European and Mediterranean Plant Protection Organization
Organisation Européenne et Méditerranéenne pour la Protection des Plantes

11-16828

PEST RISK ANALYSIS FOR : *Ludwigia peploides*

A Draft PRA had been prepared by Mr Guillaume Fried, and the Expert Working Group was attended by the following experts:
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Flower of *Ludwigia peploides,* by Franck Billeton

Stage 1: Initiation

1 - Give the reason for performing the PRA

Identification of a single pest

L. peploides is widespread and invasive in the South-East and West of France and its distribution is still very limited in Belgium, Corsica, Greece, Italy, the Netherlands, Spain, Turkey, and the UK where invasions are at an early stage. The species could spread to further EPPO countries and have negative impacts on agriculture and the environment.

1b - If other reason, specify

2a - Enter the name of the pest
Pest name (what you enter here will appear as a heading)
Ludwigia peploides (Kunth) P.H. Raven

The identification of *Ludwigia* species of the section *Oligospermum* s.l. has always been very difficult and resulted in unending taxonomic changes and inextricable synonymy (Dandelot *et al*., 2005a). The *L. uruguayensis* complex comprises a decaploid entity (2*n* = 80) and a hexaploid one (2*n* = 48), differing by quantitative, intergrading morphological features, known to produce hybrids of intermediary morphology in regions of sympatry (Nesom & Kartesz, 2000).

Ludwigia peploides is ressembling and often confused with *L. grandiflora*, which often occur together in countries. Publications therefore often mention "*Ludwigia* spp.".

2b - Indicate the type of the pest
Non parasitic plant

Perennial aquatic freshwater plant (amphibious hydrophyte, macrophyte).

2c - if other, specify

2d - Indicate the taxonomic position
Kingdom: Plantae
Class: Magnoliopsida (Dicotyledons)
Subclass: Rosidae
Order: Myrtales
Family: Onagraceae

3 - Clearly define the PRA area
The EPPO region.

4 - Does a relevant earlier PRA exist?
Yes

An EPPO Pest Risk Analysis has been performed for *Ludwigia grandiflora*. Reference will often be made to the PRA for *L. grandiflora* in the current PRA.

Plant assessment forms have been produced in California for *Ludwigia peploides* subsp. *montevidensis* (Trumbo & DiTomaso, 2004) using the Criteria for Categorizing Invasive Non-Native Plants that Threaten Wildlands (Warner *et al*., 2003).

A risk assessment has also been carried out for Great Britain for *L. grandiflora, L. hexapetala* and *L. peploides* (DEFRA, 2008).

5 - Is the earlier PRA still entirely valid, or only partly valid (out of date, applied in different circumstances, for a similar but distinct pest, for another area with similar conditions)?
Not entirely valid

5b - Explain

The EPPO PRA for *Ludwigia grandiflora* has broad similarities to this PRA, and where necessary is referred to.

6 - Specify all host plant species (for pests directly affecting plants) or suitable habitats (for non parasitic plants). Indicate the ones which are present in the PRA area.

In its native range, *L. peploides* is reported in wetlands (Rolon *et al*., 2008), in the transition zone-between aquatic and terrestrial environments (Hernandez & Rangel, 2009).
Establishment of *L. peploides* often occurs on mud in open areas of wetlands subject to fluctuating water levels (natural or managed); in disturbed marginal habitats subject to grazing, i.e. meadows (cattle, wild geese) or management. The latter can include sites where restoration for conservation or reinstatement of aquatic habitats occurs, especially where the margins have a gradual slope.
Suitable habitats include wet margins of ponds and lakes, static or slow-flowing waters, rivers, shallow ponds and lakes, canals, oxbow lakes, wetlands, ditch networks. It is also found on sediment bars on river borders and in wet meadows (Laugareil, 2002 ; Zotos *et al*., 2006), and can also colonize brackish waters (Mesleard & Perennou, 1996).

7 - Specify the pest distribution

Native range :
- Central America: Cuba, Costa Rica, Dominican Republic, El Salvador, Guatemala, Haiti; Honduras, Jamaica, Nicaragua; Panama, Puerto Rico .
- **South America**: Argentina, Bolivia, Brazil, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela,
Note: *L. peploides* in Argentina is known to occur in Buenos Aires, Corrientes, Entre Rios, Formosa, Mendoza, Salta, Santa Fe, Tucuman.
- **North America** : United States (Alabama, Arkansas, California, Florida, Georgia, Indiana, Illinois, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Nebraska, North Carolina, Oklahoma, , South Carolina, Tennessee, Texas), Mexico.
Note: The EWG considered the proliferation of subspecies and varietal names in North America associated with supposed native status to be unhelpful. However, it is clear that *L. peploides* is probably native to most States where it is found in North-America.

Introduced Range :
EPPO Region: Belgium (Branquart *et al.,* 2010), France (Dutartre *et al.*, 2007) including Corsica (Jeanmonod & Schlüssel, 2007), Greece (Zotos *et al*., 2006), Italy (Celesti-Grapow *et al*., 2009), the Netherlands (Holverda *et al*. 2009), Spain (Verloove & Sánchez Gullón, 2008), Turkey (near Antalya) (Güner *et al*., 2000), the UK (BSBI, 2011).
Australasia: Australia (New South Wales, Northern Territory, Queensland, South Australia, Victoria) (Richardson *et al*., 2007; Australia's Virtual Herbarium, 2011), New Zealand (north island) (Webb *et al*., 1988; Roy *et al*., 2004).
Africa: Madagascar (GBIF Portal, 2011)
Asia: Thailand, Taiwan (GBIF Portal, 2011).

In Belgium
L. peploides was first observed in Belgium in 1995 (Branquart *et al*., 2010), and has established isolated populations in Flanders.

In France
L. peploides and *L. grandiflora* are very widespread in hundreds of sites in Southern and Western France and more recently recorded spreading in some sites in North and East of France (Dutartre, 2004a, see map in Appendix 1).

In Corsica, *L. peploides* has been found in another site, near the golf course of Lezza where it is cultivated for ornamental purposes. The species grows in the river, and has not outcompeted the existing vegetation, probably because the water course is only temporary, not allowing the species to exhibit invasive behavior (Jeanmonod & Schlüssel, 2007).

