EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION
ORGANISATION EUROPEENNE ET MEDITERRANEENNE
POUR LA PROTECTION DES PLANTES

09-15075

Report of a Pest Risk Analysis

This summary presents the main features of a pest risk analysis which has been conducted on the pest, according to EPPO Decision support scheme for quarantine pests.

Pest: *Lysichiton americanus* Hultén and St. John

PRA area: EPPO region

Assessor: The EWG was held on 2009-03-25/27, and was composed of the follow experts:
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Date: 2009-04

STAGE 1: INITIATION

Reason for doing PRA: *Lysichiton americanus* originates from the pacific coastal zone of Northwest-America and was intentionally introduced into the EPPO region as an ornamental plant about 110 years ago. It is now found in 11 European countries. The species has been observed to reduce biodiversity in the Taunus region in Germany. The species is recorded in other parts of the EPPO region, and might represent a threat to biodiversity.
An initial EPPO PRA was performed and approved in 2005. After the proposal to list this species in the Directive 2000/29/EC, the European Food Safety Authority reviewed the initial PRA and made some comments. The initial PRA is therefore revised in the view of the EFSA comments and of information having become available after the initial PRA.

Taxonomic position of pest: Kingdom: *Plantae*
Class: *Liliopsida*
Family: *Araceae*
Subfamily: *Orontioideae*
Synonyms: *Lysichiton camtschatcensis* auct. non (L.) Schott

See St. John H & Hultén E (1956)

STAGE 2: PEST RISK ASSESSMENT

Probability of introduction

Entry

Geographical distribution:

Native Range:

Lysichiton americanus originates from the wetland areas in the north western pacific coastal zone of North America from south east Alaska to northern California. This plant is found from Kodiak Island and Cook Inlet, Alaska south through British Columbia, Washington, Oregon, and Northern California as far south as Santa Cruz County in California. Isolated populations are also found in north-east Washington, northern Idaho, Montana, and Wyoming (Hickman, 1993; FNA, 1993). More details are available from the Missouri Botanical Garden (2009) and also in Zipcodezoo (2009) and USDA (2009).

Introduced range:

Lysichiton americanus is recorded in 11 countries in Europe, but it is to be kept in mind that monitoring for this species is not systematic in EPPO countries.

EPPO region

UK*:* 198 sites, considered invasive at 2, 1 has been eradicated

L. americanus was only reported from the British Isles including Ireland in the last edition of Flora Europaea (Tutin *et al*., 1980). Within Europe, the highest numbers of established populations are found in Great Britain and Northern Ireland. *Lysichiton americanus* was first introduced in Europe for cultivation in Great Britain in 1901. The first records from the wild are from 1947 (Clement and Foster 1994). It was only recorded four times before 1970, 11 times until 1986, 159 times until 1999, 187 until 2002 (Preston *et al.* 2002) and 198 until 2006 (BSBI, 2009a). In Northern Ireland, the species was recorded in 4 sites between 1970 and 1986, and after 1986, 15 sites have been recorded (Flora of Northern Ireland, 2004). The number of plants at each site remains unknown.

In Scotland it has been found near the in Perthshire where it is clogging water channels and colonising wetland ecosystems (Anon, 2006). It is also reported as clogging ponds and ditches in a tidal estuarine site at Tarbert Woods (Cox & Curtis Machin, 2008).

See map in Appendix 2.

Ireland: 24 sites, 2 considered invasive

The first records from the wild come from Woodfield bog in 1930, it has been observed growing in vegetation with *Sphagnum* spp., *Aulacomnium palustre* (indicating nutrient enrichment) and *Betula pubescens* (Doyle & Duckett 1985). Established from 1960s (Peters, 1960; O'Mahony, 1975; Doyle & Duckett 1985, O'Malley 1996;

Webb *et al*., 1996, Preston *et al*. 2002) 24 sites are recorded up to 2009 (Reynolds, 2002; NBN 2008; BSBI, 2009a) and the species is listed on the National Biodiversity Data Centre Website.

Sweden: 29 sites, the species has not been spotted as invasive

The species was introduced around 1975 as an ornamental plant (M Josefsson, pers. comm. 2004 in Klingenstein and Alberternst, 2006). In 2003, 29 sites were recorded in south and central Sweden (Larson, 2003). Examples are the rivulets Vinån and Fylleån in the province of Halland, Tveta in the province of Södermanland (Lenfors & Nilsson 1987) and in the province of Östergötland (Lind, 1988) in bogs and moist forests, where it propagates well and seems well established (A. Anderberg, pers. comm., in Klingenstein and Alberternst, (2006); Edqvist & Karlsson, 2007). Since then, no substantial information could be found on the species (M Josefsson, pers. comm., 2009).

Germany: 6 sites, 1 invasive and 2 under eradication and 1 monitored

Stands of *Lysichiton americanus* in the wild are quite rare in Germany, 6 sites are known: in the Taunus northwest of Frankfurt, near Koblenz, in the Eifel, in Düsseldorf, in the Harz and in the Western Ruhrgebiet. Most of the stands consist of a small number of plants. The Taunus population near Frankfurt is known to have been introduced deliberately by a gardener in the 1980s who planted a few individual plants in different places, mainly at the sources of streams and in swamps. The population of *L. americanus* was comprised of some thousands of large (>80 cm) plants and many thousands of small seedlings (estimate of all plants removed between 2001 and 2008 is 30,000-40,000 – pers. comm. Alberternst, 2009) (Korneck & Krause 1990, König & Nawrath 1992, Alberternst & Nawrath 2002; see Appendix 4). Only the stand of the species in Taunus is known to be invasive in Germany (B. Alberternst, pers. comm., 2009.), the other five populations are smaller:

- at about 20 plants in swamp forests in the Western Ruhrgebiet since 2002 where the population was first recorded in 1980. It has not spread as in the Taunus. (Fuchs *et al.* 2003; B Alberternst, pers. comm., 2009),
- 20 plants at two locations in the Harz near Elendstal (Herdam 1994a; 1994b; in 2005 have been successfully controlled; Dr. Christoph Schönborn, pers. comm. in Klingenstein and Alberternst, 2006),
- 10 plants in Pillebachtal in Düsseldorf since 2004 (Dr. Michael Luwe, Kempen, pers. comm. in Klingenstein and Alberternst, 2006),
- an unknown number of plants in Brexbachtal near Koblenz since the beginning of the 1990s (Fischer & Schausten 1994),
- and approximately 150 small plants in the Eifel (Rhineland) near Rom. (FloraWeb, 2006).

Belgium: 3 sites

Since 2006, a few plants have been recorded in 3 sites in the Meuse and Ardenne regions, where it was most probably planted (Vanderhoeven *et al*., 2007, Branquart, *et al*., 2007; E. Branquart, pers. comm., 2009). The first site where the hybrid species was observed is a small water course near an arboretum (see picture and distribution map at http://ias.biodiversity.be/ias/species/show/13).

Other sites are near a pond, and another in a forest, but it is not known whether the hybrid or the species are present there. No further spread has been observed, and the species is not considered a priority for action (E. Branquart, pers. comm., 2009).

Norway: 3 sites

Three sites in the south are reported, (Bratland *et al*., 2000) where it probably was introduced in 1934. More than 200 plants have been recorded since 2001 in a swamp on Tromøy island near Arendal, where two plants have been planted around 1960 (Åsen, 2002). It has also been reported as garden escape in Bergen on the West coast of Norway (Lid & Lid 1994).

Finland: 2 sites

2 sites have been recorded since May 2005 in a Natura 2000 area, one close to a stream quite far from human settlements in the Pohja commune (between Karis and Salo, southern Finland) (Harry Helmisaari, pers. comm. 2005) and another on the shore of Lake Pääjärvi and Porvoo (Uusimaa) (Ryttäri, 2006, see http://www.ymparisto.fi/default.asp?contentid=200705&lan=EN).

France: 2 sites

In France, *L. americanus* was first recorded in 1995 along the river Furan in the massif of Mount Pilat (Delaigue, 2001). The plant was noted to have probably escaped from the garden of a collector located in the village at the source of the river Furan. However, the species has been known locally in the wild for twenty years but has probably been present for over 40 years (J.-M. Tison, pers. comm., 2009). In this location, *L. americanus* plants are rare, isolated and do not survive for a long time. In 2006, there were between 15 and 20 individuals spread over 2.7 km (Conservatoire Botanique national du Massif central, pers. comm., 2009) suggesting a gradual shift of the plant downstream, while upstream, where the plant was originally known, there was only one individual remaining (J.-M. Tison, pers. comm., 2009). Between 2006 and 2008, the situation seems to be stable with no impact reported on the ecosystem and indigenous species.

In 2005, a second location of *L. americanus* was found in the Haute-Vienne department in a hygrophilous wood (willow) along a stream dominated by *Salix acuminata* called Nouhaud at the bottom of a pond (Lebreton, 2007). In this second location, the plant is more invasive with an increasing number of individuals recorded: 4 in 2005, 12 in 2006 and 2007 and 32 in 2008, of which the majority were seedlings (Lebreton, pers. comm., 2009). The origin of the plant is not known, however, *L. americanus* has been cultivated for 20 years in Limoges botanical garden about 17 km away). The owners of the land have been contacted pending a possible eradication, they have pledged to cut spadices before seed production. In 2008, the Regional Scientific Board of natural heritage of Limousin has placed the species on a blacklist of invasive species and the French Ministry of Ecology has been alerted.

