992, McFadyen 1995 – P, see comment a25). Nevertheless, the species can be perceived as a useful plant in the production of oxalic acid, biogas (see comment a08) or bioethanol (see comments a12), in which biomass could be used, e.g., as a fuel (Bharadwaja et al. 2015 – P, CABI 2018 – B, see comment a12). In its native range, the species is used as a herbal drug in the form of a decoction made from boiled roots, which supports the treatment of intestinal and dermal diseases (Dominguez and Sierra 1970 – P). The plant also has potential healing properties due to its anti–cancer (Mew et al. 1982 – P) and antiatherosclerotic effects (Sharma and Bhutani 1988 – P). The leaves of the species are also used as a green fertilizer due to allelopathic compounds contained in them, which reduce the frequency of pest occurrence in rice crops. Plants are also a potentially rich source of potassium (CABI 2018 – B). In addition, *P. hysterophorus* may also be used due to allelopathic substances as a source of insecticides, herbicides and fungicides. Plant extract deters 95% of the beetle *Callosobruchus chinensis* feeding on pea seeds, it also inhibits the growth of the bacterial pathogen *Xanthomonas axonopodis* pv. *Vesicatoria* that infects *Capsicum frutescens*, and increases the yield of silk production (CABI 2018 – B). The species can be a potential source of high quality protein used in the production of animal feed (Savangikar and Joshi 1978 – P). The problem currently does not concern the European part of the non-native range of the species. Considering the total effect of the species on supply services and the assumption that the species is spreading in Poland, it should be assessed that the impact will be moderately negative, yet with the average degree of certainty related to the assessments of the current introduction and establishment possibilities for the analyzed species in Poland.

a32. The effect of *the species* on **regulation and maintenance services** is:

X	significantly negative
	moderately negative
	neutral
	moderately positive
	significantly positive

aconf28.	Answer provided with a	low	medium **X**	high	level of confidence

acomm32. Comments:

Parthenium hysterophorus may have negative effect on regulatory services through changes in physical, chemical and biological properties of soils (Kishor et al. 2010 – P). The presence of the species also causes a long-lasting toxic effect in the soil environment, and the allelopathic compounds secreted by the plants contained in it inhibit the binding of nitrogen and nitrifying bacteria (Kanchan and Jayachandra 1981 – P). In addition, due to rapid overgrowing, they form extensive monocultures, leading to soil erosion. *P. hysterophorus* pollen is highly sensitizing, its presence in the air significantly reduces its quality. Large patches of *P. hysterophorus* can attract pollinator insects, which reduces the chance of pollination and fruit production in native plant species. Displacement of native species can affect the biotic and climatic conditions of the occupied area. *P. hysterophorus* is a host to many plant pathogens and insect crop plant pests (Study 2013, EPPO Report 2018 – B). They also have a detrimental effect on animal production through negative effect on their

	health (see comment a25). The problem currently does not concern the European part of the non-native range of the species. Assuming that the species is spreading in Poland, it should be assessed that its effect on regulatory services will be very negative, yet with the average degree of certainty associated with assessments of the current introduction and establishment possibilities for the analyzed species in Poland.

a33. The effect of *the species* on **cultural services** is:

	significantly negative
X	moderately negative
	neutral
	moderately positive
	significantly positive

aconf29.	Answer provided with a	low	medium **X**	high	level of confidence

acomm33. Comments:

The species is a threat in public places, including gardens, parks, recreational areas, roadsides, railway areas, wasteland, as well as crop areas due to its strong toxic properties (causes strong allergies) (OEPP/EPPO 2014 – P). The plant has an adverse effect on many natural herbs, which are the basis of traditional treatments for many diseases in different parts of the world (Mahadevappa et al. 2001, Shabbir and Bajwa 2006 – P). In countries where *P. hysterophorus* is an invasive species, large patches of the species may reduce the aesthetic (landscape) values of a given area (Study 2013 – B), thus reducing the tourist attractiveness of the terrain occupied by the species (EPPO Report 2018 – B). Assuming that the species is spreading in Poland, it should be assessed that its effect on cultural services will be moderately negative, yet with the average degree of certainty associated with assessments of the current introduction and establishment possibilities for the analyzed species in Poland.

A5b | Effect of climate change on the risk assessment of the negative impact of *the species*

Below, each of the Harmonia^{+PL} modules is revisited under the premise of the future climate. The proposed time horizon is the mid-21st century. We suggest taking into account the reports of the Intergovernmental Panel on Climate Change. Specifically, the expected changes in atmospheric variables listed in its 2013 report on the physical science basis may be used for this purpose. The global temperature is expected to rise by 1 to 2°C by 2046-2065.