In Greece

L. peploides was recorded in 2001 in western Greece in 3 localities of the lake Lysimachia, covering a very small area (0.7 ha), representing a population of 10 000 individuals.

In Italy

The species occurs in Lombardia and is even considered as invasive in the provinces of Cremona and Lodi (Banfi & Galasso, 2010). The species is also reported in Emilia-Romagna, and was first recorded in Italy in 2004 by Petraglia and Antoniotti (Galasso & Bonali, 2007)

In the Netherlands

In the Netherlands, *L. peploides* was found in 4 sites, the first offical records are dated 2007 (but further analyses highlighted that plants identified as *L. grandiflora* were indeed *L. peploides*, J van Valkenburg, pers. comm., 2011). It disappeared from one site without any action. It was successfully removed from another site by the water board. A third infestation covering several hundred square meters was removed in 2007, and regrowth has not been observed since (June 2010). One other site is under management (Proosdij & van Valkenburg, in prep.).

In Spain

According to Verloove & Gullon (2008), *Ludwigia peploides* has been recorded to be well naturalized at various localities along river El Llobregat in the province of Barcelona, and it also recorded in La Selva del mar in the Province of Gerona.

In the UK

In the UK, the species was reported to be present in 3 locations in Southern Great Britain in 2006 (DEFRA, 2006).

Stage 2: Pest Risk Assessment - Section A : Pest categorization

init - -

Go to main Pest Risk Assessment

L. peploides has been considered as having high impact on agriculture and the environment by the EPPO prioritization process (Description of the EPPO priotization process Brunel *et al*., 2010).

Stage 2: Pest Risk Assessment - Section B : Probability of entry of a pest

1.1 - Consider all relevant pathways and list them (one by line)

Relevant pathways are those with which the pest has a possibility of being associated (in a suitable life stage), on which it has the possibility of survival, and from which it has the possibility of transfer to a suitable host. Make a note of any obvious pathways that are impossible and record the reasons.

There are broad similarities in answers to this question in the PRA for *L. grandiflora*, but see the additional comments below:

Intentional import as an ornamental aquatic plant for use outdoors:

As for *L. grandiflora*, the plant is considered to be introduced as an ornamental aquatic plant. There is no data available on numbers of the species imported, but the species is still sold in EPPO countries, in most cases under misapplied names such as *Jussiaea* or *Ludwigia grandiflora* (Dandelot, 2004). The species is already present in Belgium, France, Greece, Italy, Spain, Turkey, the Netherlands, and theUK .

Although regulated in some countries, the probability of entry of intentional import as an ornamental aquatic plant for use outdoors is very likely, as the species already entered the EPPO region, and continues to enter.

Other pathways that are not considered as relevant

Intentional import for non ornamental uses

Ludwigia peploides was recorded to have potential for wastewater treatment, as its nitrogen-absorbing capabilities were reported to exceed those of *Eichhornia crassipes* (Bouldin *et al*., 2006 ; Rejamánková, 1992). Measurements of nitrogen concentrations in invaded sites have not shown any bioremediation potential (experiments described in Dandelot, 2004). There is no evidence of substantial nitrogen reduction in the EPPO region with the use of this species.

There is no information on this pathway for the EPPO region, and it is not considered further in this assessment.

- Contamination of other deliberately planted aquatic plants (e.g. water lilies)

Maki & Galatowitsch (2004) highlighted that some invasive aquatic plants enter Minnesota (USA) as contaminants of other traded ornamental plants. *Ludwigia* spp. were not recorded as contaminants of other ornamental plants, and the risk associated to this pathway is considered minor and is not considered further.

- Natural and human assisted spread are considered in the dedicated section

L. grandiflora can spread either naturally with water currents or assisted by human activities through shipping, angling, etc. Such spread is not considered as a pathway of entry and is considered in the dedicated section (Q 1.32 and 1.33).

Stage 2: Pest Risk Assessment - Section B : Probability of establishment

1.15 - Estimate the number of host plant species or suitable habitats in the PRA area.

Moderate number

Level of uncertainty : low

The same habitats are colonized as for *L. grandiflora,* see the PRA for *Ludwigia grandiflora*.

In Greece, Zotos *et al.* (2006) noted that *L. peploides* is recorded in reed vegetation and in wet meadows.
In Turkey, the species occurs in a single wetland site (Güner *et al*., 2000).

1.16 - How widespread are the host plants or suitable habitats in the PRA area? (specify)
Very widely
Level of uncertainty : low

See PRA for *Ludwigia grandiflora*.

1.17 - If an alternate host or another species is needed to complete the life cycle or for a critical stage of the life cycle such as transmission (e.g. vectors), growth (e.g. root symbionts), reproduction (e.g. pollinators) or spread (e.g. seed dispersers), how likely is the pest to come in contact with such species?
Very likely
Level of uncertainty : low

As *L. grandiflora, L. peploides* is pollinated by different insects (bees, beetle, etc.) which are widely present in the EPPO region (Dandelot, 2004). No other species is needed to complete the life cycle of the plant.

See PRA on *L. grandiflora.*

1.18a - Specify the area where host plants (for pests directly affecting plants) or suitable habitats (for non parasitic plants) are present (cf. QQ 1.15-1.17).
This is the area for which the environment is to be assessed in this section. If this area is much smaller than the PRA area, this fact will be used in defining the endangered area.

The EPPO region.

1.18b - How similar are the climatic conditions that would affect pest establishment, in the PRA area and in the current area of distribution?
Moderately similar
Level of uncertainty : medium

Ludwigia peploides has already established in several EPPO countries (Belgium, France, Italy, Greece, the Netherlands, Spain, Turkey and the UK).

L. peploides is most widespread in France, and particularly in the South-East and to a lesser extent in the West of the country. Compared to *L. grandiflora*, there are fewer observations in the North of the country but some populations are established there as well (Dutartre, 2004).
Although in Europe the species, according to its distribution seems to be less cold tolerant, in the USA, the species occurs further north in Iowa, Nebraska, Ohio, Illinois and Indiana, suggesting that the species may be more resistant to cold temperatures there.
The species is already present in 8 countries of the EPPO region, either in the Mediterranean, Atlantic or continental bioregions, there is therefore no doubt that the species is able to establish.
As an approximation, given the lack of accurate data on the thermal requirements of the species, it is extrapolated that the species may establish in the same places as *L. grandiflora* (see the PRA on *Ludwigia grandiflora*).