Netherlands: 2 sites, of which one under eradication

In 2004, the plant was reported by a botanist as forming a dense stand in a willow thicket in Brummen (Gederland), the Netherlands. After a survey, this was the only location found and it was considered a remnant of a nursery for water plants situated originally on the same site, but abandoned in the 1950s. There has been an eradication action at this site (Rotteveel, 2007). As a result of publicity raised by this action, new reports and sighting of *L. americanus* in urban areas or along watercourses near housing areas have been received (Waarneming.nl, 2009). The second report of *L. americanus* in natural areas was in a forest in Limburg (2008) (Johan Valkenburg, per. comm., 2009). Action will be taken in early 2009 (J van Valkenburg, pers. comm., 2009).

Denmark: 1 site
L. americanus was first observed in the wild in the 1950s. From this original site (Vestbirk in Jutland) the species has apparently dispersed via the waterways 20 km downstream, and now is well established at this site since 1981 (Wild about Denmark, 2009).

Switzerland: 1 site eradicated
In May 2003 a stand of about 100 plants of *L. americanus* was discovered in the raised bog of Meienmoos in the canton of Berne and reported to the Office for Agriculture and Nature from the canton of Berne. It is not known by which pathway *L. americanus* reached the raised bog but it is very likely that it was deliberately planted. A successful eradication action was undertaken (Jörg, 2009). See CPS/SKEW (2006) map at: http://www.cps-skew.ch/francais/inva_lysi_ame_f.pdf

Major host plants or habitats:

It has been found in wetlands including wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Vanderhoeven, *et al*., 2007; Doyle & Duckett, 1985; Alberternst & Nawrath, 2002).

The suitable habitats for the species present in the PRA area following the CORINE land cover classification (See Appendix 1): moors and heath land, inland wetlands (fens, bogs, wet woodlands and marsh areas), costal wetlands and continental waters (shoreline of the lake and banks of rivers).

Which pathway(s) is the pest likely to be introduced on:

Pathways are:

- Intentional import as an ornamental plant for use outdoors
    a. *Imports*

The first intentional introductions of the plant as an ornamental to Europe are reported at the beginning of the 20th century in the UK.
The actual known origins for import are:
- meristem tissue culture production in Indonesia (J van Valkenburg, pers. comm., 2009)
- unknown imports of young plants from North-America
- internet sale of seeds and young plants within and from outside the EPPO region. See:
- http://www.kevockgarden.co.uk/store/product.aspx?id=3151

- http://www.wyevale.co.uk/Lysichiton-Americana---Skunk-Cabbage-+3lt/0850039051,default,pd.html
- https://www.gardens4you.co.uk/index.php?/Waterplants/Lysichiton-americanus.html
-

109 commercial websites have *L. americanus* seeds listed as available in their catalogues.

A survey in Switzerland highlighted that *Lysichiton americanus* was either produced in Switzerland, or imported from the Netherlands (S Buholzer, pers. comm., 2009). In Germany, few nurseries produce the plant themselves, and the majority buy from 2 production sites in Germany. A few import small plants from the Netherlands and Belgium (G Schrader, pers. comm., 2009).
In the Netherlands, there were no records of imports of *L. americanus* from outside EU during 2006-2007 (J. van Valkenburg, pers. comm., 2009; EPPO 2009). There are no records of import of *L. americanus* as an aquatic plant in Austria, Estonia, Latvia, Hungary and Czech Republic (EPPO, 2009), but this species might be recorded under other commodity types than aquatic plants.

In the Netherlands, annual sales amount to 20.000 -40.000 plants and exports will be roughly the same.
Plants on sale are 1-2 years old, and it takes a few more years for these to start producing flowers. Because of the extensive fleshy root system which is prone to damage and resulting in adverse effects on further plant development, plants of flowering size and age are too bulky and too expensive for trade purposes.
The volume in trade for *L. camtschatcensis* is comparable to *L. americanus*. See Q 1.33 on spread helped by human activities for data on trade within the EPPO countries.

b. Transfer from intended habitats to unintended habitats

The transfer to unintended habitats may occur through:

- escape from ornamental plantings, particularly if there is a stream in connection with natural areas in the direct vicinity of the plant. The species can spread both locally or through long distances by this pathway. In Denmark, the plant was found in 1950s in a garden a few meters from a lake, which is connected to a river. In 1981 it was found 20 km downstream of the garden and this is the first "wild" record from Denmark. The plant is now found in 1 locality (E Swart, pers. comm., 2009). In France, it is assumed that the plant escaped from a private garden situated near the source of the river where the species occurs downstream (Delaigue, 2001). In the UK, it is assumed that where plants were originally planted alongside streams, significant downstream spread has occurred at most sites (Newman, pers. comm., 2009). In Ireland, it has also been recorded to have escaped from ornamental plantings since the middle of the 1950s (Peters, 1960; Doyle & Duckett, 1985; Mahony, 1975).
- direct planting into natural sites: this occurred in the Taunus where a gardener planted or sowed the species in different

places (König & Nawrath, 1992; B Alberternst, pers. comm.., 2009), in Switzerland (Jörg, 2009), in Ireland in Woodfield bog (Doyle & Duckett, 1985), in Norway on Tromøy Island near Arendal (Åsen, 2002), and in the UK where it is considered to have been planted in the majority of the recorded sites (Newman, pers. comm., 2009), in the Netherlands, the plant was a relict of a nursery site (Rotteveel, 2007), in Belgium it has been planted along a watercourse in an arboretum (E Branquart, pers. comm., 2009).

- throwing away material containing seeds, rhizome or young seedlings of plant: it is assumed that in Western Ruhrgebiet, the plants were transferred through inappropriate disposal of garden waste (Fuchs et al., 2003).

When planted in suitable natural habitats, or when seeds and rhizomes of the plant are discarded into suitable natural habitats, the species is likely to establish. It has been observed in e.g. Germany, Belgium, and Switzerland. Nevertheless, according to the Habitats Directive (EU 92/43/EEC) and national legislation (e.g. in Switzerland, the Nature and Cultural Heritage Protection Act (NHG)) introduction of exotic species into natural habitats is prohibited.

When planted near streams, it is likely that the species will escape to natural habitats.

Establishment

Plants or habitats at risk in the PRA area:

Wetlands including wet woodlands, lakeside, raised bogs, swamps, riverbanks, pond margins, in permanently wet soils, in alluvial forests, moorlands and wet meadows (Vanderhoeven, *et al*. 2007; Doyle & Duckett, 1985; Alberternst &Nawrath, 2002).

Climatic similarity of present distribution with PRA area (or parts thereof):

L. americanus has already established in at least 11 EPPO member countries (Belgium, Denmark, France, Finland, Germany, Finland, Ireland, the Netherlands, Sweden, Switzerland, United Kingdom).

Completely similar

low uncertainty

L. americanus is typically associated with climates Cf, Dfb and Dfc in Köppen's classification, i.e. cool to hot summer, very cold to cool winter, wet year round. *L. americanus* is hardy at least to zone 7 (−15°C), and possibly colder. It is associated with the vegetation zones: temperate deciduous forests, mixed conifer forests, taiga forests, forest tundra (EPPO, 2004).

A climatic prediction with the software CLIMEX has been performed and highlights that Northern and Western Europe are the most at risk. The Mediterranean area is not considered at risk as it is assumed to be too warm and too dry during summer (see Appendix 1).
Countries where the species could establish include: Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Republic of Macedonia, Romania, Russia, Serbia, Slovenia, Spain (North), Sweden, Switzerland, Turkey (east coast of the Black Sea), Ukraine.
Areas particularly at risk are areas having an Atlantic influence (the

UK, Ireland, Northern coast of Spain, Bretagne in France, the Netherlands, Denmark, Norway) and mountainous areas (the Massif central in France, the Alps, the Pyrenees, the Carpatian Mountains, Bolsoj Kavkaz in Georgia, Ural Mountains in Russia).

Aspects of the pest's biology that would favour establishment:

Plants do not flower every year in their native range. Plants at shady sites and small plants are more likely to fail to flower (Willson & Hennon, 1997). In the PRA area only plants of 3 years or older produce seeds (E. Jörg, pers. comm., 2009; FloraWeb (2006).)),

L. americanus produces many seeds (each spadix has between 100-300 berries FNA, 1993; 300-650 seeds per spadix in Germany Alberternst & Nawrath 2002), and a large seed bank can build up in the soil, remaining viable for at least 8 years (Alberternst pers. comm. 2009). The EWG concluded that *L. americanus* has a competitive advantage because leaf development starts earlier in the season and plants are taller than native understorey plants, and out compete them.

Vegetative reproduction by fragmentation of stems/ rhizomes is possible and has occurred in the Taunus after fragmentation during the control measures (B Alberternst, pers. comm., 2009) (see pictures in Appendix 4).