Note that the answers to these questions are not used in the calculation of the overall risk score, but can be but can be considered when decisions are made about management of *the species*.

a34. INTRODUCTION – Due to climate change, the probability for *the species* to overcome geographical barriers and – if applicable – subsequent barriers of captivity or cultivation in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf30.	Answer provided with a	low	medium **X**	high	level of confidence

acomm34. Comments:

The species occupies subtropical regions within its native range (Kohli et al. 2006 – P). Areas with low annual precipitation below 500 mm may be not suitable for the species, however,

strong adaptation mechanisms of the plant allow it to tolerate the stress related to humidity (Kohli and Rani 1994 – P) and salinity (Hegde and Patil 1982, Khurshid et al. 2012 – P). The species also demonstrates great adaptability to climate changes (McConnachie et al. 2011 – P). Increasing the range of *P. hysterophorus* presence after climate warming was also confirmed by the CLIMEX analyses of climate models, which demonstrated that the species may threaten, e.g., the Mediterranean countries, including: Algeria, Croatia, France, Greece, Italy, Morocco, Spain, Tunisia, Turkey etc. (McConnachie et al. 2011 – P). Using the same models, it was shown that in the conditions of climate change, the invasion of the species also threatens the northern part of the African continent, the northern China and the greater part of the eastern and the northern Europe (Shabbir 2012 – P). Having considered that, assuming that in the future the temperature will increase by 1-2°C, the probability that the species will overcome barriers related to its occurrence in Poland will increase moderately.

a35. ESTABLISHMENT – Due to climate change, the probability for *the species* to overcome barriers that have prevented its survival and reproduction in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf31.	Answer provided with a	low	medium **X**	high	level of confidence

acomm35. Comments:

Assuming that in the future, the temperature will increase by 1-2°C, the probability that the species will overcome additional barriers related to its spread and reproduction in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may have a positive effect on the spread of the species. The scope of tolerance of the species in terms of preferred climatic parameters is stated in the report on the CABI website (2018 – B, see comment a34).

a36. SPREAD – Due to climate change, the probability for *the species* to overcome barriers that have prevented its spread in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf32.	Answer provided with a	low	medium **X**	high	level of confidence

acomm36. Comments:

Assuming that in the future the temperature will increase by 1-2°C, the probability that the species will overcome additional barriers related to its spread and reproduction in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017), the temperature rise may have a positive effect on the spread of the species. The scope of tolerance of the species in terms of preferred climatic parameters is included in the report on the CABI website (2018 – B, see comment a34).

a37. IMPACT ON THE ENVIRONMENTAL DOMAIN – Due to climate change, the consequences of *the species* on wild animals and plants, habitats and ecosystems in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf33.	Answer provided with a	low	medium	high **X**	level of confidence

acomm37. Comments:

It is assumed that due to climate change, the effect of the described species on wild plants and animals, as well as habitats and ecosystems in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may have a positive effect on the spread of the species. The scope of tolerance of the species in terms of preferred climatic parameters is included in the CABI report (2018 – B, see comment a34). The occurrence, establishment and spreading of *P. hysterophorus* may have negative effect on the natural environment (see comments a14, a16, a17).

a38. IMPACT ON THE CULTIVATED PLANTS DOMAIN – Due to climate change, the consequences of *the species* on cultivated plants and plant domain in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf34.	Answer provided with a	low	medium	high **X**	level of confidence

acomm38. Comments:

It is assumed that due to climate change, the effect of the described species on arable crops or plant production in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may have a positive effect on the spread of the species. The scope of tolerance of the species in terms of preferred climatic parameters is included in the CABI report (2018 – B, see comment a34). The occurrence, establishment and spreading of *P. hysterophorus* may have negative effect on plant cultivation (see comments a20, a22, a23, a35).

a39. IMPACT ON THE DOMESTICATED ANIMALS DOMAIN – Due to climate change, the consequences of *the species* on domesticated animals and animal production in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf35.	Answer provided with a	low	medium	high **X**	level of confidence

acomm39.	Comments: It is assumed that due to climate change, the impact of the described species on livestock and household animals, as well as on animal production in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may have a positive effect on the spread of the species. The scope of tolerance of the species in terms of preferred climatic parameters is included in the CABI report (2018 – B, see comment a34). The occurrence, establishment and spreading of *P. hysterophorus* may have a negative impact on animal husbandry (see comments a25, a35).