Different biogeographical regions of the EPPO region are considered to be suitable for the establishment of

L. peploides:
The Mediterranean basin: Albania, Algeria, Bosnia & Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Israel, Italy, Jordan, Montenegro, Morocco, Spain, Republic of Macedonia, Romania, Tunisia, Turkey, Slovenia
Atlantic Western Europe: Belgium, France, Ireland, the Netherlands, Portugal, the UK are susceptible to establishment of this species.
Continental Europe and other parts of Europe (but for which the ecoclimatic index of the species is lower): Austria, Azerbaijan, Czech Republic, Denmark, North-Western Germany, Hungary, Luxembourg, South-Western coast of Norway, Poland, Serbia, Slovakia, Sweden, North Western Switzerland, Russia, Ukraine (Black Sea region).

The EWG considered that the CLIMEX map for *L. grandiflora* predicts quite accurately the range at high risk from this species on the basis of the current distribution of the species. This map is to be taken as an indication of the potential distribution of the species only. Indeed, there is a lack of data on cold tolerance of *L. grandiflora*, and it is possible that the species could establish in countries with more continental climates. The areas where establishment is considered unlikely may be overestimated by CLIMEX. Because of the early stage of some invasions (e.g. in Belgium, in the Netherlands), it is not possible to use the climate data for the current range to predict the entire area at risk (see the PRA for *L. grandiflora*).
Thermal ponds or waters with artificially raised temperatures may be additional suitable habitats in countries that are not identified as having suitable overall climates.

1.19 - How similar are other abiotic factors that would affect pest establishment, in the PRA area and in the current area of distribution?
Completely similar
Level of uncertainty : low

See PRA for *L. grandiflora.*
Relative Growth Rate (RGR) of *L. peploides* was up to 0.064±0.006 d^{-1} under experiments, with a minimum at 0.030±0.005 d^{-1} on drained surface with low nutrient availability (Hussner, 2010).

Differences are noted for the salinity tolerance of *L. peploides*
L. peploides can grow in brackish waters of the Camargue, with salt concentrations of about 10 g/L (e.g., at the mouth of the Rhône) (Mesleard & Perennou, 1996).

1.20 - If protected cultivation is important in the PRA area, how often has the pest been recorded on crops in protected cultivation elsewhere?
N/A
Level of uncertainty : low

1.21 - How likely is the pest to establish despite existing pest management practice?
Very likely
Level of uncertainty : low

See PRA on *Ludwigia grandiflora.*

1.22 - To what extent is the managed environment in the PRA area favourable for establishment?
Very highly favourable
Level of uncertainty : low

See PRA for *Ludwigia grandiflora*.

1.23 - How likely is it that existing pest management practice will fail to prevent establishment of the pest?

Very likely

Level of uncertainty : low

As *L. grandiflora*, *L. peploides* has a high regeneration capacity with the ability to form new shoots from single nodes (Dandelot, 2004). See PRA for *Ludwigia grandiflora*.

1.24 - Based on its biological characteristics, how likely is it that the pest could survive eradication programmes in the PRA area?

Likely

Level of uncertainty : low

Eradication is very difficult or even impossible in water bodies with heavy infestations. Local eradication is possible if it is started early and the water body is reasonably accessible (Grillas, 2004). In France eradication is not possible. Elsewhere where the species is still of limited distribution, and in small isolated water bodies, eradication is possible.

For a description of eradication actions of *Ludwigia* spp. in France and the UK, refer to the PRA on *L. grandiflora*.

In the Netherlands, *L. peploides* was found in 4 sites and disappeared from one site without any action. It was successfully removed from another site by the water board. A third infestation covering several hundred square meters was removed in 2007, and regrowth has not been observed since (June 2010). One other site is under management (Proosdij & van Valkenburg, in prep.).

1.25 - How likely is the reproductive strategy of the pest and the duration of its life cycle to aid establishment?

Very likely

Level of uncertainty : low

Life cycle

The species has a high growth rate, and several overwintering strategies (e.g. seeds, persistent vegetative material) (Dutartre *et al*., 2007).

Vegetative reproduction

See PRA on *L. grandiflora*.

Vegetative reproduction and regeneration capacity are very efficient with new shoots formed from small fragments of stems of only a few centimeters including a node (Dandelot, 2004). Dandelot (2004) noted under controlled conditions that *L. peploides* had a lower vegetative regeneration capacity than *L. grandiflora*. Nevertheless, *L. peploides* is reported to be able to regenerate 67% of its initial biomass in just 45 days after 95% of above ground biomass was removed (Rejmánková, 1992).

Strategy for survival

Survival strategies include perennial vegetative tissues and prolific seed production (Ruaux, 2009). Ruaux (2009) notes that the germinative capacity of seeds of *L. peploides* seems to be higher than for *L. grandiflora*. Variability is nevertheless also dependent upon the site invaded.

The adventitious roots are capable of absorbing atmospheric oxygen, allowing the plant to tolerate anaerobic conditions (Rejmánková, 1992).

Sexual reproduction

This species is very fertile and each fruit contains about 60 seeds of about 1.5 mm in length. One metre square of *L. peploides* produces between 10 000 and 14 000 seeds which are viable for between 2 and 3 years in air (Dandelot, 2004). Their longevity when present in aquatic sediments is unknown, but seeds germinate in the dark and in anoxic conditions. Germination rates are known to be extremely variable (Ruaux, 2008). In the Loire river in France, seed viability was found to be significantly higher in *L. peploides* (82-87%) than in *L. grandiflora* (48-58%) (Ruaux *et al*., 2009).

1.26 - How likely are relatively small populations to become established?
Very likely
Level of uncertainty : low

The EWG considered that founder populations probably have low genetic diversity (due to small initial import numbers and propagation by cuttings, etc.), but that small populations are very likely to become established. The main mean of dispersal of *Ludwigia peploides* is vegetative reproduction by fragmentation, with small fragments of a few cm with a single node capable of forming new plants.

1.27 - How adaptable is the pest? Adaptability is:
High
Level of uncertainty : low

L. peploides is considered to be as adaptable as *L. grandiflora* (see PRA on *L. grandiflora*).

1.28 - How often has the pest been introduced into new areas outside its original area of distribution? Specify the instances if possible in the comment box.
Very often
Level of uncertainty : low

L. peploides has been introduced independently in Belgium, France including Corsica, Greece, the Netherlands, Italy, Spain, Turkey and the UK.
The plant has been introduced in other continents: North America (to States where the species is not native), Asia, Africa and Australasia.