Nevertheless, a survey performed in Switzerland in nurseries highlighted that the plant is difficult to grow. In average garden soil, it often survives for less than two or three years (personal comment from different sellers) (S. Buholzer, pers. comm., 2009). In the Netherlands, only a few nurseries have mastered the skill of propagating *Lysichiton* to make it a profitable business (J van Valkenburg, pers. comm., 2009).

Characteristics (other than climatic) of the PRA area that would favour establishment:

Abiotic factors

In its native range, the typical soil associated with this species in Alaska is Histosol (D'Amore & Lynn, 2002). In Southeast Alaska, North-west Canada, America and California the species is an obligate wetland species (Reed, 1988; Fish and Wildlife Service, 1996). It is found in calcareous fens in Southeast Alaska, these fens can be classified floristically as the Sitka sedge-forb community type. In these calcareous fens, the pH values of 6.7 to 7.4 and calcium concentrations of 41.8 to 51.4 mg/L are recorded (McClellan *et al*., 2003). Calcareous fens are a very unusual habitat for this area, and although *L. americanus* was found at two locations, it is likely that the conditions reported in this paper are not the ideal habitat for this species, and it is assumed that the species grows best in acidic saturated soils.

The principal environmental factor determining presence of *L. americanus* is the absence of soil drainage in southeastern Alaskan forests (Hanley & Brady, 1996). It can also tolerate fluctuating water levels (Washington Department of Education Datasheet).

According to Klinkenberg (2008), it is found in British Columbia at elevations between 358 and 1740 m.

In the EPPO region, it is found in the same conditions as in its native range. The EWG concluded from field experience that *L. americanus*

can grow in acid or neutral permanently wet soils and grows better in deep humus rich soils. It has been observed in the Taunus (Germany) to grow in flowing or standing waters of up to 30 cm depth (Alberternst, pers. comm., 2009). It usually occurs in semi-shaded situations, tolerates shade and also grows well in full light. The EWG concluded that the factor determining the presence of the species is permanently wet acidic soils (see map in Appendix 1).

In Europe, Fuchs (2008) determined the following abiotic factors for *L. americanus*:

- for light (4); semi-shade plant,
- soil moisture (9); plant often on waterlogged, badly aerated soils
- for soil nitrogen (5); intermediate fertility.

Note : numbers between brackets refers to Ellenberg ecological scores (Ellenberg *et al*., 1992).

Competition

The plant already established in at least 11 countries. The EWG concluded that in its preferred habitat in under storey forest, there are no serious competitors. Additionally, *L. americanus* has a competitive advantage because leaf development starts earlier in the season and the plants are generally taller than native under storey plants, and out compete them.

Natural enemies

In its native range, this species is eaten by black tailed deer (*Odocoileus hemionus sitkensis*) (Gillingham *et al*, 1997 and 2001) and by Grizzly bear (*Ursus arctos*) (Gyug, 2004). These species are not present in the PRA area. The fruits and seeds have not been reported as being eaten by animals in the EPPO region (Alberternst, pers. comm., 2006)). Several species of slugs (Succineidae) and snails eating the leaves of *L. americanus* have been observed in the Haute-Vienne station in France (Lebreton, 2007), but this did not prevent the plant from establishing.

Managed environment

The species is planted along watercourses and in ponds and artificial lakes. These managed environments are favorable for the establishment of *L. americanus*. Maintenance work in infested areas may spread seeds of the plant (e.g. movement of soil, cleaning of ponds, etc).

In natural areas (swamps, peat bogs, etc.), there are very few management activities.

Which part of the PRA area is the endangered area:

As *Lysichiton americanus* occurs in North America from Alaska to California and has established in at least 11 European Countries (Belgium, France, Denmark, Finland, Norway, Sweden, Switzerland, Ireland, Great Britain, Germany, The Netherlands) it is assumed that swamp woods and other inland wetlands in northern and western EPPO region are at risk. The Mediterranean area is not considered at risk as it is assumed to

be too warm and too dry during summer (see Appendix 3). In the Mount Pilat where continental climate with some Mediterranean influences prevails, the negative dynamic of the plant is believed to be a consequence of too hot temperatures.

Countries where the species could establish include: Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Republic of Macedonia, Romania, Russia, Serbia, Slovenia, Spain (North), Sweden, Switzerland, Turkey (east coast of the Black Sea), Ukraine.
Areas particularly at risk being are areas having an Atlantic influence (the UK, Ireland, Northern coast of Spain, Bretagne in France, the Netherlands, Denmark, Norway), and mountainous areas (the Massif central in France, the Alpes, the Pyrenees, the Carpatian Mountains, Bolsoj Kavkaz in Georgia, Ural Mountains in Russia).

POTENTIAL ECONOMIC CONSEQUENCES

How much economic impact does the pest have in its present distribution:

Effect on crop yield and/or quality to cultivated plants or on control costs

No presence in crops or cultivated lands.

The costs of control measures are not known for all countries, but they differ significantly. In Switzerland, only one hundred plants were dug out in the first and controlled in the second season and cost around 1000 euros, while in the Taunus several thousand plants in many localities were dug out by volunteers and forest workers. (Klingenstein & Alberternst, 2006). The total costs of removing *Lysichiton americanus* from the Taunus since 2001 up to 2008 including research work on the species (e.g. mapping, ecological studies, documentation, monitoring) were estimated to 53,000 € (B Alberternst, pers. comm., 2009)
The cost of chemical control is 600 euros/ha/site visit in the UK (Newman, pers. comm., 2009).

Environmental impacts

In the native range, no environmental impacts are reported.

In the EPPO region, *Lysichiton americanus* is able to establish in particularly vulnerable habitats such as woods and bog woodlands which are nature conservation areas listed under EU Directive 92/43 (EU, 1992) (EPPO, 2006). After some years its huge leaves build a dense layer excluding light from native species which usually are not adapted to extreme darkness because native swamp woods are more porous.
There is locally high damage in the Taunus in Germany. In other countries, impacts have not been documented.

In the Taunus area of Germany, adverse environmental impacts such as species displacement and local extinctions have been reported and attributed to the presence of *L. americanus* (König & Nawrath, 1992), due to the formation of dense layers of vegetation which exclude light, and thus affect biodiversity in ecologically sensitive wetland habitats.

It can displace, and cause local extinction of rare species of mosses (like different *Sphagnum* species) and vascular plants (*Carex echinata, Viola palustris*, and orchids) (König & Nawrath, 1992, Alberternst & Nawrath, 2002), some of them included in the national red lists. In the Taunus, studies have shown a reduction in species number of more than 50% in dense stands (B Alberternst, pers. comm., 2009). See Appendix 4.

Although the species is present in 6 sites in Germany, the Taunus is the only site where the species is known to be invasive (B. Alberternst, pers. comm., 2009).

In Switzerland in the bog of Meienmoos no negative impact are reported, because of the early eradication of all plants.

In France, no impacts are reported from the sites where the plant is known in the Mount Pilat (J.-M. Tison, pers. comm., 2009). This may be due to the lack of compatibility with the climatic optimum of the species in that area that may reduce the competitiveness of plants. In Haute-Vienne, *L. americanus* has not yet induced changes in vegetation (A. Lebreton, pers. comm., 2009) but this seems understandable since there is currently only 32 individuals most of which are seedlings.

In the UK, although *L. americanus* often occurs in quite dense stands, there are no survey data to assess changes in native vegetation. This is due to the acceptance of *L. americanus* as a garden plant in the UK (Newman, pers. comm., 2009).

Social impacts

Although the plant is moderately harmful if eaten (containing calcium oxalate raphides), this does not present a great risk to animals or man in practice. Social damage is considered minimal (EFSA, 2007). In its native range the roots have even some value as medicine (Thomas & Schumann, 1993). The Flora of North America states (FNA, 1993, http://www.efloras.org)): “Plants of this species were used as food, as medicine, and also in the material culture of Native Americans of north-western North America (S. A. Thompson 1995)”.

Describe damage to potential hosts in PRA area: The deleterious effects on biodiversity described above could also occur in other countries.

How much economic impact would the pest have in the PRA area: No presence in crops or cultivated lands.
No social impacts are expected.