a40. IMPACT ON THE HUMAN DOMAIN – Due to climate change, the consequences of *the species* on human in Poland will:

	decrease significantly
	decrease moderately
	not change
	increase moderately
X	increase significantly

aconf36.	Answer provided with a	low	medium	high **X**	level of confidence

acomm40.	Comments: It is assumed that due to climate change, the impact of the described species on people in Poland will increase extremely. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may positively affect the spread of *P. hysterophorus*. The scope of tolerance of the species in terms of preferred climatic parameters is included in the CABI report (2018 – B, see comment a34). The occurrence, establishment and spread of *P. hysterophorus* may have negative impact on people (see comments a28, a35).

a41. IMPACT ON OTHER DOMAINS – Due to climate change, the consequences of *the species* on other domains in Poland will:

	decrease significantly
	decrease moderately
	not change
X	increase moderately
	increase significantly

aconf37.	Answer provided with a	low	medium	high **X**	level of confidence

acomm41.	Comments: It is assumed that due to climate change, the impact of the described species on other objects in Poland will increase moderately. Studies on the potential range of *P. hysterophorus* have shown that this species has favorable invasion conditions in the Mediterranean and the Black Sea areas, and in Hungary – as the location closest to Poland (McConnachie et al. 2011 – P, EPPO Report 2018 – B). As demonstrated in the study by Nguyen et al. (2017 – P), the temperature rise may positively affect the spread of *P. hysterophorus*. The scope of tolerance of the species in terms of preferred climatic parameters is included in the CABI report (2018 – B, see comment a34). The occurrence, establishment and spread of *P. hysterophorus* can have negative effects on other objects (see comments a30, a35).

Summary

Module	Score	Confidence
Introduction (questions: a06-a08)	0.33	1.00
Establishment (questions: a09-a10)	0.50	0.50
Spread (questions: a11-a12)	0.88	0.50
Environmental impact (questions: a13-a18)	0.70	0.60
Cultivated plants impact (questions: a19-a23)	0.45	0.80
Domesticated animals impact (questions: a24-a26)	1.00	0.50
Human impact (questions: a27-a29)	1.00	0.50
Other impact (questions: a30)	0.50	0.50
Invasion (questions: a06-a12)	0.57	0.67
Impact (questions: a13-a30)	1.00	0.58
Overall risk score	0.57	
Category of invasiveness	very invasive alien species	

A6 | Comments

This assessment is based on information available at the time of its completion.. However, it has to be taken into account that biological invasions are, by definition, very dynamic and unpredictable. This unpredictability includes assessing the consequences of introductions of new alien species and detecting their negative impact. As a result, the assessment of the species may change in time. For this reason it is recommended that it is regularly repeated.

acomm42. Comments:

Santa Maria feverfew weed originates from the subtropical regions of North, Central and South America. It is an invasive species in many regions of the world – in Africa, Asia, Australia, and eastern North America. It poses a great threat to biodiversity and leads to degradation of natural ecosystems and irreversible changes in various habitats (including grasslands, forests, river banks and flood plains). The species competes with native species and displaces them. It affects pastures and crops, allelopathically affecting crop plants. It contains toxic compounds that can cause cattle death. Human and animal contact with the *Parthenium hysterophorus* may cause allergic diseases and its pollen is sensitizing. Cross-allergy (in both directions) between *P. hysterophorus* and ragweeds (*Ambrosia* spp.) has also been demonstrated.

After the risk assessment for Poland, whitetop weed was included in the category – "very invasive alien species", with the highest total score of negative effect (questions a13–a30). The obtained result of the effect assessment is based on the data from other regions of the non-native range of this species. The maximum score refers to the modules: 'Influence on animal husbandry' (1.00, questions: a24–a26) and 'Impact on humans' (1.00; questions: a27–a29); the result for the 'Impact on the natural environment' module (questions a13–a18) amounted to 0.70, which entitles to classify the species according to the category 'very high' and 'high' effect category.

In Poland, Santa Maria feverfew is designated with ephemerophyte status – a foreign species, brought temporarily, not permamently established, and eliminated mainly due to climate factors. In our country, it only appeared in Szczecin at the landfill in the 1930s, and nowadays, there is no information about its occurrence in Poland.

However, it is not possible to rule out periodic occurrence of individuals of this species in

Poland. *Parthenium hysterophorus* can be confused with plants of the *Ambrosia* genus, especially in the vegetative phase. Due to the currently unconfirmed presence of the species in the neighboring countries, the probability of the species appearing in the natural environment of Poland as a result of independent expansion after being introduced outside the area of Poland earlier is low. In turn, taking into account the possible vectors for bringing the diaspores of this species, the probability of its introduction into the natural environment of Poland due to unintended human activities was assessed as quite high. At the same time, the threat associated with the potentially high outflow of the species to the above-mentioned spheres (domains) indicates the validity of the principles of prevention and precaution in its case.

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