1.29a - Do you consider that the establishment of the pest is very unlikely ?
No

Establishment of the pest has already occurred in 8 countries of the EPPO region.

1.29b - How likely are transient populations to occur in the PRA area through natural migration or entry through man's activities (including intentional release into the environment)?

1.29c - The overall probability of establishment should be described.

The pest has already established in at least 8 countries of the EPPO region, the probability of establishment is therefore very high.
Different biogeographical regions of the EPPO region are considered to be suitable for the established of *L. peploides*:
The Mediterranean basin: Albania, Algeria, Bosnia & Herzegovina, Bulgaria, Cyprus, Croatia, Greece, Israel, Italy, Jordan, Montenegro, Morocco, Spain, Republic of Macedonia, Romania, Tunisia, Turkey, Slovenia

Atlantic Western Europe: Belgium, France, Ireland, the Netherlands, Portugal, the UK are susceptible to establishment of this species.
Continental Europe and other parts of Europe (but for which the ecoclimatic index of the species is lower): Austria, Azerbaijan, Czech Republic, North-western of Germany, Denmark, Hungary, Luxembourg, North western Switzerland, South-Western coast of Norway, Poland, Serbia, Slovakia, Sweden, Russia, Ukraine (Black Sea region).

The EWG considered that the CLIMEX map predicts quite accurately the range at high risk from this species on the basis of the current distribution of the species. This map is to be taken as an indication of the potential distribution of the species only. Indeed, there is a lack of data on cold tolerance of *L. grandiflora*, and it is possible that the species could establish in countries with more continental climates. The areas where establishment is considered unlikely may be overestimated by CLIMEX. Because of the early stage of some invasions (e.g. in Belgium, in the Netherlands), it is not possible to use the climate data for the current range to predict the entire area at risk.
Thermal ponds or waters with artificially raised temperatures may be additional suitable habitats in countries that are not identified as having suitable overall climates.

Stage 2: Pest Risk Assessment - Section B : Probability of spread

1.30 - How likely is the pest to spread rapidly in the PRA area by natural means?
Moderately likely
Level of uncertainty : medium

L. peploides probably has the same natural dispersal mechanism as *L. grandiflora*. See PRA for *L. grandiflora*.
Fruits of *L. peploides* float for no more than 1.5 months (Ruaux, 2008), which is less than for *L. grandiflora*, but the EWG considered that it is still sufficient for long distance dispersal.

In Turkey, the first outbreak of *L. peploides* has been recorded in 1998 near Antalya, and there is no evidence of spread to new sites, either locally or anywhere else in the country (Güner *et al*., 2000).

In France, the species is very widespread in the South-East, and there are new occurrences in the North and East of the country (Dutartre, 2004). The mechanism of spread responsible for new isolated occurrences has not been fully identified. In numerous sites, it is considered that the species was accidentally introduced through human activities.

1.31 - How likely is the pest to spread rapidly in the PRA area by human assistance?
Likely
Level of uncertainty : low

L. peploides has probably the same human helped dispersal capacity as *L. grandiflora*. See PRA for *L. grandiflora*.
In Camargue (France), Aznar *et al*. (2003) report that the canal network seems to facilitate dispersal of *L. peploides* between marshes.

The EWG considered that as volumes of *L. peploides* in trade are assumed to be very much lower than for *L. grandiflora*, the risk of accidental contamination of other pond plants is likewise reduced.

Information on trade of *L. peploides* into some EPPO countries is as follows:

The Netherlands
In the Netherlands a Code of conduct has been signed by the "Unie van Waterschappen" on behalf of all 26 local water boards of the Netherlands, the Ministry of Agriculture, Nature and Food safety, as well as umbrella organisations and various associations representing producers, importers, retailers and garden centres such as DIBEVO, Tuinbranche Nederland, De Nederlandse Bond van Boomkwekers, De Vereniging van Vasteplantenkwekers. Several individual importers and producers of aquatic plants also signed the Code of conduct. The signatories have agreed to refrain from selling several invasive aquatic plants (incl. *L. grandiflora* and *L. peploides*) in the Netherlands as of 1st January 2011. Before the implementation of this Code of conduct, *L. grandiflora* and *L. peploides* could be found in almost any garden centre (J. van Valkenburg, Plant Protection Service, The Netherlands, pers. comm., 2010).

Other countries
In France, sale of *L. peploides* is forbidden, and the EWG could not find retailers through an internet search, but the species could be traded under different names.
In Germany, although sale is not banned, the plant is not widely available in trade.
In the UK, all sales of *Ludwigia* spp. for outdoors use are labeled as either *L. grandiflora* or *J. grandiflora*. However, sales of *L. peploides* under these names cannot be excluded (J. Newman, Waterland Management Ltd, United Kingdom, pers. comm., 2010).

As a conclusion for trade of *L. peploides*, the EWG considered that the volumes in trade are likely to be smaller than for *L. grandiflora*. Nevertheless, the risk of human transplantation from an infested site to another site is equal.

Since *L. peploides* is introduced intentionally as an ornamental plant and is probably still for sale in garden centres in some parts of Europe and since exchanges between gardeners and deliberate transplantation by human activity also occur, the probability of spread to areas of the EPPO region where it is currently not present is high. Where present, the probability of short distance spread is very high as vegetative spread is very effective for local colonization. Human activity is principally responsible for long distance spread. The risk of spread through management practices and accidental spread through recreational activities is the same as for *L. grandiflora*.

1.32 - Based on biological characteristics, how likely is it that the pest will not be contained within the PRA area?

Moderately likely

Level of uncertainty : high

The ability to contain the pest is considered to be the same as for *L. grandiflora*. See PRA on *L. grandiflora.* The EWG considered that maintenance of a constant water level may reduce the opportunity for spread within sites and reduce the opportunity for significant spread to new sites.

1.32c - The overall probability of spread should be described.

The overall probability of spread is high, uncertainty is medium.
In some situations, *L. peploides* did not spread. Indeed, in Corsica, near the golf course of Lezza where it is cultivated for ornamental purposes, the species grows in the river, and has not outcompeted the existing vegetation, probably because the water course is only temporary, not allowing the species to exhibit invasive behavior. In Turkey, the first outbreak of *L. peploides* has been recorded in 1998 near Antalya, and there is no evidence of spread to new sites, either locally or anywhere else in the country).