CONCLUSIONS OF PEST RISK ASSESSMENT

Summarize the major factors that influence the acceptability of the risk from this pest:

Estimate the probability of entry: The plant has already entered the EPPO region, and is produced and traded within the European Union and the EPPO region, and imports are recorded as meristem tissue from Indonesia to the Netherlands,

Very high Low uncertainty	and seeds and plants are sold on the Internet. The volume of sold plants in the EPPO countries remains quite low. A survey of nurseries selling the plant mentions that the species is considered expensive and difficult to grow (S. Buholzer, pers. comm., 2009; J van Valkenburg, pers. comm., 2009; G Schrader, pers. comm., 2009). When planted along streams, the plant has the ability to spread mostly by seeds to unintended habitats.
Estimate the probability of establishment: Very high Low uncertainty	The species is already established in at least 11 EPPO countries, and is recorded in natural habitats protected by EU Habitats Directive 92/43/EEC, or under national legislation (e.g. in Switzerland the Nature and Cultural Heritage Protection Act (NHG)) Where planted under Northern and Western climates and in wetland habitats, *L. americanus* is able to establish by producing seeds and reproducing vegetatively. Seeds or parts of the plants usually fall near the parent plants, but can also be spread through water or human activities. The spread through animals cannot be quantified and is not considered to be a significant pathway fro spread. The probability of introduction to areas of the EPPO region where it is currently not present is high or even very high. Nevertheless, if detected at an early stage, the species can be eradicated.
Estimate the potential economic impact: Low to moderate Low uncertainty	**Economic impacts are considered to be low:** they only consist in the costs of control measures are not known for all countries, but they differ significantly. **Environmental impacts they are considered to be low to moderate:** *Lysichiton americanus* occurs in swamp woods and associated wetlands which are rare habitats containing endangered species (see also Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora). In Germany, where *L. americanus* was planted in such natural area, it has displaced endangered species. Otherwise, when not directly planted in natural areas, no significant impact has been recorded so far. **No social impacts are reported.**
Degree of uncertainty **Low**	The areas of uncertainty identified are the following: - Details on environmental impacts in other countries than Germany Further researches to be undertaken: - investigations of the species behaviour in the wetland habitats in different locations (e.g. in Western Ruhrgebiet in Germany), in comparison with other areas (e.g. the Taunus)
OVERALL CONCLUSIONS	Considering the wide distribution of *Lysichiton americanus* into the EPPO region (present in at least 11 countries), its relatively small importance for import and trade, its moderate ability to spread, the few stands where impacts to biodiversity are reported, its very restricted habitats, the fact that it has been directly planted in the German site where impacts are reported, it is considered that the species does not qualify as a quarantine pest. Prevention measures at

the international level are not considered appropriate, but national action of monitoring, communication and eradication are encouraged (see Appendix 5 for pictures).

STAGE 3: PEST RISK MANAGEMENT

IDENTIFICATION OF THE PATHWAYS

Pathways studied in the pest risk management

Other pathways identified but not studied

IDENTIFICATION OF POSSIBLE MEASURES

Possible measures for pathways Intentional import as an ornamental plant for use outdoors

Measures related to consignments: **/**

Measures related to the crop or to places of production: /

Other possible measures

- Impacts of the species when planted in natural areas are acknowledged, and the implementation of the EU Habitat Directive (92/43/EEC) or national legislations (e.g. in Switzerland the Nature and Cultural Heritage Protection Act (NHG)) prohibiting the introduction of exotic species in natural habitat should be followed and promoted. Fines could be implemented for planting the species into the wild.

- General monitoring in EPPO member countries of exotic species, followed by rapid action is also recommended. When recorded in or near wetland habitats, the species should be eradicated. After eradication, monitoring only needs to be performed every 2 years since only older plants (3 years or older) of *L. americanus* are producing seeds, and this should be undertaken for a duration of at least 8 years (duration of the seed bank).

- National legislation should allow and ease the execution of such eradication. Management mainly consists in manual removal of the plant and subsequent monitoring in wetland habitats.

- Communication to the public could be enhanced. In Switzerland, the species has been registered on a black list, which helped raising awareness in the nursery sector. In Germany, no black list exist, but the media are interested in the topic of invasive alien plants, and articles were released on *Lysichiton americanus*. Involvement of the public is important so that there is no opposition to management measures.

- Cooperation with the nursery industry through the

implementation of a code of conduct (see Heywood & Brunel, 2009) seems particularly appropriate for this species. The species should be carefully labelled with a mention that the species should only be planted in ponds isolated from at least 50 m away from running water. Wastes containing seeds or rhizomes of the plant should not be disposed into the wild. Substitution species are also available like *Calla palustris* in Switzerland, but substitution species have to be chosen on a country basis. See also a German initiative providing information and recommendations on the plant to professionals (including the PPP index): http://www.g-net.de/download/Empfehlung-Invasive-Arten.pdf. *L. camtschatcensis* has been suggested by professionals as an alternative species, this species is not considered as appropriate since it is very close to *L. americanus*, and has been found growing in the wild in the Taunus (Alberternst B & Schmitz , 2002). In France, the Conservatoire Botanique de Bailleul implemented a voluntary code of conduct with the professionals which recommend to stop the trade of invasive alien plants.

See the EPPO Standard PM 3/67 'Guidelines for the management of invasive alien plants or potentially invasive alien plants which are intended for import or have been intentionally imported'.

EVALUATION OF THE MEASURES IDENTIFIED IN RELATION TO THE RISKS PRESENTED BY THE PATHWAYS

Degree of uncertainty Low

CONCLUSION:
Recommendation for possible measures (type presentation):

Intentional import as an ornamental plant for use outdoors	National measures: - Prohibition to grow in the wild - Monitoring of the species - Legislation allowing eradication - Communication to the public - Implementation of the code of conduct on horticulture and invasive alien plants.

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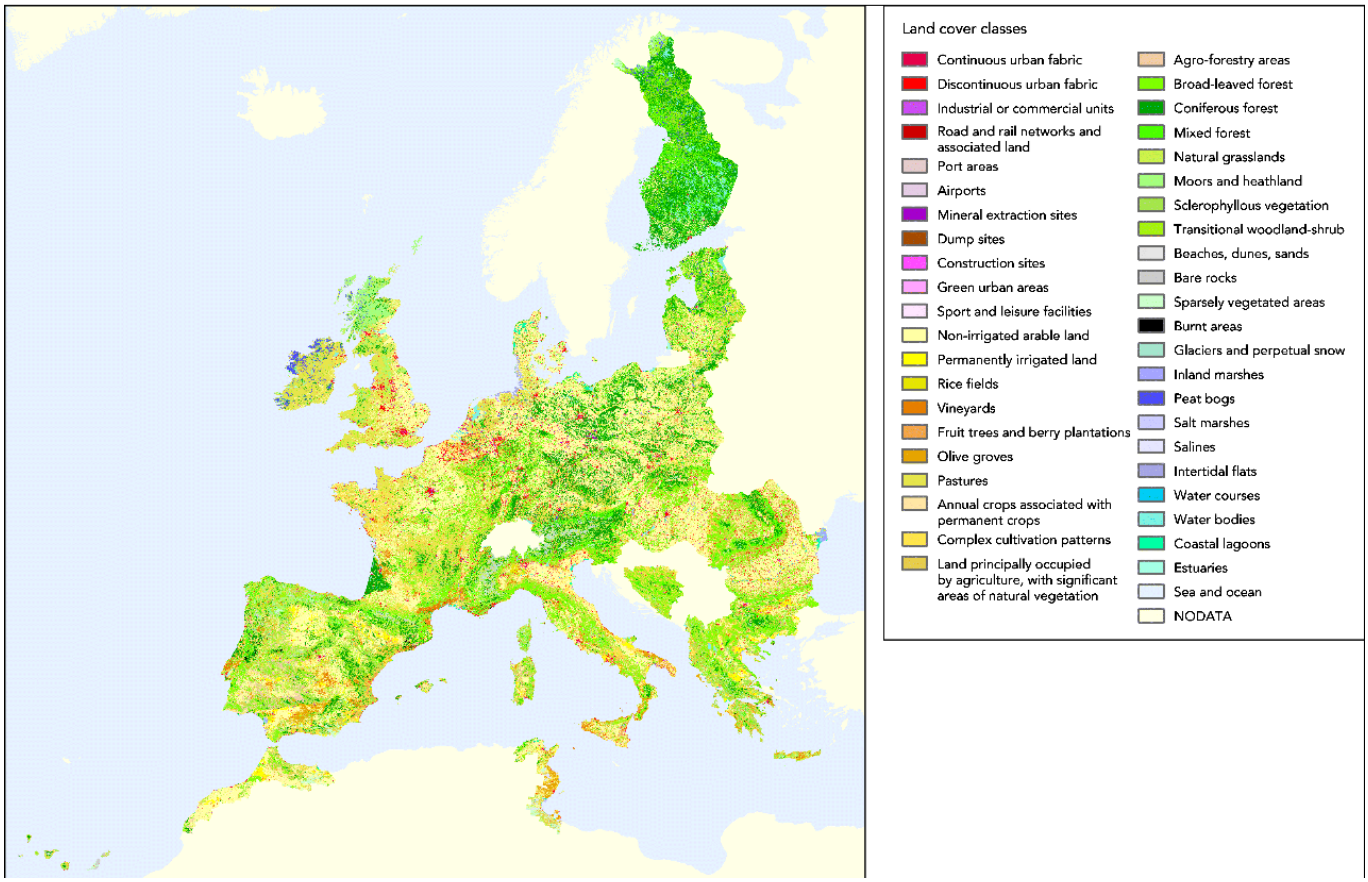
Appendix 1

Maps relevant for the distribution of *Lysichiton americanus*

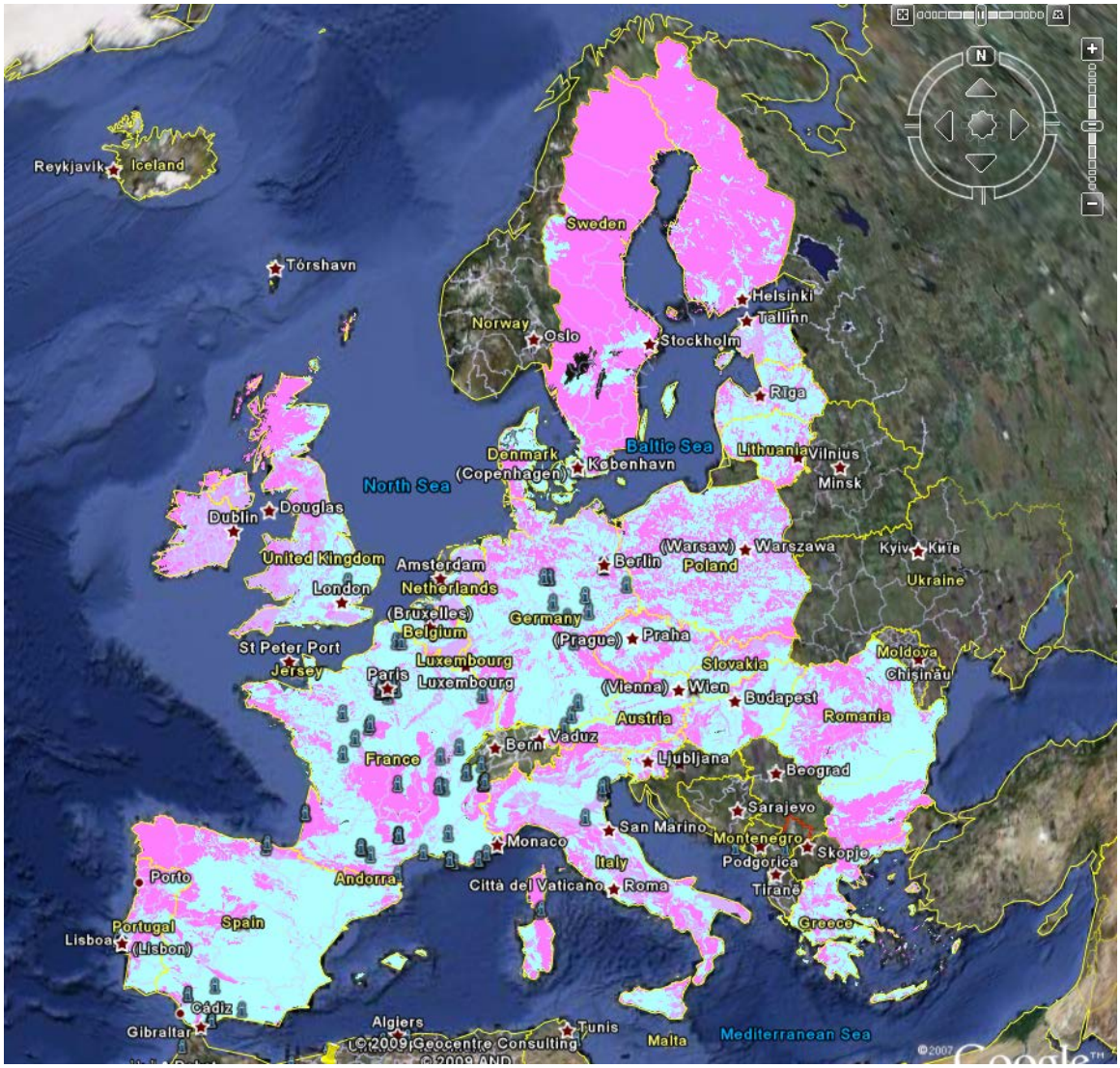
CORINE land cover classification

http://dataservice.eea.eu.int/download.asp?id=5859&type=gif.



pH maps

The following map can be found on the European Soil Portal maintained by the European Commission (http://eusoils.jrc.ec.europa.eu/, European soil data center > Data > European soil data base > Raster version or Google earth version> chemical properties > base saturation top soil (BS TOP)
The areas in pink (darker) represent acidic soils which are suitable for *Hydrocotyle ranunculoides.*


Reykjavik
Iceland
Tórshavn
Sweden
Helsinki
Tallinn
Norway
Oslo
Stockholm
Riga
Baltic Sea
Lithuania
Vilnius
Minsk
Denmark
(Copenhagen)
København
North Sea
Dublin
Douglas
United Kingdom
Amsterdam
Netherlands
Berlin
(Warsaw)
Warszawa
Poland
Kyiv
Київ
Ukraine
London
(Bruxelles)
Belgium
Germany
(Prague)
Praha
St Peter Port
Jersey
Luxembourg
Paris
Luxembourg
Slovakia
Moldova
Chişinău
(Vienna)
Wien
Budapest
Austria
Romania
Vaduz
Bern
France
Ljubljana
Beograd
Sarajevo
San Marino
Monaco
Montenegro
Skopje
Italy
Podgorica
Porto
Andorra
Città del Vaticano
Roma
Tirane
Portugal
Spain
Greece
Lisboa
(Lisbon)
Cádiz
Gibraltar
Algiers
Tunis
Malta
Mediterranean Sea
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Appendix 2

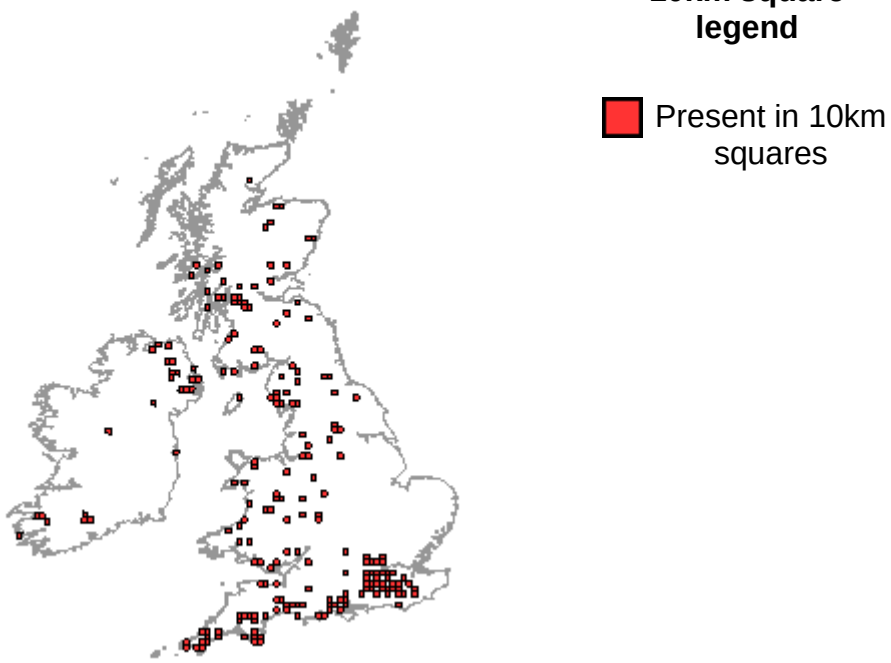
Maps of distribution of *Lysichiton americanus*

North America

Map available at http://plants.usda.gov/java/profile?symbol=LYAM3
More detail data at the state scale are available on the website.

The UK

http://data.nbn.org.uk/gridMap/gridMap.jsp?allDs=1&srchSpKey=NHMSYS0000460539



Germany

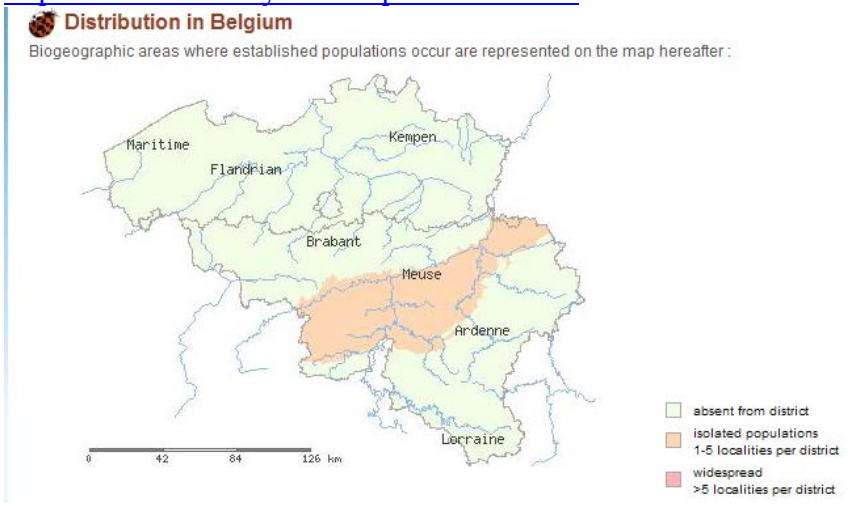
Lysichiton americanus in Germany in 2009 (B. Alberternst, pers. comm., 2009)

Site of *Lysichiton americanus*

Source of the underlying map:
http://upload.wikimedia.org/wikipedia/commons/0/0d/Germany_location_map.svg