Stage 2: Pest Risk Assessment - Section B : Conclusion of introduction and spread and identification of endangered areas

1.33a - Conclusion on the probability of introduction and spread.

Since *L. peploides* is introduced intentionally as an ornamental plant and is still for sale in some parts of Europe (e.g. France) (see Q. 1.31) and since exchanges between gardeners may occur, the probability of introduction to areas of the EPPO region where it is currently not present is high. Direct sale and internet sale within and from other countries clearly provides the greatest risk for spread within the EPPO region.
L. peploides has already established in at least 8 countries of the EPPO region, the probability of establishment is therefore very high.
Different biogeographical regions of the EPPO region are considered to be suitable for the established of *L. grandiflora*:
The Mediterranean basin: Albania, Algeria, Bosnia & Herzegovina, Bulgaria, Cyprus, Croatia, Greece, Israel, Italy, Jordan, Montenegro, Morocco, Spain, Republic of Macedonia, Romania, Tunisia, Turkey, Slovenia
Atlantic Western Europe : Belgium, France, Ireland, the Netherlands, Portugal, the UK are susceptible to establishment of this species..
Continental Europe and other parts of Europe (but for which the ecoclimatic index of the species is lower): Austria, Azerbaijan, Czech Republic, Denmark, North-Western Germany, Hungary, Luxembourg, South-Western coast of Norway, Poland, Serbia, Slovakia, Sweden, North Western Switzerland, Russia, Ukraine (Black Sea region) (see maps in Appendix 3).
L. peploides is capable of growing in a wide range of aquatic environments. It possesses inherent characteristics enabling rapid vegetative spread between connected water bodies. Where present, the probability of short distance spread is very high as vegetative spread is very effective for local colonization. Human activity is principally responsible for long distance spread.
The presence of *L. peploides* in some EPPO countries and its capacity for vigorous growth favours its spread to neighbouring countries, although in some situations the species did not express high spread capacities (e.g. in Corsica, in Turkey).

1.33b - Based on the answers to questions 1.15 to 1.32 identify the part of the PRA area where presence of host plants or suitable habitats and ecological factors favour the establishment and spread of the pest to define the endangered area.

The endangered area consists of wet margins of ponds and lakes, static or slow-flowing waters, rivers, shallow ponds and lakes, canals, oxbow lakes, wetlands, ditch networks,sediment bars on river borders, wet meadows, brackish waters where climatic conditions are suitable.
Aquatic habitats of the Mediterranean and Atlantic Western countries of the EPPO region are considered the most at risk (excluding water bodies in the Mediterranean area that dry out during summer) and Continental Europe is also considered at risk.

Stage 2: Pest Risk Assessment - Section B : Assessment of potential economic consequences

2.1 - How great a negative effect does the pest have on crop yield and/or quality to cultivated plants or on control costs within its current area of distribution?

Major

Level of uncertainty : low

The negative impact on crop yield and/or quality to cultivated plants or on control costs is expected to be the same as for *L. grandiflora.* Most data were gathered in France, where the 2 species are present and it is difficult to separate the impacts of each species in these situations.
While the impacts on crop yields and/or quality to cultivated plants are minor, the control costs are major.
See the PRA for *L. grandiflora.*

2.2 - How great a negative effect is the pest likely to have on crop yield and/or quality in the PRA area without any control measures?

Minor

Level of uncertainty : low

The impacts of *L. peploides* on crop yield and quality in the EPPO region is probably restricted to loss of grazing areas in wet meadows, as for *L. grandiflora*. See PRA for *L. grandiflora*.

2.3 - How easily can the pest be controlled in the PRA area without phytosanitary measures?

With much difficulty

Level of uncertainty : low

Same answer as for *L. grandiflora*. See the PRA on *L. grandiflora.*

2.4 - How great an increase in production costs (including control costs) is likely to be caused by the pest in the PRA area?

Major

Level of uncertainty : low

Unit area control costs would be similar to those already spent in infested parts of the PRA area (see Q. 2.1 of the PRA for *L. grandiflora*).

2.5 - How great a reduction in consumer demand is the pest likely to cause in the PRA area?

Minimal

Level of uncertainty : low

Not relevant

2.6 - How important is environmental damage caused by the pest within its current area of distribution?

Major

Level of uncertainty : low

Environmental impacts are the same as for *L. grandiflora*.
See PRA on *L. grandiflora*.

In Greece, *L. peploides* occurs in the lake Lysimachia which constitutes one of the proposed sites of community interest included in the European Ecological network Natura 2000 of Greece (Zotos *et al*., 2006).

2.7 - How important is the environmental damage likely to be in the PRA area (see note for question 2.6)?

Major

Level of uncertainty : low

Environmental impact is assumed to be the same wherever the species grows in suitable conditions.

2.8 - How important is social damage caused by the pest within its current area of distribution?

Moderate

Level of uncertainty : low

The social impacts are expected to be the same as for *L. grandiflora*. See PRA on *L. grandiflora.*

2.9 - How important is the social damage likely to be in the PRA area?

Moderate

Level of uncertainty : low

Social impact is assumed to be the same wherever the species grows in suitable conditions.

2.10 - How likely is the presence of the pest in the PRA area to cause losses in export markets?

Impossible/very unlikely

Level of uncertainty : low

Not relevant.

2.16a - Conclusion of the assessment of economic consequences

Ludwigia peploides causes significant problems in areas where it has been introduced. It is considered as invasive in France (including Corsica), and potentially invasive in the Netherlands, in Belgium, in the UK, in Italy, in Spain, in Greece and in Turkey. According to Dandelot (2005b), it can be defined as a ‘‘transformer’’ species *sensu* Richardson *et al*. (2000).

In France, *Ludwigia peploides* has several types of impacts (Dutartre, 2004) :

- Changes in physical characteristics of waterbodies: a reduction in water flow causing problems to irrigation or drainage, accelerated sedimentation or accumulation of litter ;
- Local reduction in biodiversity: the species forms monospecific stands that outcompete indigeneous aquatic freshwater plants, and impact animal species;
- Chemical quality of water: dissolved oxygen fall under 1 mg/L, pH decreases
- Social impact: dense stands of *L. peploides* prevent several activities such as hunting, fishing, water sports, etc. Dense mats can create favorable conditions for mosquito development, as well as increased risks of flooding.