Belgium

Map available on the website of the Forum for Invasive Species in Belgium at http://ias.biodiversity.be/ias/species/show/13



Switzerland

Map available at: http://www.cps-skew.ch/francais/inva_lysi_ame_f.pdf

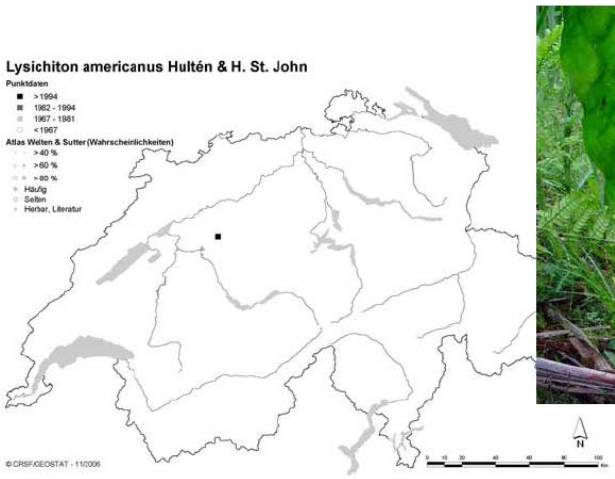


Photo : E. Jörg

Appendix 3

Climatic prediction for *Lysichiton americanus*

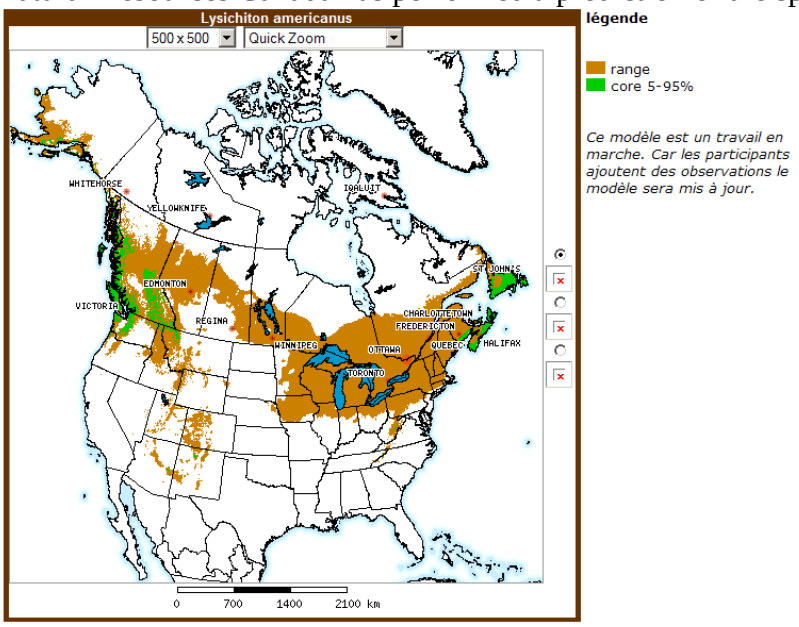
The CLIMEX model is a computer programme aiming at predicting the potential geographical distribution of an organism considering its climatic requirements. It is based on the hypothesis that climate is an essential factor for the establishment of a species in a country.

For *Lysichiton americanus*, a compare location analysis has been undertaken.

1. Geographical distribution of the species

Existing climatic prediction

Natural Resources Canada has performed a prediction of the species distribution based on current climate.



Phenology

Inflorescences appear between March and May, emerging and flourishing before the leaves come out. Seeds mature in its native area of distribution from June to July, and in Germany in July or early August. Plants do not flower every year in their native range.

Influence of climatic factors on distribution

Information from the Jepson Horticultural Database (Hickman, 1993) for *Lysichiton americanus*
Given WET(fresh water), grows especially well in **zones 4 and 5**.
Given SHD,WET(fresh water), grows especially well in **zones 6, 15, 16, and 17** and also in zones 1, 2, 3, 7, 14, 18, and 19.

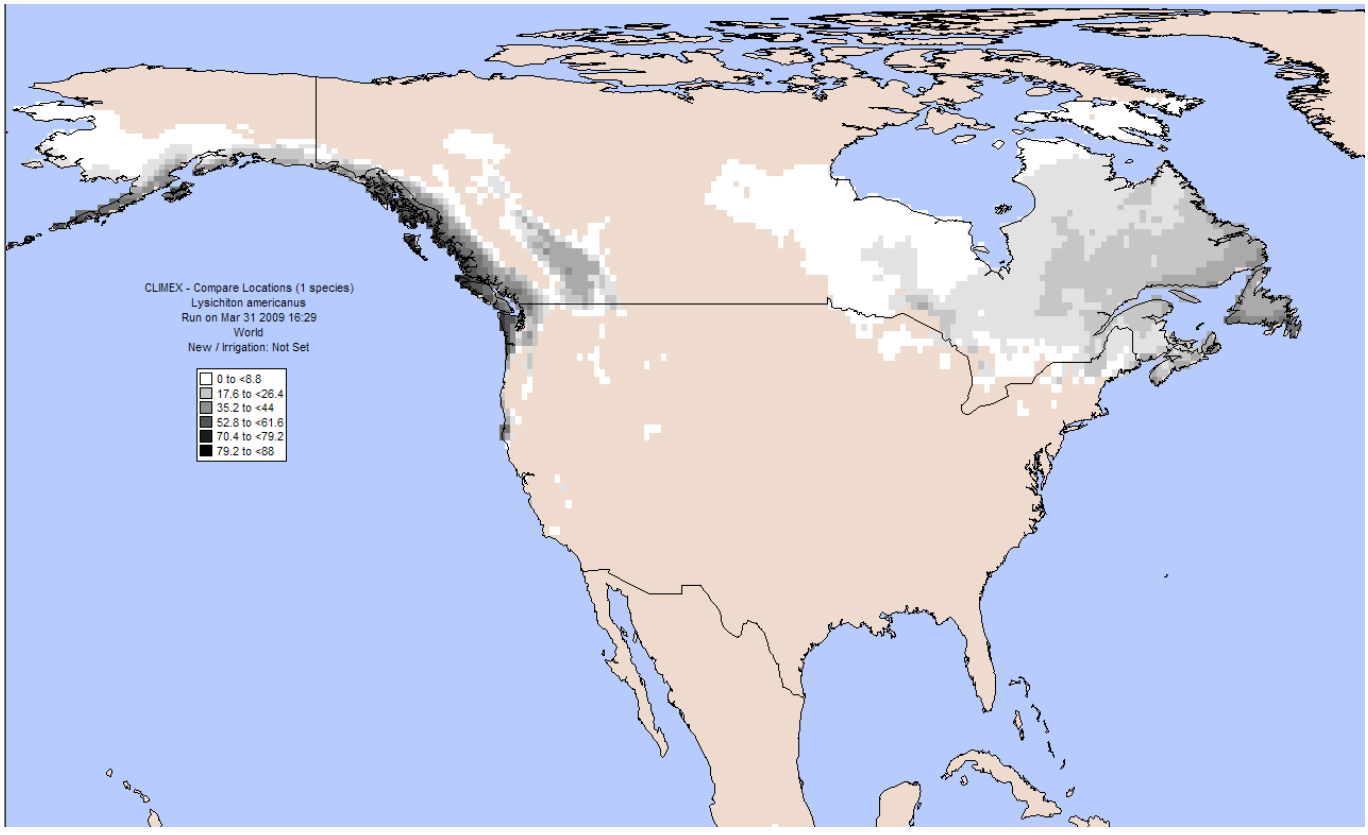
Soil moisture
The species only grows in permanently wet soils. The moisture indexes are therefore at the threshold mentioned in the table below.

Temperature index
L. americanus is typically associated with climates Cf, Dfb and Dfc in Köppen's classification, i.e. cool to hot summer, very cold to cool winter, wet year round. *L. americanus* is hardy at least to zone 7 (−15°C), and possibly colder.

Considering its distribution, the species is considered to grow best between 8 and 15 °C of weekly average temperature, with a range for growth comprised between 0 and 24 C of weekly average temperature.
The species is considered to accumulate stress at -10°C of weekly average temperature, at a low rate (-0.0001). The distribution of *L. americanus* shows that it does not grow well in hot environment. A stress is set at 24°C of weekly average temperature with a rate of 0.003.

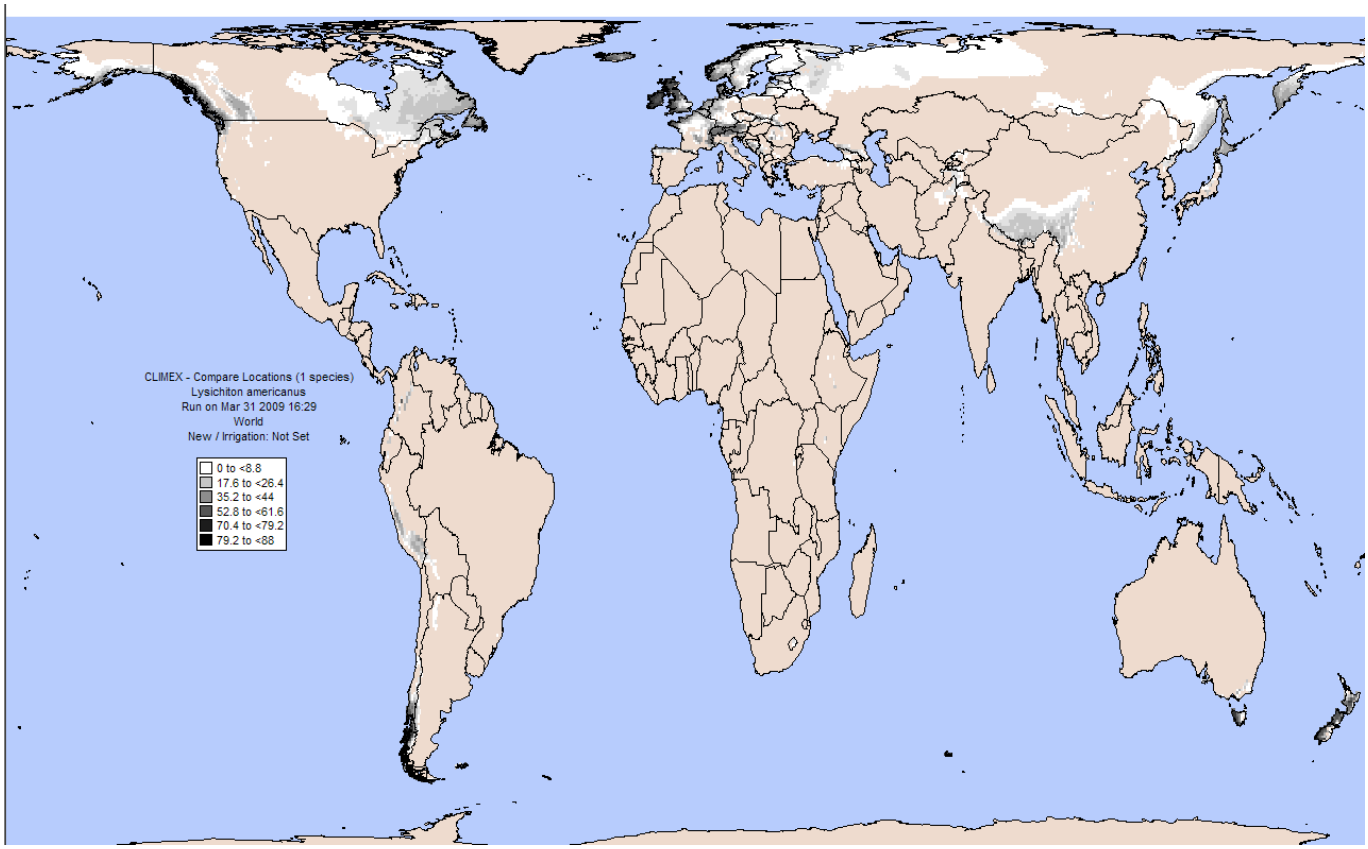
☑ Moisture Index					
SM0	SM1	SM2	SM3		
0.5	1	2	3.5		
☑ Temperature Index					
DV0	DV1	DV2	DV3		
0	8	15	24		
☐ Light Index					
☐ Diapause Index					
☑ Cold Stress					
TTCS	THCS	DTCS	DHCS	TTCSA	THCSA
-10	-0.0001	0	0	0	0
☑ Heat Stress					
TTHS	THHS	DTHS	DHHS		
24	0.003	0	0		
☐ Dry Stress					
☐ Wet Stress					
☐ Cold-Dry Stress					
☐ Cold-Wet Stress					
☐ Hot-Dry Stress					
☐ Hot-Wet Stress					
Day-degree accumulation above DV0					
DV0	DV3	MTS			
0	24	7			
Day-degree accumulation above DVCS					
DVCS	*DV4	MTS			
8	100	7			
Day-degree accumulation above DVHS					
DVHS	*DV4	MTS			
24	100	7			
Degree-days per Generation					
PDD					
0					

2. Climatic prediction in the native range



The fitting parameters provide a distribution into North-America very close to the current distribution of the species (see appendix 2 for the distribution of the species in North America). The species is present in Alaska, and some localities are found in Northern California. The species could thrive in Eastern Canada but is not native to this area, most probably because it geographic distribution has been stopped by inappropriate climatic conditions in between Eastern and Western parts of North America.
This climatic prediction fits quite well with the Canadian prediction.

3. Distribution for the world



The fitting parameters show that few areas in the world have suitable climatic conditions. Among these are:

- the EPPO region (see detail below)k
- New Zealand and Tasmania
- Himalaya in China, India, Pakistan, Tazikistan, Afghanistan, Kyrgyzistan
- In South America:Northern Andes in Ecuador and Columbia, Cordillera oriental and Occidental in Peru, southern Andes in Chile
- In Japan (Northern part), Sakhaline Island, Sichot Alien (Russia), Kamchatcka (Russia). To be noted that this corresponds to *Lysichiton camtschatcensis'* distribution.

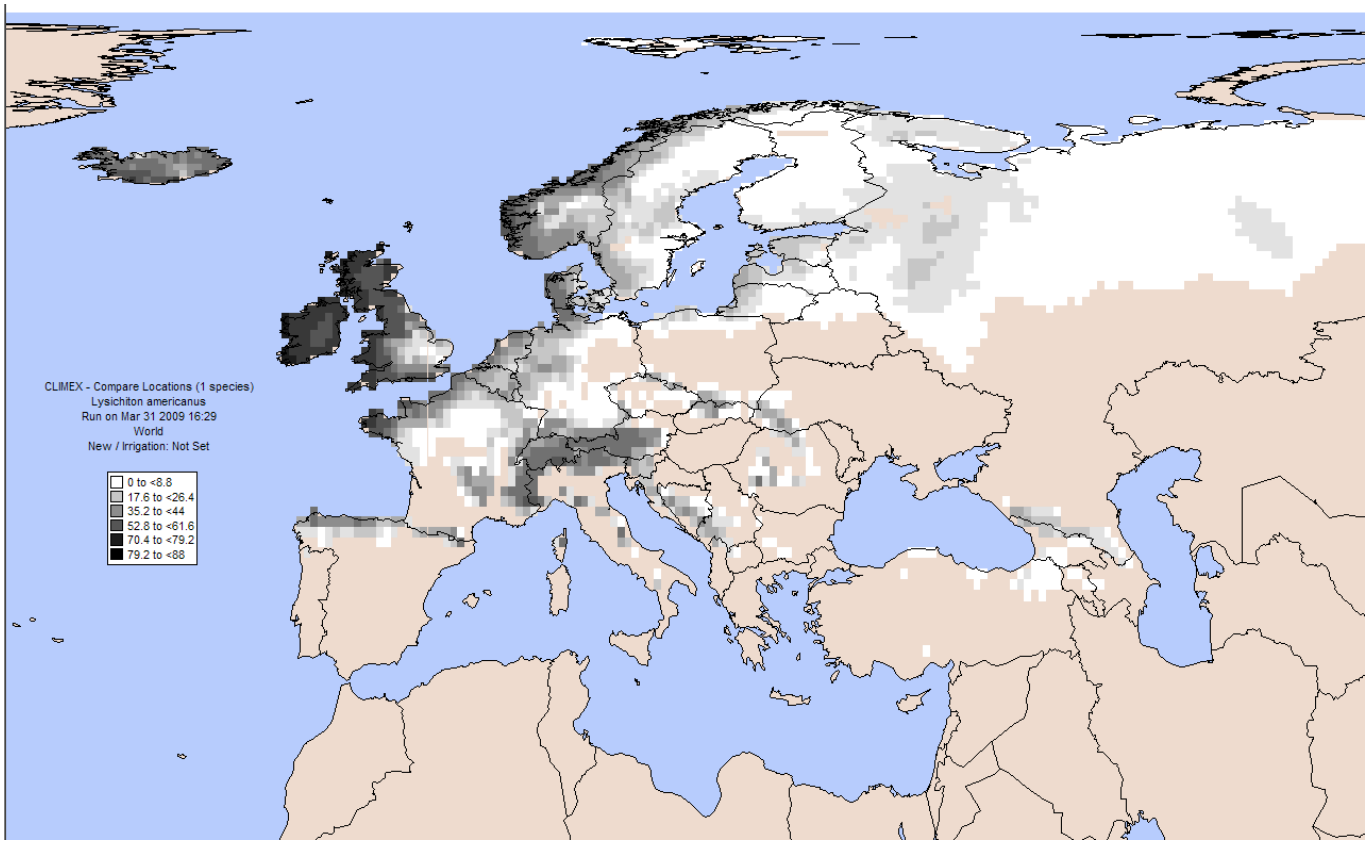
4. The EPPO region

The countries where the species is able to naturalize in the EPPO region are the following:
Austria, Azerbaijan, Belarus, Belgium, Bosnia & Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Great Britain, Ireland, Italy, Latvia, Lithuania, the Netherlands, Norway, Poland, Portugal, Republic of Macedonia, Romania, Russia, Serbia, Slovenia, Spain (North), Sweden, Switzerland, Turkey (east coast of the Black Sea), Ukraine.