2.16 - Referring back to the conclusion on endangered area (1.33) :
Identify the parts of the PRA area where the pest can establish and which are economically most at

risk.

Suitable habitats include wet margins of ponds and lakes, static or slow-flowing waters, rivers, shallow ponds and lakes, canals, oxbow lakes, wetlands, ditch networks, sediment bars on river borders, in wet meadows and in brackish waters where climatic conditions are suitable.
Establishment of *L. peploides* often occurs on mud in open areas of wetlands subject to fluctuating water levels (natural or managed); in disturbed marginal habitats subject to grazing (cattle, geese) or management. The latter can include sites where restoration for conservation or reinstatement of aquatic habitats occurs, especially where the margins have a gradual slope.
Aquatic habitats of the Mediterranean and Atlantic Western countries of the EPPO region are considered the most at risk (excluding water bodies in the Mediterranean area that dry out during summer) and Continental Europe is also considered at risk.

Stage 2: Pest Risk Assessment - Section B : Degree of uncertainty and Conclusion of the pest risk assessment

2.17 - Degree of uncertainty : list sources of uncertainty

The overall uncertainty of the assessment is low, owing to the very detailed information available in France.

The areas of uncertainty identified are the following:
- volume in trade ;
- natural spread by waterfowl (see PRA on *L. grandiflora*) ;
- the extent of human assisted spread via contaminated equipment or deliberate planting ;

Further areas of research to be investigated:
- the possible use of a biological control agent ;
- tolerance of anoxia (vegetative material and seed) ;
- effects of water level on potential establishment and spread ;
- critical density of competitive tall helophytes.

2.18 - Conclusion of the pest risk assessment

Short summary on pest:
Ludwigia peploides is a perennial aquatic plant which forms very dense (almost impenetrable) mats. …

Entry, pathways:
Intentional import as an ornamental aquatic plant for use outdoors

Establishment:
L. peploides has already established in at least 8 countries of the EPPO region, the probability of establishment is therefore very high.
According to the climatic prediction, additional countries are at risk.

Spread:
The overall probability of spread is high, uncertainty is medium.

Economic impacts: major impacts considering the management cost, low uncertainty. Any economic benefit of the introduction of this plant as an ornamental aquatic plant is heavily outweighed by management costs.
Environmental impacts: major, low uncertainty. Invasion of slow flowing waters, loss of biodiversity degradation and modification of aquatic ecosystem including protected habitats.
Social impact: moderate, with low uncertainty. Where it occurs, it has an impact on recreational activities, it can even create favorable conditions for mosquito development, increased risk of flooding.
The part of the EPPO region which seem the most economically at risk are the Atlantic and Mediterranean areas, as well as the Black sea area.

The risk of establishment of *Ludwigia peploides* in aquatic habitats, and negative impacts on their vegetation and use, justifies measures to prevent its further spread in the EPPO region.
The pest qualifies as a quarantine pest.

Stage 3: Pest Risk Management

The conclusions of the Pest Risk Management are the same as for *L. grandiflora.* See PRA on *L. grandiflora*.

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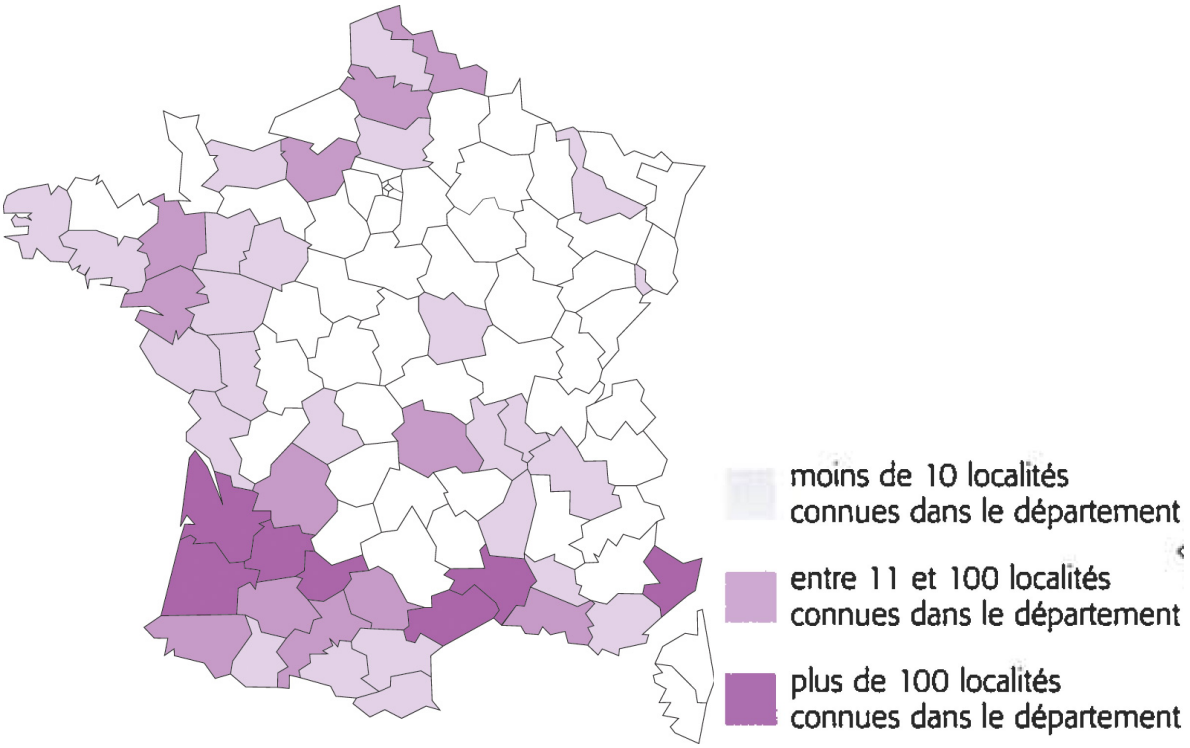
Appendix 1