Areas particularly at risk being are areas having an Atlantic influence (the UK, Ireland, Northern coast of Spain, Bretagne in France, the Netherlands, Denmark, Norway), and mountainous areas (the Massif

central in France, the Alpes, the Pyrenees, the Carpatian Mountains, Bolsoj Kavkaz in Georgia, Ural Mountains in Russia).

The Mediterranean area is not considered at risk as it is assumed to be too warm and too dry during summer.



References

Hickman J C eds (1993) *The Jepson Manual: Higher Plants of California.* University of California Press, Berkeley (US). http://books.google.co.uk/books?id=_sTR5_CQ-yAC&printsec=frontcover&dq=hickman,+1993,+lysichiton&source=gbs_summary_s&cad=0#PPA1104,M1
http://www.coe.int/t/dg4/cultureheritage/conventions/Bern/T-PVS/sc24_inf04_en.pdf

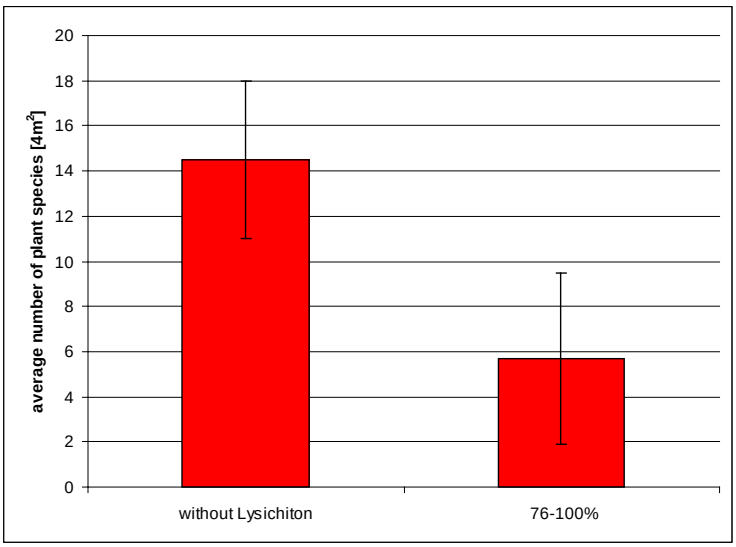
Natural Resources Canada Website
http://planthardiness.gc.ca/ph_gcm.pl?lang=fr&speciesid=1002124 Accessed in May 2009.

Appendix 4

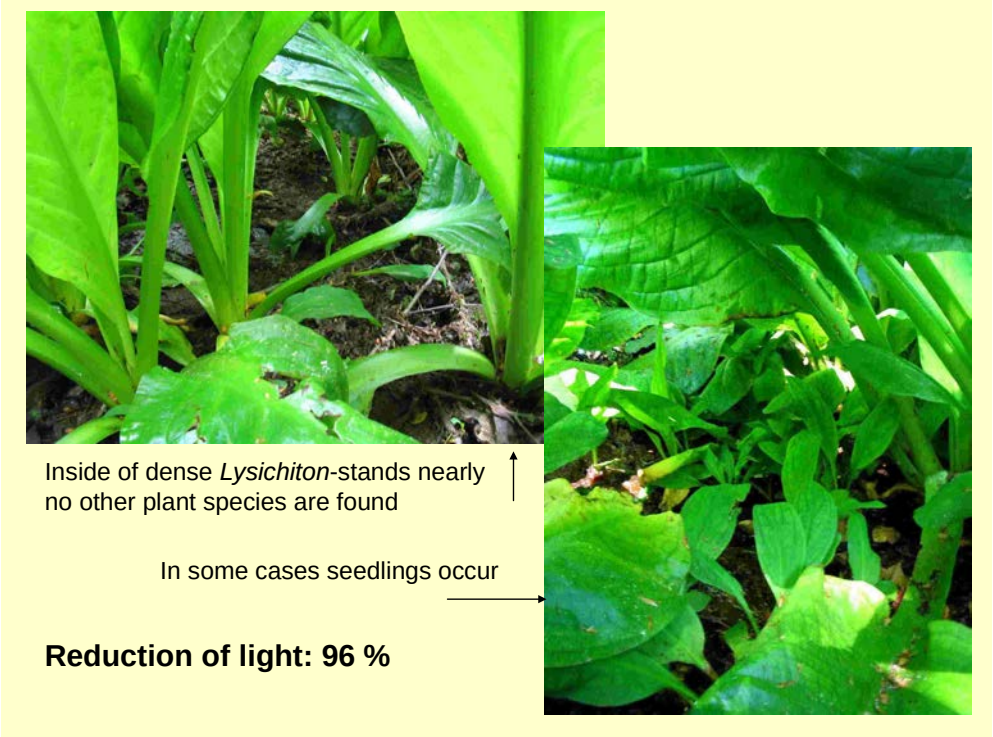
Impact of *Lysichiton americanus* in the Taunus

From B. Alberternst

1. Average number of species



Average number of plant species in relevées ($4m^2$) without occurrence of *Lysichiton americanus* (n=40) and with *Lysichiton americanus* covering an area of 76-100% (unpubl. Data Alberternst).
The number of plant species is significantly decreased in dense stands of *Lysichiton americanus*.



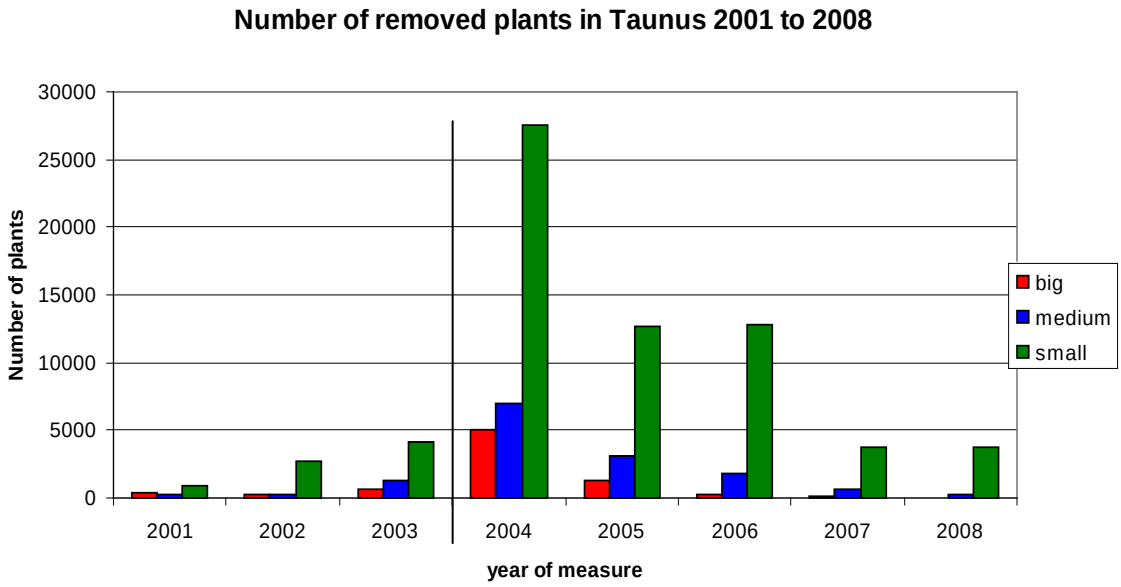
B. Alberternst

2. Endangered species

Endangered species and species which populations decrease at growing sites of *L. americanus* (Red List Mooses Germany, RL Farn- und Seedplants Hesse):

Sphagnum teres (RL D: 3)
S. subnitens (RL D: 3)
S. russowii (RL D: V)
S. inundatum (RL D: V)
*S. denticulatum (*RL D: V)
*S. capillifolium (*RL D: V)
S. flexuosum (RL D: V)
S. squarrosum (RL D: V)
*Hookeria lucens (*RL D: 3)
Leucobryum glaucum (RL D: V)
Metzgeria furcata (RL D: V)
Polytrichum commune (RL D: V)
Scapania nemorea (RL D: V)
Scapania undulata (RL D: V)
Carex canescens (RL He: 3)
Carex echinata (RL He: V)
Carex demissa (RL (NW) He: V)
Dactylorhiza majalis (RL He: 3)
Dactylorhiza maculata (RL He: 3)
Epilobium palustre (RL He: V)
Menyanthes trifoliata (RL He: 3)
Valeriana dioica (RL He: V)
Viola palustris (RL He: V)

1.Removal of *Lysichiton americanus* in the Taunus



Test of appropriate measures

Digging up the plants in the whole area

Small: < 40 cm **medium: 40-80 cm** **big: >80 cm leaf length**

Appendix 5

Pictures of stands of *Lysichiton americanus* in the Taunus

Regeneration of *L. americanus.* Picture: B. Alberternst

Lysichiton americanus at Robinienrondell, 2004-06-02. Picture: B. Alberternst