Distribution maps of *Ludwigia peploides*

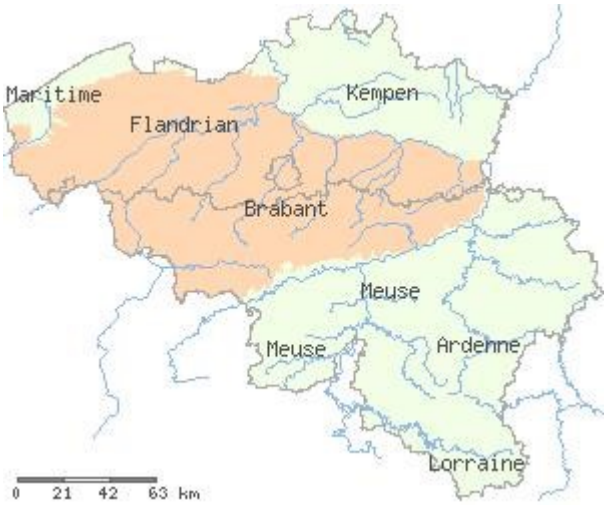
In France



Map of established populations of *L. grandiflora* and *L. peploides* in France

Source: Dutartre A (2004) *Ludwigia peploides* (Kunth.) P.H. Raven *Ludwigia grandiflora* (Michaux) Greuter & Burdet. Les jussies. In : Muller, S. (coord.) *Plantes invasives en France*. Museum national d'Histoire naturelle, Paris (Patrimoines naturels, 62), pp. 76-81.

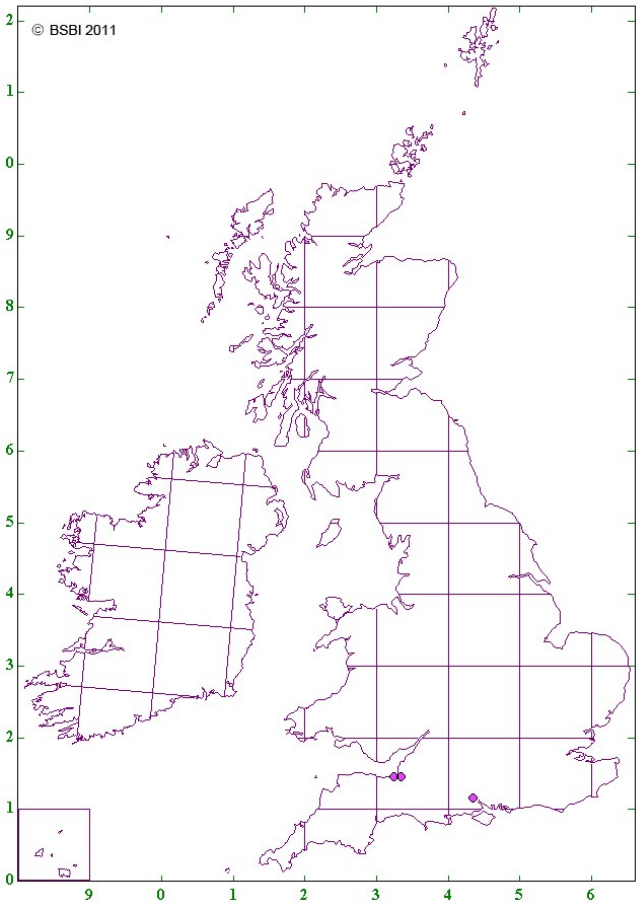
In Belgium



Map of established populations of *L. peploides* in Belgium
absent from district
isolated populations (1-5 localities per district)
widespread (>5 localities per district)

Branquart E, Vanderhoeven S, Van Landuyt W, Van Rossum F, Verloove F (2010) *Ludwigia peploides* - Water primrose. Invasive speceis in Belgium.
http://ias.biodiversity.be/species/show/12

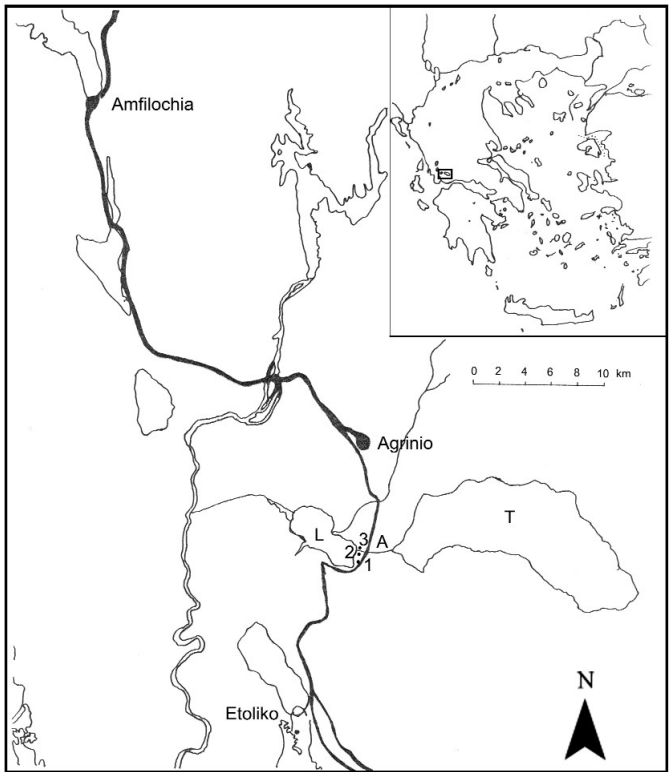
In the UK



Hectad map of *Ludwigia peploides* in GB and Ireland
-1930 (0 hectads); 1930-1969 (0 hectads); 1970-1986 (0 hectads); 1987-1999 (0 hectads); 2000-2009 (3 hectads); 2010- (0 hectads)

Source: Botanical Society of the British Isles Mass Scheme. http://www.bsbimaps.org.uk/atlas/map_page.php?spid=23557.0&sppname=Ludwigia peploides&commname=Floating Primrose Willow

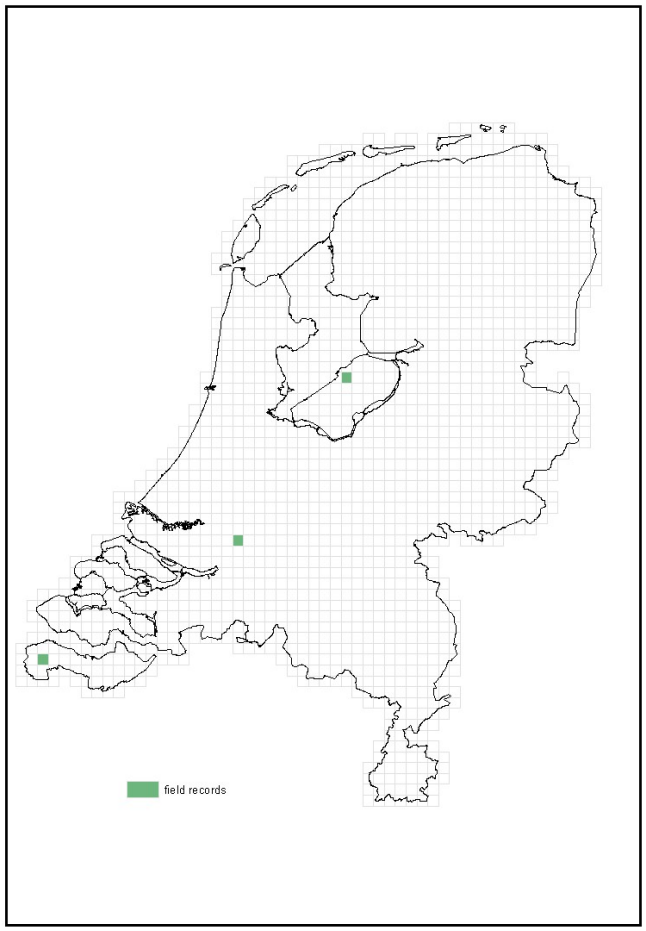
In Greece



Distribution of *L. peploides* in Greece.

Source: Zotos A, Sarika M, Lucas E & Dimopoulos P (2006) *Ludwigia peploides* subsp. *montevidensis*, a new alien taxon for the flora of Greece and the Balkans. *Journal of Biological Research* 5, 71-78 http://www.jbr.gr/papers20061/07-Zotos.pdf

In the Netherlands



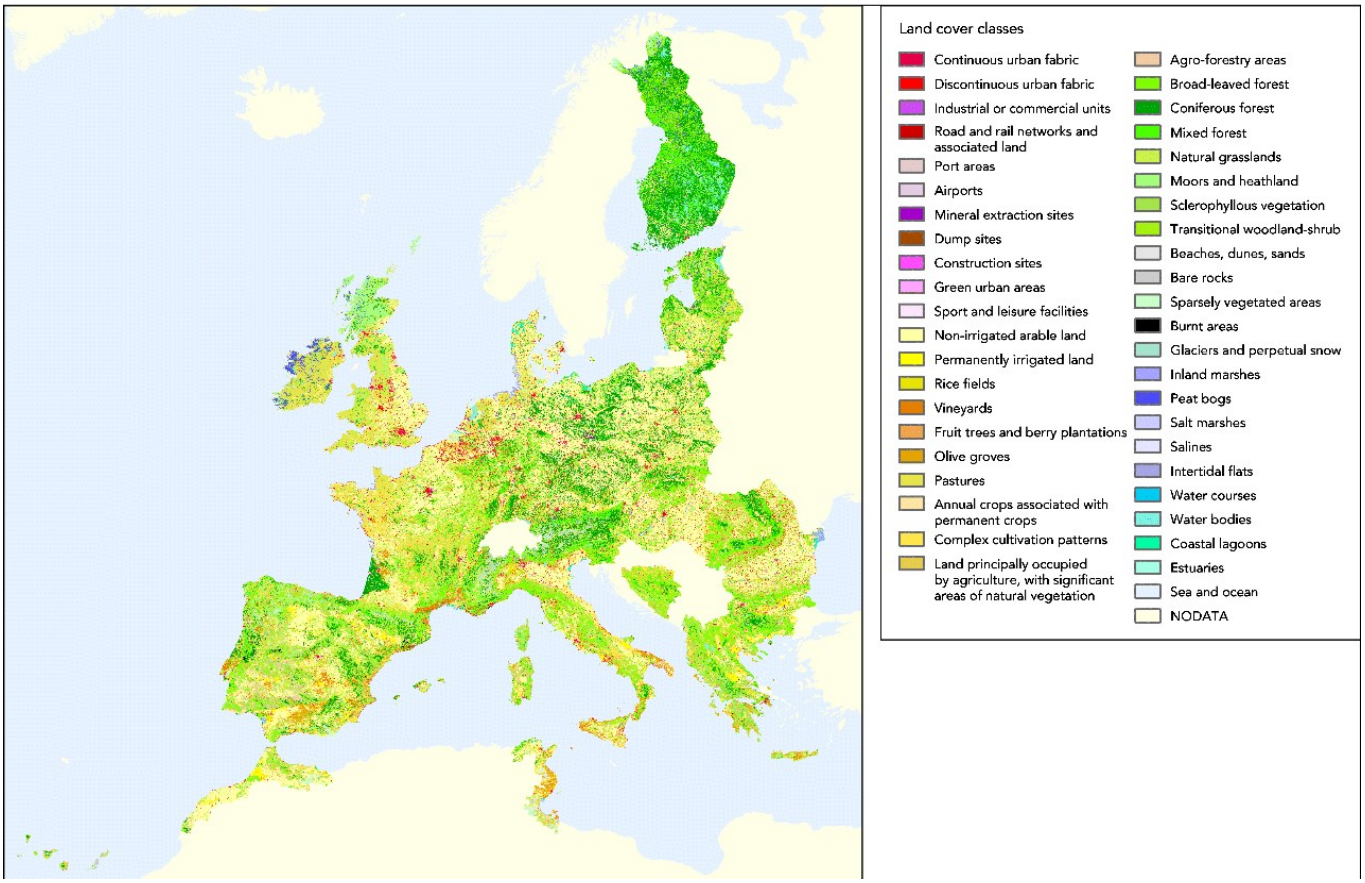
Map of occurences of *L. peploides* in the Nethrlands.The speceis has disappeared from the 2 lower locations, the site localised in the north of the country is under management.

Source Q-bank http://www.q-bank.eu/Plants/BioloMICS.aspx?Table=Plants%20-%20Species&Rec=171&Fields=All

Appendix 2

CORINE Land Cover classification

Available at:
http://www.eea.europa.eu/data-and-maps/figures/corine-land-cover-2000-geographic-view-1



Corine land cover 2000 geographic view, European Environment Agency